Headquarters Expansion
Construction Documents

South Llano River State Park
Texas Parks & Wildlife Department
SECTION 00 0105
CERTIFICATIONS PAGE

OWNER: TEXAS PARKS AND WILDLIFE DEPARTMENT
4200 SMITH SCHOOL ROAD,
(512) 389-8299 OFFICE
(512) 389-4400 FAX

ARCHITECT:
FORD, POWELL & CARSON, ARCHITECTS AND PLANNERS, INC.
CAROLYN PETERSON, FAIA
1138 EAST COMMERCE STREET
SAN ANTONIO, TEXAS 78205
(210) 226-1246 PHONE
(210) 226-6482 FAX

STRUCTURAL ENGINEER:
ARCHITECTURAL ENGINEERS COLLABORATIVE, LLC.
KARINA TRIBBLE, PE
3800 N. LAMAR BLVD., SUITE 330
AUSTIN, TEXAS 78756
(512) 472-2111 PHONE

MEP ENGINEER:
CLEARY ZIMMERMAN ENGINEERS, LLC
THOMAS WATSON, PE.
1344 S. FLORES, SUITE 200
SAN ANTONIO, TEXAS 78204
(210) 447-6100 OFFICE
(210) 447-6101 FAX

CIVIL ENGINEER:
GARZA EMC.
JULIA MRNAK, P.E.
7708 RIALTO BLVD., SUITE 125
AUSTIN, TEXAS 78735
(512) 298-3284 OFFICE
(512) 298-2592 FAX
LANDSCAPE ARCHITECT:
CFZ GROUP, LLC
LETICIA ZAVALA, ASLA
7410 JOHN SMITH DRIVE, SUITE 208
SAN ANTONIO, TEXAS 78229
(210) 366-1911 OFFICE

CODE:
PROTECTION DEVELOPMENT, INCORPORATED - PDI
DAVID R. ELMER
8620 N. NEW BRAUNFELS AVE. SUITE 100
SAN ANTONIO, TEXAS 78217-6361
(210) 828.7533 OFFICE

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STATE OF TEXAS

04/09/2021

[Signature]

JULIA L. MRNAK
LICENSED PROFESSIONAL ENGINEER

CONSTRUCTION DOCUMENTS
04.09.2021

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PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.01 SUMMARY
   A. This Section includes administrative and procedural requirements for the following:
      1. Preconstruction photographs.
      2. Periodic construction photographs.
      3. Final Completion construction photographs.
   B. Photographic documentation is a significant part of the record of the project work.

1.02 REFERENCE STANDARDS
   A. Photography Guildlines (HABS/HAER/HALS) - National Park Service

1.03 PERFORMANCE REQUIREMENTS
   A. Photographs should clearly depict the appearance of the building or building element.
      Photographs that are blurry, out-of-focus, underexposed, overexposed, or pixilated will not be accepted.
   B. Minimum photographic requirements: Provide images in uncompressed .JPG format, produced by a digital camera, with resolution of at least 300 pixels per inch with an image size of at least 1600 x 1200 pixels.
   C. Photographs should be taken from the same locations, and general viewpoint.

1.04 SUBMITTALS
   A. Key Plan: Submit an annotated key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same label information as corresponding set of photographs.
   B. Photographic Index:
      1. With the key plan, provide a written description of each image, including:
         a. A header indicating the Building name (if applicable) and address.
         b. Photograph file name.
         c. View Shown (eg. north side) and numbered (1,2,3)
         d. Description of the view (eg. plaster damage in dining room, north wall). Indicate location, general direction (by compass point) and elevation or story of construction.
         e. Date photograph was taken.
   C. Construction Photographs: Submit one PDF document monthly as a submittal, including each photographic view of taken photographs since the previous submission.
      1. Identification: On the PDF cover sheet, provide the following information:
         a. Name of Project and Project Number.
         b. Name of Architect.
         c. Name of Contractor.
         d. Date photographs were taken.
         e. Include both Key Plan and Photographic Index.
         f. Include one image per 8.5" x11" pdf sheet.
   D. Digital Images: At Project close-out, submit a complete set of digital electronic image files as a Project Record Document on CD-ROM or USB flashdrive.
      1. Identification: On the label side of CD-ROM or USB flashdrive, provide an applied label with the following information:
         a. Name of Project and Project Number.
         b. Name of Architect.
         c. Name of Contractor.
         d. Include both Key Plan and Photographic Index as digital files on the CD-ROM or USB flashdrive.
      2. Submit two (2) copies (1- duplicate set) of all photos on CD-ROM or USB flashdrive.
PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 CONSTRUCTION PHOTOGRAPHS

A. Maintain key plan with each set of photographs that identifies each photographic location.
   1. Before, During, and After images of the project work shall be from the same locations to clearly illustrate work as it progresses.
   2. Additional views may be added during construction, as necessary to document the work.
   3. Establish markers at locations of photographs viewpoint, identified by a 6"x6" paper sign with a 4" tall number, laminated for weather protection.
   4. Marker location should be selected to not be an obstruction or hinder construction.
   5. Markers should be securely mounted at their locations through the duration of the construction progress.

B. Date and Time: Include date and time in filename for each image.

C. Preconstruction Photographs:
   1. Submit photographs showing all existing conditions of the building immediately prior to any construction work.
   2. Include photographs of the building's site and environment, all of the building's sides, all major interior spaces and features, and representative secondary spaces and features.
   3. Submit Preconstruction Photographs to Architect for approval prior to any construction activities. Allow seven business days for review before commencing construction activities.

D. Periodic Construction Photographs: Take periodic digital photographs during the course of demolition and construction weekly.
   1. Every week, provide images at all vantage points used for the Preconstruction Photographs. Submit monthly.
   2. Select additional vantage points to show status of construction and progress since last photographs were taken.

E. Final Completion Construction Photographs:
   1. Provide images at all vantage points used for the Preconstruction Photographs and Periodic Construction Photographs.
   2. Select additional vantage points as necessary to show all completed work

END OF SECTION
PART 1 GENERAL

1.01 SUMMARY
   A. This Section includes administrative and procedural requirements for the following:
      1. Salvaging nonhazardous construction waste.
      2. Recycling nonhazardous construction waste.
      3. Disposing of nonhazardous construction waste.

1.02 WASTE MANAGEMENT REQUIREMENTS
   A. Owner requires that this project generate the least amount of trash and waste possible. Divert a minimum of 75% by weight of construction and demolition debris from disposal in landfills and incinerators.
   B. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.
   C. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.
   D. RECYCLE DAY IS EVERY WEDNESDAY IN JUNCTION, TX. VERIFY CONSTRUCTION WASTE CAN BE HAULED TO THE CITY HALL. VERIFY WHAT MATERIALS CAN BE RECYCLED.
   E. Required Recycling, Salvage, and Reuse: The following may not be disposed of in landfills or by incineration:
      1. Aluminum and plastic beverage containers.
      2. Corrugated cardboard.
      3. Wood pallets.
      4. Clean dimensional wood.
      5. Land clearing debris, including brush, branches, logs, and stumps.
      6. Concrete.<>
      7. Metals, including packaging banding, metal studs, sheet metal, structural steel, piping, reinforcing bars, door frames, and other items made of steel, iron, galvanized steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze.
      8. Glass.
      9. Gypsum drywall and plaster.
     11. Paint.
   F. Contractor shall:
      1. Develop, coordinate, and follow a Waste Management Plan designed to implement these requirements.
      2. Provide and pay all costs for labeled containers for receipt of recyclable materials and for disposal of recyclable material.
      3. Monthly log construction and demolition materials diverted from landfill and either reused on-site or sent to an approved recycling facility. An approved recycling facility is a facility that can legally accept construction and demolition waste for the purpose of processing the materials into an altered form for the manufacture or a new product.
   G. The following sources may be useful in developing the Waste Management Plan:
      1. State Recycling Department, at Texas Facilities Commission.
   H. Methods of trash/waste disposal that are not acceptable are:
      1. Burning on the project site.
      2. Burying on the project site.
      3. Dumping or burying on other property, public or private.
      4. Other illegal dumping or burying.
I. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

1.03 RELATED REQUIREMENTS
   A. NOTE: THIS SECTION IS INTENDED TO SUPPLEMENT THE OWNER'S GENERAL CONDITIONS AND SPECIAL CONDITIONS. FOR ANY INFORMATION IN CONFLICT, THE OWNER'S CONDITIONS SUPERCEDES INFORMATION FOUND IN THIS SECTION

1.04 DEFINITIONS
   A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.
   B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.
   C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
   D. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.
   E. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.
   F. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.
   G. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.
   H. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.
   I. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.
   J. Return: To give back reusable items or unused products to vendors for credit.
   K. Reuse: To reuse a construction waste material in some manner on the project site.
   L. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.
   M. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.
   N. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.
   O. Toxic: Poisonous to humans either immediately or after a long period of exposure.
   P. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.
   Q. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.05 SUBMITTALS
   A. Refer to Owner's Uniform General Conditions and Special Conditions, for submittal procedures.
   B. Submit Waste Management Plan within 21 calendar days after receipt of Notice of Award of Bid, or prior to any trash or waste removal, whichever occurs sooner; submit projection of all trash and waste that will require disposal and alternatives to landfilling.
   C. Waste Management Plan: Include the following information:
      1. Analysis of the trash and waste projected to be generated during the entire project construction cycle, including types and quantities.
2. Landfill Options: The name, address, and telephone number of the landfill(s) where trash/waste will be disposed of, the applicable landfill tipping fee(s), and the projected cost of disposing of all project trash/waste in the landfill(s).
3. Landfill Alternatives: List all waste materials that will be diverted from landfills by reuse, salvage, or recycling.
4. Meetings: Describe regular meetings to be held to address waste prevention, reduction, recycling, salvage, reuse, and disposal.
5. Materials Handling Procedures: Describe the means by which materials to be diverted from landfills will be protected from contamination and prepared for acceptance by designated facilities; include separation procedures for recyclables, storage, and packaging.
6. Transportation: Identify the destination and means of transportation of materials to be recycled; i.e. whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler.

D. Waste Disposal Reports: Submit at specified intervals, with details of quantities of trash and waste, means of disposal or reuse, and costs; show both totals to date and since last report.
   1. Submit updated Report with each Application for Progress Payment; failure to submit Report will delay payment.
   2. Submit Report on a form acceptable to Owner.
   3. Landfill Disposal: Include the following information:
      a. Identification of material.
      b. Amount, in tons or cubic yards (cubic meters), of trash/waste material from the project disposed of in landfills.
      c. State the identity of landfills, total amount of tipping fees paid to landfill, and total disposal cost.
      d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
   4. Incinerator Disposal: Include the following information:
      a. Identification of material.
      b. Amount, in tons or cubic yards (cubic meters), of trash/waste material from the project delivered to incinerators.
      c. State the identity of incinerators, total amount of fees paid to incinerator, and total disposal cost.
      d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
   5. Recycled and Salvaged Materials: Include the following information for each:
      a. Identification of material, including those retrieved by installer for use on other projects.
      b. Amount, in tons or cubic yards (cubic meters), date removed from the project site, and receiving party.
      c. Transportation cost, amount paid or received for the material, and the net total cost or savings of salvage or recycling each material.
      d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
      e. Certification by receiving party that materials will not be disposed of in landfills or by incineration.
   6. Material Reused on Project: Include the following information for each:
      a. Identification of material and how it was used in the project.
      b. Amount, in tons or cubic yards (cubic meters).
      c. Include weight tickets as evidence of quantity.
   7. Other Disposal Methods: Include information similar to that described above, as appropriate to disposal method.

1.06 QUALITY ASSURANCE
   A. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
PART 2  EXECUTION

2.01  WASTE MANAGEMENT PLAN IMPLEMENTATION

A. General: Implement waste management plan as approved by Architect and Owner. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

B. Waste Management Coordinator: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan. Coordinator shall be present at Project site full time for duration of Project.

C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.

D. Communication: Distribute copies of the Waste Management Plan to job site foreman, each subcontractor, Owner, and Architect.

E. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.

F. Meetings: Discuss trash/waste management goals and issues at project meetings.
   1. Prebid meeting.
   2. Preconstruction meeting.
   3. Regular job-site meetings.

G. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.
   1. Provide containers as required.
   2. Provide adequate space for pick-up and delivery and convenience to subcontractors.
   3. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.

H. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

I. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.

J. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.

K. Reuse of Materials On-Site: Set aside, sort, and protect separated products in preparation for reuse.

L. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

2.02  RECYCLING CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.

B. Use recycling receivers and processors for the following:
   1. Landclearing: Landclearing debris includes stumps, trees, and brush, primarily processed into a mulch or compost base.
   2. Dimensional Wood: Keep wood clean and site separated.
   3. Concrete
   4. Metals
   5. Gypsum
   6. Used Building Materials
   7. Paper
   8. Old Corrugate Cardboard
   9. Plastic
C. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.

D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical.
   1. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
      a. Inspect containers and bins for contamination and remove contaminated materials if found.
   2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
   4. Store components off the ground and protect from the weather.
   5. Remove recyclable waste off Owner's property and transport to recycling receiver or processor.

2.03 DISPOSAL OF WASTE
A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
   1. Except as otherwise specified, do not allow waste materials that are to be disposed of to accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Disposal: Transport waste materials off Owner's property and legally dispose of them.

END OF SECTION
SECTION 031000

CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Form-facing material for cast-in-place concrete.
   2. Form liners.
   3. Insulating concrete forms.
   4. Shoring, bracing, and anchoring.

B. Related Requirements:
   1. Section 321313 "Concrete Paving" for formwork related to concrete pavement and walks.
   2. Section 321316 "Decorative Concrete Paving" for formwork related to decorative concrete pavement and walks.

1.3 DEFINITIONS

A. Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.

B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review the following:
      a. Special inspection and testing and inspecting agency procedures for field quality control.
      b. Construction, movement, contraction, and isolation joints
      c. Forms and form-removal limitations.
      d. Shoring and reshoring procedures.
      e. Anchor rod and anchorage device installation tolerances.
1.5 ACTION SUBMITTALS

A. Product Data: For each of the following:
   1. Exposed surface form-facing material.
   2. Concealed surface form-facing material.
   3. Forms for cylindrical columns.
   4. Pan-type forms.
   5. Void forms.
   6. Form liners.
   7. Insulating concrete forms.
   8. Form ties.
  10. Form-release agent.

B. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.
   1. For exposed vertical concrete walls, indicate dimensions and form tie locations.
   2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.
      a. Location of construction joints is subject to approval of the Architect.
   3. Indicate location of waterstops.
   4. Indicate form liner layout and form line termination details.
   5. Indicate proposed schedule and sequence of stripping of forms, shoring removal, and restoshing installation and removal.
   6. Indicate layout of insulating concrete forms, dimensions, course heights, form types, and details.

C. Samples:
   1. For waterstops.
   2. For Form Liners: 12-inch by 12-inch sample, indicating texture.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing and inspection agency.


C. Field quality-control reports.

D. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

A. Testing and Inspection Agency Qualifications: An independent agency, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
B. **Mockups:** Formed surfaces to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship.

   1. Build panel approximately 100 sq. ft. in the location indicated or, if not indicated, as directed by Architect.
   2. Subject to compliance with requirements, approved mockups may become part of the completed Work.

1.8 **DELIVERY, STORAGE, AND HANDLING**

   A. **Form Liners:** Store form liners under cover to protect from sunlight.
   
   B. **Insulating Concrete Forms:** Store forms off ground and under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.
   
   C. **Waterstops:** Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

**PART 2 - PRODUCTS**

2.1 **PERFORMANCE REQUIREMENTS**

   A. **Concrete Formwork:** Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

   1. Design wood panel forms in accordance with APA’s "Concrete Forming Design/Construction Guide."
   2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

      a. For architectural concrete specified in Section 033300 "Architectural Concrete," limit deflection of form-facing material, studs, and walers to 0.0025 times their respective clear spans (L/400).

2.2 **FORM-FACING MATERIALS**

   A. **As-Cast Surface Form-Facing Material:**

   1. Provide continuous, true, and smooth concrete surfaces.
   2. Furnish in largest practicable sizes to minimize number of joints.
   3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete," and as follows:

      a. Plywood, metal, or other approved panel materials.
      b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

         1) APA HDO (high-density overlay).
2) APA MDO (medium-density overlay); mill-release agent treated and edge sealed.
3) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.
4) APA Plyform Class I, B-B or better; mill oiled and edge sealed.

B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.
   1. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces without spiral or vertical seams not exceeding specified formwork surface class.
   1. Provide forms with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

2.3 WATERSTOPS

A. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Henry Company.
      b. Sika Corporation.

B. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer-modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Kryton International Inc.
      b. Sika Corporation.

2.4 RELATED MATERIALS

A. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.


D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
   2. Form release agent for form liners shall be acceptable to form liner manufacturer.

F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
   1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
   2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
   3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with ACI 301.

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes.

C. Limit concrete surface irregularities as follows:
   1. Surface Finish-1.0: ACI 117 Class D, 1 inch.
   2. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.

D. Construct forms tight enough to prevent loss of concrete mortar.
   1. Minimize joints.
   2. Exposed Concrete: Symmetrically align joints in forms.

E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.
   1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
   2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
   3. Install keyways, reglets, recesses, and other accessories, for easy removal.

F. Do not use rust-stained, steel, form-facing material.

G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.
   1. Provide and secure units to support screed strips
   2. Use strike-off templates or compacting-type screeds.
H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.
   1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
   2. Locate temporary openings in forms at inconspicuous locations.

I. Chamfer exterior corners and edges of permanently exposed concrete.

J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.

K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.
   1. Determine sizes and locations from trades providing such items.
   2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.

L. Construction and Movement Joints:
   1. Construct joints true to line with faces perpendicular to surface plane of concrete.
   2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
   3. Place joints perpendicular to main reinforcement.
   4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.
      a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
   5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
   6. Space vertical joints in walls at 30'-0" o.c. or as indicated on Drawings.
      a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.
   1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
   2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

P. Coat contact surfaces of forms with form-release agent, according to manufacturer’s written instructions, before placing reinforcement.
3.2 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
4. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
5. Clean embedded items immediately prior to concrete placement.

3.3 INSTALLATION OF WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm.

1. Install in longest lengths practicable.
2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
3. Allow clearance between waterstop and reinforcing steel of not less than 2 times the largest concrete aggregate size specified in Section 033000 "Cast-In-Place Concrete."
4. Secure waterstops in correct position at 12 inches on center.
5. Field fabricate joints in accordance with manufacturer's instructions using heat welding.
   a. Miter corners, intersections, and directional changes in waterstops.
   b. Align center bulbs.
6. Clean waterstops immediately prior to placement of concrete.
7. Support and protect exposed waterstops during progress of the Work.

B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated on Drawings, according to manufacturer's written instructions, by adhesive bonding, mechanically fastening, and firmly pressing into place.

1. Install in longest lengths practicable.
2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
3. Protect exposed waterstops during progress of the Work.

3.4 INSTALLATION OF INSULATING CONCRETE FORMS

A. Comply with ACI 301 and manufacturer's instructions.

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Install forms in running bond pattern.

1. Align joints.
2. Align furring strips.
D. Construct forms tight to prevent loss of concrete mortar.

E. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.
   1. Determine sizes and locations from trades providing such items.
   2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.

F. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.
   1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
   2. Close temporary ports and openings with tight fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

G. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

H. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

I. Shore insulating concrete forms to ensure stability and to resist stressing imposed by construction loads.

3.5 REMOVING AND REUSING FORMS

A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.
   1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
   2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work.
   1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.
   1. Align and secure joints to avoid offsets.
   2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.6 SHORING AND RESHORING INSTALLATION

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.
1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.7 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.
2. Inspect insulating concrete forms for shape, location, and dimensions of the concrete member being formed.

END OF SECTION 03 1000
SECTION 03 2000
CONCRETE REINFORCING

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 reinforcement bars.
   2. Welded-wire reinforcement.

B. Related Requirements:
   1. Section 033816 "Unbonded Post-Tensioned Concrete" for reinforcing related to post-
      tensioned concrete.
   2. Section 034100 "Precast Structural Concrete" for reinforcing used in precast structural
      concrete.
   3. Section 034500 "Precast Architectural Concrete" for reinforcing used in precast
      architectural concrete.
   4. Section 321313 "Concrete Paving" for reinforcing related to concrete pavement and walks.
   5. Section 321316 "Decorative Concrete Paving" for reinforcing related to decorative
      concrete pavement and walks.

1.3 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site.
   1. Review the following:
      a. Special inspection and testing and inspecting agency procedures for field quality
         control.
      b. Construction contraction and isolation joints.
      c. Steel-reinforcement installation.

1.4 ACTION SUBMITTALS
A. Product Data: For the following:
   1. Each type of steel reinforcement.
   2. Epoxy repair coating.
   3. Zinc repair material.
4. Bar supports.

B. Shop Drawings: Comply with ACI SP-066:
   1. Include placing drawings that detail fabrication, bending, and placement.
   2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.

C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.
   1. Location of construction joints is subject to approval of the Architect.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For testing and inspection agency.

B. Material Certificates: For each of the following, signed by manufacturers:
   1. Epoxy-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."
   2. Dual-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."

C. Material Test Reports: For the following, from a qualified testing agency:
   1. Steel Reinforcement:
      a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.
   2. Mechanical splice couplers.

D. Field quality-control reports.

E. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage, and to avoid damaging coatings on steel reinforcement.
   1. Store reinforcement to avoid contact with earth.
   2. Do not allow epoxy-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
   3. Do not allow dual-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
4. Do not allow stainless steel reinforcement to come into contact with uncoated reinforcement.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

B. Low-Alloy Steel Reinforcing Bars: ASTM A706/A706M, deformed.

C. Headed-Steel Reinforcing Bars: ASTM A970/A970M.

D. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.


2.2 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Epoxy-Coated Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, ASTM A775/A775M epoxy coated.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

   a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

   b. For epoxy-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.

   c. For dual-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.

   d. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

   e. For stainless steel reinforcement, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

D. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.

1. Finish: Plain.
2.3 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:
   1. Do not cut or puncture vapor retarder.
   2. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

B. Accurately position, support, and secure reinforcement against displacement.
   1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
   2. Do not tack weld crossing reinforcing bars.

C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

D. Provide concrete coverage in accordance with ACI 318.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Splices: Lap splices as indicated on Drawings.
   1. Bars indicated to be continuous, and all vertical bars shall be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
   2. Stagger splices in accordance with ACI 318.
   3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.

G. Install welded-wire reinforcement in longest practicable lengths.
      a. For reinforcement less than W4.0 or D4.0, continuous support spacing shall not exceed 12 inches.
   2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire and 8 inches for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

3.3 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
   1. Place joints perpendicular to main reinforcement.
   2. Continue reinforcement across construction joints unless otherwise indicated.
   3. Do not continue reinforcement through sides of strip placements of floors and slabs.

B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

A. Comply with ACI 117.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:
   1. Steel-reinforcement placement.

D. Manufacturer's Inspections: Engage manufacturer of structural thermal break insulated connection system to inspect completed installations prior to placement of concrete, and to provide written report that installation complies with manufacturer's written instructions.

END OF SECTION 03 2000
SECTION 03 3000
CAST-IN-PLACE CONCRETE

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. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
3. Section 033300 "Architectural Concrete" for general building applications of specially finished formed concrete.
4. Section 033543 "Polished Concrete Finishing" for concrete floors scheduled to receive a polished concrete finish.
5. Section 035300 "Concrete Topping" for emery- and iron-aggregate concrete floor toppings.
6. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.
7. Section 321313 "Concrete Paving" for concrete pavement and walks.
8. Section 321316 "Decorative Concrete Paving" for decorative concrete pavement and walks.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Require representatives of each entity directly concerned with cast-in-place concrete 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 Subcontractor.
e. Special concrete finish Subcontractor.

2. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction joints, control joints, isolation joints, and joint-filler strips.
c. Semirigid joint fillers.
d. Vapor-retarder installation.
e. Anchor rod and anchorage device installation tolerances.
f. Cold and hot weather concreting procedures.
g. Concrete finishes and finishing.
h. Curing procedures.
i. Forms and form-removal limitations.
j. Shoring and reshoring procedures.
k. Methods for achieving specified floor and slab flatness and levelness.
l. Floor and slab flatness and levelness measurements.
m. Concrete repair procedures.
n. Concrete protection.
o. Initial curing and field curing of field test cylinders (ASTM C31/C31M.)
p. Protection of field cured field test cylinders.

1.5 ACTION SUBMITTALS

A. Product Data: For each of the following.

1. Portland cement.
2. Fly ash.
3. Slag cement.
5. Silica fume.
6. Performance-based hydraulic cement
7. Aggregates.
8. Admixtures:
   a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
10. Fiber reinforcement.
11. Vapor retarders.
12. Floor and slab treatments.
13. Liquid floor treatments.
   a. Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.
15. Joint fillers.

B. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Calculated equilibrium unit weight, for lightweight concrete.
7. Air content.
8. Nominal maximum aggregate size.
9. Steel-fiber reinforcement content.
10. Synthetic micro-fiber content.
11. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
12. Include manufacturer's certification that permeability-reducing admixture is compatible with mix design.
13. Include certification that dosage rate for permeability-reducing admixture matches dosage rate used in performance compliance test.
15. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
   a. Location of construction joints is subject to approval of the Architect.

D. Samples: For manufacturer's standard colors for color pigment.

E. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.
3. Testing agency: Include copies of applicable ACI certificates.

B. Material Certificates: For each of the following, signed by manufacturers:
1. Cementitious materials.
2. Admixtures.
3. Fiber reinforcement.
4. Curing compounds.
5. Floor and slab treatments.
7. Adhesives.
8. Vapor retarders.

C. Material Test Reports: For the following, from a qualified testing agency:
   1. Portland cement.
   2. Fly ash.
   3. Slag cement.
   5. Silica fume.
   7. Aggregates.
   8. Admixtures:
      a. Permeability-Reducing Admixture: Include independent test reports, indicating compliance with specified requirements, including dosage rate used in test.

D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.

E. Research Reports:
   1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
   2. For sheet vapor retarder/termite barrier, showing compliance with ICC AC380.

F. Preconstruction Test Reports: For each mix design.

G. Field quality-control reports.

H. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician with experience installing and finishing concrete, incorporating permeability-reducing admixtures.
   1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.

1. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

D. Field Quality Control Testing Agency Qualifications: An independent agency, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests shall be qualified as an ACI Concrete Field Testing Technician, Grade I, in accordance with ACI CPP 610.1 or an equivalent certification program.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.

1. Include the following information in each test report:

   a. Admixture dosage rates.
   b. Slump.
   c. Air content.
   d. Seven-day compressive strength.
   e. 28-day compressive strength.
   f. Permeability.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301.

1.10 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.
5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:
   1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.
   2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

1.11 WARRANTY
   A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.
      1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL
   A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS
   A. Source Limitations:
      1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
      2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
      3. Obtain aggregate from single source.
      4. Obtain each type of admixture from single source from single manufacturer.
   B. Cementitious Materials:
      2. Fly Ash: ASTM C618, Class C or F.
   C. Normal-Weight Aggregates: ASTM C33/C33M, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.
      1. Alkali-Silica Reaction: Comply with one of the following:
         a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.

c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. for moderately reactive aggregate or 3 lb./cu. yd. for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301.


D. Air-Entraining Admixture: ASTM C260/C260M.

E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.


2.3 VAPORETARDERS

A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A; not less than 15 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Raven Industries, Inc.
   b. Stego Industries, LLC.

2.4 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. BASF Corporation.
   b. Dayton Superior.
   c. Sika Corporation.
   d. W.R. Meadows, Inc.
B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

   1. Color:
      a. Ambient Temperature Below 50 deg F: Black.
      b. Ambient Temperature between 50 deg F and 85 deg F: Any color.
      c. Ambient Temperature Above 85 deg F: White.

D. Water: Potable or complying with ASTM C1602/C1602M.

E. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Dayton Superior.
      b. Euclid Chemical Company (The); an RPM company.
      c. W.R. Meadows, Inc.

F. Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B, certified by curing compound manufacturer to not interfere with bonding of floor covering.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Dayton Superior.
      b. Euclid Chemical Company (The); an RPM company.
      c. W.R. Meadows, Inc.

G. Clear, Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Dayton Superior.
      b. Euclid Chemical Company (The); an RPM company.
      c. W.R. Meadows, Inc.

H. Clear, Solvent-Borne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Dayton Superior.
      b. Euclid Chemical Company (The); an RPM company.
      c. W.R. Meadows, Inc.
I. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Dayton Superior.
   b. Euclid Chemical Company (The); an RPM company.
   c. W.R. Meadows, Inc.

2.5 RELATED MATERIALS


B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 in accordance with ASTM D2240.

C. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:

   1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.6 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

   1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
   2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
   3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand, as recommended by underlayment manufacturer.
   4. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109/C109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

   1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
   2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
   3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109/C109M.

2.7 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.

1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Other Pozzolans: 25 percent by mass.
2. Slag Cement: 50 percent by mass.
3. Silica Fume: 10 percent by mass.
4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing, or plasticizing 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.
3. Use water-reducing admixture in pumped concrete, and concrete with a w/cm below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
5. Use permeability-reducing admixture in concrete mixtures where indicated.

D. Color Pigment: Add color pigment to concrete mixture in accordance with manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.8 CONCRETE MIXTURES

A. Class A: Normal-weight concrete used for footings, grade beams, slab on grade, and slab on metal deck.

1. Minimum Compressive Strength: per Contract Drawings
2. Maximum w/cm: 0.45.

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M, and furnish batch ticket information.
B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:

1. Daily access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
3.4 INSTALLATION OF VAPOR RETARDER

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.
   1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
   2. Face laps away from exposed direction of concrete pour.
   3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
   4. Lap joints 6 inches and seal with manufacturer's recommended tape.
   5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
   6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
   7. Protect vapor retarder during placement of reinforcement and concrete.
      a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

3.5 JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.
   1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
   2. Place joints perpendicular to main reinforcement.
      a. Continue reinforcement across construction joints unless otherwise indicated.
      b. Do not continue reinforcement through sides of strip placements of floors and slabs.
   3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
   4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
   5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
   6. Space vertical joints in walls at 30'-0" on center maximum. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
   7. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   8. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.

2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 079200 “Joint Sealants,” are indicated.

3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints:

1. Install dowel bars and support assemblies at joints where indicated on Drawings.

2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

F. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.

1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.

2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

1. If a section cannot be placed continuously, provide construction joints as indicated.
2. Deposit concrete to avoid segregation.
3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.

   a. Do not use vibrators to transport concrete inside forms.
   b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
   c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
   d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Do not place concrete floors and slabs in a checkerboard sequence.
2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.7 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
   a. Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
   b. Remove projections larger than 1 inch.
   c. Tie holes do not require patching.
   d. Surface Tolerance: ACI 117 Class D.
   e. Apply to concrete surfaces not exposed to public view.

2. ACI 301 Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
   a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
   b. Remove projections larger than 1/4 inch.
   c. Patch tie holes.
   d. Surface Tolerance: ACI 117 Class B.
   e. Locations: Apply to concrete surfaces to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.
3. **ACI 301 Surface Finish SF-3.0:**
   a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
   b. Remove projections larger than 1/8 inch.
   c. Patch tie holes.
   d. Surface Tolerance: ACI 117 Class A.
   e. Locations: Apply to concrete surfaces exposed to public view.

B. **Rubbed Finish:** Apply the following to as cast surface finishes where indicated on Drawings:

1. **Smooth-Rubbed Finish:**
   a. Perform no later than one day after form removal.
   b. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.
   c. If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.
   d. Maintain required patterns or variances as shown on Drawings or to match field sample panels.

2. **Grout-Cleaned Rubbed Finish:**
   a. Clean concrete surfaces after contiguous surfaces are completed and accessible.
   b. Do not clean concrete surfaces as Work progresses.
   c. Mix 1 part portland cement to 1-1/2 parts fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
   d. Wet concrete surfaces.
   e. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap, and keep surface damp by fog spray for at least 36 hours.
   f. Maintain required patterns or variances as shown on Drawings or to match field sample panels.

3. **Cork-Float Finish:**
   a. Mix 1 part portland cement to 1 part fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint.
   b. Mix 1 part portland cement and 1 part fine sand with sufficient water to produce a mixture of stiff grout. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
   c. Wet concrete surfaces.
   d. Compress grout into voids by grinding surface.
   e. In a swirling motion, finish surface with a cork float.
   f. Maintain required patterns or variances as shown on Drawings or to match field sample panels.

4. **Scrubbed Finish:** After concrete has achieved a compressive strength of from 1000 to 1500 psi, apply scrubbed finish.
   a. Wet concrete surfaces thoroughly and scrub with stiff fiber or wire brushes, using water freely, until top mortar surface is removed and aggregate is uniformly exposed.
b. Rinse scrubbed surfaces with clean water.
c. Maintain continuity of finish on each surface or area of Work.
d. Remove only enough concrete mortar from surfaces to match field sample panels.

C. Abrasive-Blast Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

2. Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at the same age.
3. Surface Continuity:
   a. Perform abrasive-blast finishing as continuous operation, maintaining continuity of finish on each surface or area of Work.
   b. Maintain required patterns or variances in depths of blast to match field sample panels.

4. Abrasive Blasting:
   a. Abrasive-blast corners and edges of patterns carefully, using backup boards to maintain uniform corner and edge lines.
   b. Determine type of nozzle pressure and blasting techniques required to match field sample.
   c. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match field sample, as follows:
      1) Brush Texture: Remove cement matrix to dull surface sheen and expose face of fine aggregate, with no significant reveal.
      2) Light Texture: Expose fine aggregate with occasional exposure of coarse aggregate and uniform color, with maximum reveal of 1/16 inch.
      3) Medium Texture: Generally, expose coarse aggregate with slight reveal and with a maximum reveal of 1/4 inch.
      4) Heavy Texture: Expose and reveal coarse aggregate to a maximum projection of one-third its diameter, with reveal range of 1/4 to 1/2 inch.
   d. Maintain required patterns or variances in reveal projection to match field sample panels.

D. High-Pressure Water-Jet Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

1. Perform high-pressure water jetting on concrete that has achieved a minimum compressive strength of 4500 psi.
2. Coordinate with formwork removal to ensure that surfaces to be high-pressure water-jet finished are treated at same age for uniform results.
3. Surface Continuity: Perform high-pressure water-jet finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work.
4. Maintain required patterns or variances in reveal projection to match field sample panels.

E. Bushhammer Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

1. Perform bushhammer finish to concrete that has achieved a minimum compressive strength of 4500 psi.
2. Surface Continuity:
a. Perform bushhammer finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work.

3. Surface Cut:
   a. Maintain required depth of cut and general aggregate exposure.
   b. Use power tool with hammer attachments for large, flat surfaces, and use hand hammers for small areas, at corners and edges, and for restricted locations where power tools cannot reach.

4. Remove impressions of formwork and form facings with exception of tie holes.
5. Maintain required patterns or variances of cut as shown on Drawings or to match field sample panels.
6. Maintain control of concrete chips, dust, and debris in each Work area, limiting migration of airborne materials and dust by use of tarpaulins, wind-breaks, or similar devices.

F. Related Unformed Surfaces:
   1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
   2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.8 FINISHING FLOORS AND SLABS

A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish:
   1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
   2. Use stiff brushes, brooms, or rakes to produce a profile depth of 1/4 inch in one direction.
   3. Apply scratch finish to surfaces to receive concrete floor toppings or to receive mortar setting beds for bonded cementitious floor finishes.

C. Float Finish:
   1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
   2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
   3. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

D. Trowel Finish:
   1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
   2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface.
5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
7. Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:
   a. Slabs on Ground:
      1) Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.-long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch and 1/16 inch in 2ft.
   b. Suspended Slabs:
      1) Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.-long straightedge resting on two high spots and placed anywhere on the surface does not exceed 3/16 inch.
      2) Specified overall values of flatness, $F_F 35$; and of levelness, $F_L 20$; with minimum local values of flatness, $F_F 24$; and of levelness, $F_L 15$.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated on Drawings. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.
   1. Coordinate required final finish with Architect before application.
   2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.
   1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
   2. Coordinate required final finish with Architect before application.

G. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate finish to concrete stair treads, platforms, ramps as indicated on Drawings
   1. Apply in accordance with manufacturer's written instructions and as follows:
      a. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate over surface in one or two applications.
      b. Tamp aggregate flush with surface, but do not force below surface.
      c. After broadcasting and tamping, apply float finish.
      d. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate.

H. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces in accordance with manufacturer's written instructions and as follows:
1. Uniformly apply dry-shake floor hardener at a rate of 100 lb/100 sq. ft. unless greater amount is recommended by manufacturer.
2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating.
3. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
4. After final floating, apply a trowel finish.
5. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

3.9 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:
   1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
   2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
   3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:
   1. Coordinate sizes and locations of concrete bases with actual equipment provided.
   2. Construct concrete bases 4 inches high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
   3. Minimum Compressive Strength: 4000 psi at 28 days.
   4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
   6. Prior to pouring concrete, place and secure anchorage devices.
      a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      b. Cast anchor-bolt insert into bases.
      c. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.
   1. Cast-in inserts and accessories, as shown on Drawings.
   2. Screed, tamp, and trowel finish concrete surfaces.

3.10 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
   a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
   b. Continuous Sprinkling: Maintain concrete surface continuously wet.
   c. Absorbive Cover: Pre-dampen absorbive material before application; apply additional water to absorbive material to maintain concrete surface continuously wet.
   d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
   e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
      1) Recoil areas subject to heavy rainfall within three hours after initial application.
      2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

1. Begin curing immediately after finishing concrete.
2. Interior Concrete Floors:
   a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
      1) Absorbive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorbive cover over entire area of floor.
         a) Lap edges and ends of absorbive cover not less than 12-inches.
         b) Maintain absorbive cover water saturated, and in place, for duration of curing period, but not less than seven days.
      2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
         a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
         b) Cure for not less than seven days.
3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
   a) Water.
   b) Continuous water-fog spray.

b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:

   1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
      a) Lap edges and ends of absorptive cover not less than 12 inches.
      b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

   2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
      a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
      b) Cure for not less than seven days.

   3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
      a) Water.
      b) Continuous water-fog spray.

c. Floors to Receive Polished Finish: Contractor has option of the following:

   1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
      a) Lap edges and ends of absorptive cover not less than 12 inches.
      b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

   2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
      a) Water.
      b) Continuous water-fog spray.

d. Floors to Receive Chemical Stain:
1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.
2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.
3) Butt sides of curing paper tight; do not overlap sides of curing paper.
4) Leave curing paper in place for duration of curing period, but not less than 28 days.

e. Floors to Receive Urethane Flooring:
1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
2) Rewet absorptive cover, and cover immediately with polyethylene moisture-retaining cover with edges lapped 6 inches and sealed in place.
3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.
4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.

f. Floors to Receive Curing Compound:
1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoil areas subjected to heavy rainfall within three hours after initial application.
3) Maintain continuity of coating, and repair damage during curing period.
4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

g. Floors to Receive Curing and Sealing Compound:
1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoil areas subjected to heavy rainfall within three hours after initial application.
3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.11 TOLERANCES

A. Conform to ACI 117.

3.12 APPLICATION OF LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than seven days old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
4. Rinse with water; remove excess material until surface is dry.
5. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

3.13 JOINT FILLING

A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.
   1. Defer joint filling until concrete has aged at least one month(s).
   2. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.

D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.14 CONCRETE SURFACE REPAIRS

A. Defective Concrete:
   1. Repair and patch defective areas when approved by Architect.
   2. Remove and replace concrete that cannot be repaired and patched to Architect’s approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
   1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.
      a. Limit cut depth to 3/4 inch.
      b. Make edges of cuts perpendicular to concrete surface.
      c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
      d. Fill and compact with patching mortar before bonding agent has dried.
      e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
   2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.
      a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
b. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that will affect concrete’s durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
   a. Correct low and high areas.
   b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

3. After concrete has cured at least 14 days, correct high areas by grinding.

4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.
   a. Finish repaired areas to blend into adjacent concrete.

5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
   a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
   b. Feather edges to match adjacent floor elevations.

6. Correct other low areas scheduled to remain exposed with repair topping.
   a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
   b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.
   a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
   b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
   c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
   d. Place, compact, and finish to blend with adjacent finished concrete.
   e. Cure in same manner as adjacent concrete.

8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.
   a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
b. Dampen cleaned concrete surfaces and apply bonding agent.
c. Place patching mortar before bonding agent has dried.
d. Compact patching mortar and finish to match adjacent concrete.
e. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.15 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

1. Testing agency shall be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
2. Testing agency shall immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
3. Testing agency shall report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.

   a. Test reports shall include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:

      1) Project name.
      2) Name of testing agency.
      3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
      4) Name of concrete manufacturer.
      5) Date and time of inspection, sampling, and field testing.
      6) Date and time of concrete placement.
      7) Location in Work of concrete represented by samples.
      8) Date and time sample was obtained.
      9) Truck and batch ticket numbers.
     10) Design compressive strength at 28 days.
     11) Concrete mixture designation, proportions, and materials.
     12) Field test results.
     13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
     14) Type of fracture and compressive break strengths at seven days and 28 days.

C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.

D. Inspections:
1. Headed bolts and studs.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.
5. Verification of concrete strength before removal of shores and forms from beams and slabs.

E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M shall be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
   a. When frequency of testing provides 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 C143/C143M:
   a. 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.
   b. Perform additional tests when concrete consistency appears to change.

3. Slump Flow: ASTM C1611/C1611M:
   a. 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.
   b. Perform additional tests when concrete consistency appears to change.

4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete:
   a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

5. Concrete Temperature: ASTM C1064/C1064M:
   a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.

   a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

7. Compression Test Specimens: ASTM C31/C31M:
   a. Cast and laboratory cure two sets of four 6-inch by 12-inch or 4-inch by 8-inch cylinder specimens for each composite sample.
   b. Cast, initial cure, and field cure two sets of four standard cylinder specimens for each composite sample.
   a. Test one specimen of laboratory-cured specimens at seven days and one set of three specimens at 28 days.
      1) If one of the 28-day specimens produces low results, hold the third 28-day specimen for a 56-day test.
   b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

10. Strength of each concrete mixture will be satisfactory if every 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 if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.

11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

12. Additional Tests:
   a. Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
   b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.

      1) Acceptance criteria for concrete strength shall be in accordance with ACI 301 section 1.6.6.3.

13. Additional testing and inspecting, at Contractor’s expense, will be performed to determine compliance of replaced or additional work with specified requirements.

14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 72 hours of completion of floor finishing and promptly report test results to Architect.

3.16 PROTECTION

A. Protect concrete surfaces as follows:
   1. Protect from petroleum stains.
   2. Diaper hydraulic equipment used over concrete surfaces.
   4. Prohibit use of pipe-cutting machinery over concrete surfaces.
   5. Prohibit placement of steel items on concrete surfaces.
   6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

END OF SECTION 03 3000
PART 1 GENERAL

1.01 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and TPWD Uniform General Conditions Sections, apply to this Section.

1.02 SUMMARY
A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for site improvements.

1.03 DEFINITIONS
A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.04 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
   1. Indicate amounts of mixing water to be withheld for later addition at Project site.
   2. Submit design mixes on form provided with these specifications.
C. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
   1. Location of construction joints is subject to approval of the Architect and Engineer.
D. Material Certificates: For each of the following, signed by manufacturers:
   1. Cementitious materials.
   2. Admixtures.
   3. Form materials and form-release agents.
   4. Steel reinforcement and accessories.
   5. Fiber reinforcement.
   6. Waterstops.
   7. Curing compounds.
   8. Floor and slab treatments.
  10. Adhesives.
  11. Semirigid joint filler.
E. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
   1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS
A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
   1. Portland Cement: ASTM C 150, Type I/II, Supplement with the following:
B. Normal-Weight Aggregates: ASTM C 33, coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
   1. Maximum Coarse-Aggregate Size: typically 3/4” nominal diameter, u.n.o. in Structural drawings.
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.


2.02 ADMIXTURES


B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   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.

C. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
   1. Color: As selected by Architect from manufacturer's full range.

2.03 WATERSTOPS

A. Flexible Rubber Waterstops: CE CRD-C 513, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
   1. Profile: Ribbed with center bulb.
   2. Dimensions: 4 inches by 3/16 inch thick (100 mm by 4.75 mm thick).

B. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
   1. Profile: Ribbed with center bulb.
   2. Dimensions: 4 inches by 3/16 inch thick (100 mm by 4.75 mm thick).

C. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

2.04 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

2.05 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
   1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
   1. Fly Ash: 25 percent.
   2. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 in Prestressed Concrete areas, and 0.30 otherwise as a percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.
   1. Use water-reducing or high-range water-reducing admixture in concrete, as required, for placement and workability.
   2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
   3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.06 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
   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

3.01 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
   1. Class B, 1/4 inch (6 mm) for smooth-formed finished surfaces.
   2. Class C, 1/2 inch (13 mm) for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
   1. Install keyways, reglets, recesses, and the like, for easy removal.
   2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and
other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.02 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect and Structural Engineer.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.

2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.

3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.

2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants," are indicated.

3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.03 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Water may be added at site only if specifically withheld at time of batching and specifically noted on batch ticket.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of
weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

G. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.04 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where concrete is exposed to view and where otherwise indicated:
1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.05 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.06 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed 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.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
   1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
      a. Water.
      b. Continuous water-fog spray.
      c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
   2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
      a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
      b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
      c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

   a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.07 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
   1. Defer joint filling until concrete has aged at least [one] [six] month(s). Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.08 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
   1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
   2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
   3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect and Engineer.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
   1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
   2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.

4. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

5. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

6. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect and Engineer's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Products and procedures for placement, finishing, and polishing cast-in-place concrete floors.

1.02 RELATED SECTIONS

A. Cast-in-place Concrete notes on Structural Drawings.
B. Section 07 9005 - Joint Sealers.

1.03 PERFORMANCE

A. Minor variations in appearance of colored concrete/mortar, which are similar to natural variations in color and appearance of unpigmented concrete/mortar, are acceptable, provided the variations are within the range and the same character as the approved mock-up.

1.04 REFERENCE STANDARDS

A. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute International; 2005.
B. ACI 302.1R - Guide for Concrete Floor and Slab Construction; American Concrete Institute International; 2004 (Errata 2007).
E. Samples for Verification: Submit 12" square samples of polished finish in each texture, and pattern specified; include not less than 3 in each sample set showing limits of variations expected for each texture, and pattern specified.
F. Product Data: Provide complete technical data on each product specified, including information on compatibility of different products and limitations.
G. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent construction for concrete accessories.
H. Maintenance Data: Include manufacturer's instructions for maintenance of installed work, including methods and frequency recommended for maintaining optimum condition under anticipated use. Include precaution against cleaning products and methods which may be detrimental to polished finishes and performance.

1.05 QUALITY ASSURANCE

A. Concrete Producer Qualifications: Firm experienced in manufacturing ready-mixed concrete products and that complies with following requirements for production facilities and equipment:
   1. ASTM C 94.
   2. NRMCA's Certification of Ready Mixed Concrete Production Facilities.

B. Polisher Qualifications:
   1. Experience: Company with not less than 5 years experience in performing specified work similar in design, products, and extent to scope of this Project; with a record of successful in-services performance; and with sufficient production capability, facilities, and personnel to produce required Work.
   2. Supervision: Maintain competent supervisor who is at Project during times specified Work is in progress, and who is experienced in installing systems similar to type and scope required for Project.
   3. Trade Association: Member in good standing of IPCI.

C. Walkway Auditor: Person certified by NFSI, trained to test polished surfaces for static coefficient of friction according to NFSI 101-A.
D. Static Coefficient of Friction: Products and polishing operations shall achieve following as determined by quality control testing according to NFSI-A:
   1. Level Floor Surfaces: Minimum 0.6.
   2. Sloping Floor Surfaces: Minimum 0.8.
   3. All surfaces must meet TAS 302.1.

1.06 PRE-INSTALLATION MEETING
A. Prior to placing concrete for areas scheduled for polished concrete floor finish, conduct meeting at Project.
B. Required Attendees:
   1. Owner.
   3. Contractor, including supervisor.
   4. Polisher, including supervisor.
   5. Concrete producer.
   6. Concrete finisher, including supervisor
   7. Walkway auditor.
C. Minimum Agenda: Polisher shall demonstrate understanding of work required by reviewing and discussing procedures for, but not limited to, following:
   1. Tour mock-up and representative areas of required work, discuss and evaluate for compliance with Contract Documents, including substrate conditions, surface preparations, sequence of installation and other preparatory Work performed by other installers.
   3. Review approved submittals.
   4. Review installation procedures, including, but not limited to:
      a. Concrete placement, finishing, and preparation for polished finish.
      b. Concrete curing.
      c. Application of polishing products.
      d. Grinding and polishing operations.
      e. Reports: Record discussions, including decisions and agreements reached, and furnish copy of record to each party attending.

1.07 MOCK-UP
A. Before performing work of this Section, provide as many field samples as required to verify selections made under submittals and to demonstrate aesthetic effects of polished finish. Approval does not constitute approval of deviations from Contract Documents, unless such deviations are specifically approved by Architect in writing.
B. Provide an 8’X10’ test area of polished floor as specified in concrete notes on Structural Drawings. Coordinate location noted on drawings.
C. Use same personnel, including supervisors, which will perform work.
D. Install products and materials according to specified requirements.
E. Mock-up will be used to evaluate:
   1. Concrete substrate preparation,
   2. Compliance with approved submittals,
   3. Uniformity of exposed aggregate, and
   4. Uniformity of sheen.
F. Show maximum variation that will exist in work.
G. Show example of damaged concrete repair / fix.
H. When approved, the mock-up will demonstrate the minimum standard of quality for proceeding with this work.
I. Approved mock-up shall remain for comparison as part of the finished work. Protect approved field mock-ups from elements with weather-resistant covering.

1.08 PROJECT CONDITIONS
A. Damage and Stain Prevention: Take precautions to prevent damage and staining of concrete surfaces to be polished:
   1. Prohibit the following over concrete surfaces to be polished:
      a. Vehicle parking.
      b. Pipe cutting operations.
      c. Ferrous metals storage.
   2. Protect concrete surfaces to be polished from following:
      a. Petroleum, oil, hydraulic fluid, or other liquid dripping from equipment.
      b. Acids and acidic detergents.
      c. Painting activities.

1.09 FIELD CONDITIONS
A. Comply with manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting polishing operations.
B. Maintain light level equivalent to minimum 200 W light source, placed 8 feet above the floor surface, for each 425 sq ft of floor being finished.
C. Do not apply materials in wet weather.
D. Do not finish floors until interior heating system is operational.
E. Where feasible, prepare surface and apply concrete floor sealer after other interior finish work is completed and before baseboards are installed.
F. Maintain ambient temperature of 60 degrees F. minimum.
   1. Concrete Floor Sealer: Do not apply when air or surface temperature is below 60 degrees F.
G. Provide ventilation sufficient to prevent injurious gases from temporary heat or other sources affecting concrete.
H. Protect concrete slabs from damage and staining both before and after application of concrete finish.

PART 2 PRODUCTS
2.01 CONCRETE MATERIALS
A. Cementitious Materials: As specified in appropriate Structural Drawings.

2.02 CURING MATERIALS
A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from juts or kenaf, weighing approximately 9 oz. per sq. yd.

2.03 APPLIED PRODUCTS
A. Liquid Densifier:
   1. Description: Odorless, non-hazardous, potassium silicate that penetrates concrete to react with free lime and calcium hydroxide to produce permanent chemical reaction that hardens, densifies and tightens concrete surface.
B. Patching Compound:
   1. Description: Compound composed of 40 percent portland cement, 45 limestone, and 15 percent vinyl acetate copolymer, when mixed with dust salvaged from grinding process forms a paste that hardens when surface imperfections are filled.
C. Grout Material:
   1. Description: Clear modified silicate sealant, containing no pore clogging latex, when mixed with dust salvaged from grinding process forms a paste that reacts with calcium hydroxide in concrete that hardens when surface imperfections are filled.
D. Polish Guard:
   1. Description: Non-film forming, stain resistant, food resistant, chemical stain resistant, impregnating sealant designed to be used on concrete surfaces previously densified.

E. Protective Cover:
   1. Description: Non-woven, puncture and tear resistant, polypropylene fibers laminated with a multi-ply, textured membrane, not less than 18 mils in thickness.

2.04 POLISHING EQUIPMENT
A. Field Grinding and Polishing Equipment:
   1. Variable speed, 3 or 4 head counter-rotating, walk-behind machine with not less than 600 lbs of down pressure on grinding or polishing pads.
   2. Dust extraction equipment with flow rate suitable for dust generated, with pre-separator and squeegee attachments.

B. Edge Grinding and Polishing Equipment: Hand-held or single head walk-behind machines which produces same results, without noticeable differences, as field grinding and polishing equipment.

C. Burnishing Equipment: Single head high speed walk-behind machines.

D. Grinding Pads: Metal bonded pads with embedded industrial grade diamonds of varying grits fabricated for mounting on equipment.

E. Polishing Pads: Resin bonded pads with embedded industrial grade diamonds of varying grits fabricated for mounting on equipment.

F. Burnishing Pads: Maintenance pads coated with embedded industrial grade diamonds for use with burnishing equipment.

2.05 CONCRETE MIX DESIGN
A. Material Quality Standards: Mix designs for each type and strength of concrete used for floors will be prepared as specified in appropriate Structural Drawings, with following qualifications:
   1. Slump Limit: 4 inches, plus or minus 1 inch.
   2. Maximum Water-Cement Ratio: 0.45.
   3. Air Content: No permitted.
   4. Admixtures: Calcium chloride based compounds not permitted.

PART 3 EXECUTION
3.01 EXAMINATION
A. Plan joint pattern layout; coordinate slab dimensions and construction joint locations with concrete installer.

B. Verify that floor surfaces are acceptable to receive the work of this section.

C. Acceptance of Surfaces and Conditions: Examine substrates to be polished for compliance with requirements and other conditions affecting performance. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting Work within a particular area will be construed as acceptance of surface conditions.

3.02 PREPARATION
A. Preparation For Application:
   1. Ensure concrete is a minimum of 28 days old.
   2. Remove all dirt, form oil, plaster or mortar residue, water repellants, or adhesives completely and in a manner which will not alter surface texture uniformly.
   3. If curing compounds or other residue cannot be removed completely by hand cleaning, remove with a terrazzo grinder. Do not sandblast surfaces to be sealed.
   4. Pressure wash and rinse all surfaces completely using methods approved by the manufacturer.
   5. Do not acid wash or use heavy alkali cleaners.
   6. Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, paint splatter, and other contaminants.
incompatible with polished concrete floor finish.

3.03 PLACING AND FINISHING CONCRETE FOR FLOORS

A. General: Comply with appropriate Structural Drawings.

B. Hot and Cold Weather Placement: As specified in appropriate Structural Drawings.

C. Placement: Deposit and consolidate concrete in continuous operation, within limits of construction joints, until placement of a panel or section is complete.
   1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   2. Screed slab surfaces with a straight edge and strike off to correct elevations.
   3. After screeding, consolidating and leveling, do not work surface until ready for floating.

D. Float Finishing:
   1. Begin floating operations when water sheen has disappeared, and/or when concrete has stiffened sufficiently to permit proper operation of power-driven equipment.
   2. Consolidate surface with power-driven troweling using steel float pans.
   3. Hand float with wood or cork faced floats in locations inaccessible to power-driven machine.
   4. Level surface using 10 foot highway straight edge.
   5. Cut down high spots and fill low spots to produce planes checking true under straightedge in any direction.
   6. Bring surface to uniform, smooth, granular texture with power-driven troweling using steel float pans.

E. Joints: Saw cut of tool joints to match approved mock-up.

F. Moisture Curing: Immediately begin after floating.

G. Keep concrete surface continuously wet by covering with absorptive cover or by using continuous water-fog spray.

H. Cover concrete surface with absorptive cover with 4 inch lap over adjacent absorptive covers.

I. Thoroughly saturate cover with water and keep continuously wet.

3.04 CONCRETE POLISHING

A. Initial Grinding:
   1. Use grinding equipment and low grit grinding pads.
   2. Grind concrete to specified aggregate exposure imparting uniform scratch pattern in concrete.
   3. Vacuum floor using squeegee vacuum attachment.

B. Level of Grinding:
   1. Description: Minimally grind concrete without removing the cement cream leaving surface of uniform color matching approved mock-up.

C. Treating Surface Imperfections:
   1. Match patching compound and grout material with dust created by grinding operations to match color of adjacent concrete surface.
   2. Fill surface imperfections including, but not limited to, holes, surface damage, small and micro cracks, air holes, pop-outs, and voids.
   3. Work compound and treatment until color difference between concrete surface and filled surface imperfections are not noticeable.

D. Grout Grinding:
   1. Use grinding equipment and appropriate grit grinding pads.
   2. Apply fresh grout material prior to, grind concrete in direction perpendicular to initial grinding to remove scratches.
   3. Vacuum floor using squeegee vacuum attachment.

E. Additional Grinding:
   1. Use grinding equipment and increasing finer grit grinding pads.
2. Grind concrete in as many passes necessary with each pass perpendicular to previous pass to remove scratches.
3. Vacuum floor using squeegee vacuum attachment.

F. Polishing:
   1. Use polishing equipment and increasing finer grip polishing pads.
   2. Polish concrete in as many passes necessary with each pass perpendicular to previous pass to remove scratches.
   3. Vacuum floor using squeegee vacuum attachment.

G. Applying Polish Guard: Uniformly apply and remove excessive liquid.

H. Applying Final Polish: Using burnishing equipment and finest grit burnishing pads, burnish to uniform sheen matching approved mock-up
   1. Final Polished Sheen: Uniform Level 3 - semi-gloss sheen using 1500 grit polishing heads.

3.05 FIELD QUALITY CONTROL
   A. Static Coefficient of Friction Testing: Retain Walkway Auditor to test polished finishes according to NFSI 101-A to confirm compliance with specified static coefficient of friction.

3.06 PROTECTION
   A. Covering: Protect polished finish work from subsequent construction with protective covering.

END OF SECTION
SECTION 05 1200
STRUCTURAL STEEL FRAMING

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. Structural steel.
2. Shear stud connectors.
3. Shrinkage-resistant grout.

B. Related Requirements:

1. Section 051213 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.
2. Section 053100 "Steel Decking" for field installation of shear stud connectors through deck.
3. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and other steel items not defined as structural steel.
4. Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for painting requirements.
5. Section 133419 "Metal Building Systems" for structural steel.

1.3 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.

C. Heavy Sections: Rolled and built-up sections as follows:

1. Shapes included in ASTM A6/A6M with flanges thicker than 1-1/2 inches.
2. Welded built-up members with plates thicker than 2 inches.
3. Column base plates thicker than 2 inches.

D. Protected Zone: Structural members or portions of structural members indicated as "protected zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.
E. **Demand-Critical Welds:** Those welds, the failure of which would result in significant degradation of the strength and stiffness of the seismic-load-resisting system and which are indicated as "demand critical" or "seismic critical" on Drawings.

1.4 **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 anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.5 **PREINSTALLATION MEETINGS**

A. Preinstallation Conference: Conduct conference at Project site.

1.6 **ACTION SUBMITTALS**

A. Product Data:

2. High-strength, bolt-nut-washer assemblies.
3. Shear stud connectors.
4. Anchor rods.
5. Threaded rods.
6. Forged-steel hardware.
7. Shop primer.
8. Galvanized-steel primer.
9. Etching cleaner.
11. Shrinkage-resistant grout.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
5. Identify members and connections of the seismic-load-resisting system.
6. Indicate locations and dimensions of protected zones.
7. Identify demand-critical welds.
8. Identify members not to be shop primed.

C. **Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs):** Provide in accordance with AWS D1.1/D1.1M for each welded joint whether prequalified or qualified by testing, including the following:
1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand-critical welds.

D. Delegated-Design Submittal: For structural-steel connections indicated on Drawings to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.
B. Welding certificates.
C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
D. Mill test reports for structural-steel materials, including chemical and physical properties.
E. Product Test Reports: For the following:
   1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
   2. Direct-tension indicators.
   3. Tension-control, high-strength, bolt-nut-washer assemblies.
   4. Shear stud connectors.
   5. Shop primers.
F. Survey of existing conditions.
G. Source quality-control reports.
H. Field quality-control reports.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).
B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
C. Shop-Painting Applicators: Qualified in accordance with AISC's Sophisticated Paint or to SSPC-QP 3.
D. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.
   1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.
1.9 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer’s labels intact.

1. Fasteners may be repackaged provided Owner’s testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers’ written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with applicable provisions of the following specifications and documents:

1. ANSI/AISC 303.
2. ANSI/AISC 341.
3. ANSI/AISC 360.
4. RCSC’s "Specification for Structural Joints Using High-Strength Bolts."

B. Connection Design Information:

1. Option 3 and 3B: Design connections and final configuration of member reinforcement at connections in accordance with ANSI/AISC 303 by fabricator’s qualified professional engineer.
   a. Use Load and Resistance Factor Design; data are given at factored-load level.

C. Moment Connections: Type PR, partially and Type FR, fully restrained.

D. Construction: Combined system of moment frame, braced frame, and shear walls.

2.2 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A992/A992M or ASTM A572/A572M, Grade 50.

B. Channels, Angles: ASTM A36/A36M or ASTM A572/A572M, Grade 50.

C. Plate and Bar: ASTM A36/A36M or ASTM A572/A572M, Grade 50.

D. Corrosion-Resisting (Weathering) Structural-Steel Shapes, Plates, and Bars: ASTM A588/A588M, 50 ksi.
E. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade B structural tubing.

F. Corrosion-Resisting (Weathering), Cold-Formed Hollow Structural Sections: ASTM A847/A847M structural tubing.

G. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.
   2. Finish: Black except where indicated to be galvanized.

H. Steel Castings: ASTM A216/A216M, Grade WCB, with supplementary requirement S11.

I. Steel Forgings: ASTM A668/A668M.

J. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
   1. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1, compressible-washer type with plain finish.

B. High-Strength A490 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A490, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
   1. Direct-Tension Indicators: ASTM F959/F959M, Type 490-1, compressible-washer type with plain finish.

C. Zinc-Coated High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
   1. Finish: Hot-dip zinc coating.
   2. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1, compressible-washer type with mechanically deposited zinc coating finish.

D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, heavy-hex head assemblies, consisting of steel structural bolts with splined ends; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
   1. Finish: Plain.

E. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

2.4 RODS

A. Unheaded Anchor Rods: ASTM F1554, Grade 36 or ASTM F1554, Grade 55, weldable.
4. Washers: ASTM F436, Type 1, hardened carbon steel.
5. Finish: Plain.

B. Headed Anchor Rods: ASTM F1554, Grade 36 or ASTM F1554, Grade 55, weldable, straight.
   3. Washers: ASTM F436, Type 1, hardened carbon steel.

C. Threaded Rods: ASTM A36/A36M or ASTM A572/A572M, Grade 50.
   3. Finish: Plain.

2.5 FORGED-STEEL STRUCTURAL HARDWARE

B. Eye Bolts and Nuts: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1030.

2.6 PRIMER

A. Steel Primer:
   1. Comply with Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."
   2. SSPC-Paint 23, latex primer.
   3. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

B. Galvanized-Steel Primer: MPI#26, MPI#80, MPI#134.
   1. Etching Cleaner: MPI#25, for galvanized steel.
   2. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

2.7 SHRINKAGE-RESISTANT GROUT

A. Metallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
2.8 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.
   1. Camber structural-steel members where indicated.
   2. Fabricate beams with rolling camber up.
   3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
   4. Mark and match-mark materials for field assembly.
   5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
   1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted in accordance with SSPC-SP 1.

F. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using automatic end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural-steel frame. Straighten as required to provide uniform, square, and true members in completed wall framing. Build up welded framing, weld exposed joints continuously, and grind smooth.

H. Welded-Steel Door Frames: Build up welded-steel door frames attached to structural-steel frame. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches o.c. unless otherwise indicated on Drawings.

I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
   1. Cut, drill, or punch holes perpendicular to steel surfaces.
   2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
   3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.9 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened.
B.  Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

2.10 GALVANIZING
   A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.
      1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
      2. Galvanize lintels, shelf angles, and welded door frames attached to structural-steel frame and located in exterior walls.

2.11 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 inches.
      2. Surfaces to be field welded.
      4. Surfaces to receive sprayed fire-resistant materials (applied fireproofing).
      5. Galvanized surfaces.
      7. Surfaces enclosed in interior construction.

   B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:
      1. SSPC-SP 2.
      2. SSPC-SP 3.
      3. SSPC-SP 7 (WAB)/NACE WAB-4.
      4. SSPC-SP 14 (WAB)/NACE WAB-8.
      5. SSPC-SP 11.
      6. SSPC-SP 6 (WAB)/NACE WAB-3.
      7. SSPC-SP 10 (WAB)/NACE WAB-2.
      8. SSPC-SP 5 (WAB)/NACE WAB-1.
      9. SSPC-SP 8.

   C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner or in accordance with SSPC-SP 16.

   D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. 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 paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.12 SOURCE QUALITY CONTROL

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

1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
   a. Liquid Penetrant Inspection: ASTM E165/E165M.
   b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
   c. Ultrasonic Inspection: ASTM E164.
   d. Radiographic Inspection: ASTM E94/E94M.
4. In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:
   a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear stud connector.
   b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear stud connectors if weld fracture occurs on shear stud connectors already tested.
5. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

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

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated on Drawings.

1. Do not remove temporary shoring supporting composite deck construction and structural-steel framing until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.


1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.

C. Maintain erection tolerances of structural steel within ANSI/AISC 303.

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

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

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.

1. Joint Type: Snug tightened.
B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

3.5 REPAIR

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.

B. Touchup Painting:

1. Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

2. Cleaning and touchup painting are specified in Section 099113 "Exterior Painting," Section 099123 "Interior Painting," Section 099600 "High-Performance Coatings."

C. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

3.6 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.
2. Verify weld materials and inspect welds.
3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.
   a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
      1) Liquid Penetrant Inspection: ASTM E165/E165M.
2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.

3) Ultrasonic Inspection: ASTM E164.

4) Radiographic Inspection: ASTM E94/E94M.

END OF SECTION 05 1200
SECTION 05 5200
HANDRAILS AND RAILINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Painted Galvanized steel handrails, balusters, and fittings.

1.02 RELATED SECTIONS
A. Section 09 9000 - Paints and Coatings

1.03 REFERENCE STANDARDS

1.04 DESIGN REQUIREMENTS
A. Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of ASTM E 985 and applicable local code.
B. Hand rail shall be designed and equipped with full provisions for horizontal and vertical adjustment as well as for thermal expansion and contraction of railings.
C. Fabricate railing assembly, wall rails, and attachments in accordance with ASTM E 985.

1.05 SUBMITTALS
A. Manufacturer/Fabricator shall submit evidence of satisfactory completion of similar work during a minimum period of 15 years in business. Engineer reserves the right to require financial disclosure and inspect fabrication facilities in determining qualifications.
B. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.
C. Samples: Submit two, 6 inch long samples of handrail. Submit two samples of wall bracket and railing grid panel showing typical shop welded joint.

1.06 QUALITY ASSURANCE
A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation
B. Field welding of railing grilles and panels, or of railing panel to vertical and horizontal railings or to posts is completely unacceptable.
C. Welders employed to fabricate railings shall have passed qualification tests within the preceding 12 months in the position for which qualified, using test procedures covered in the AWS D1.1-80
D. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, to ensure fitting of work. Allow for trimming and fitting wherever taking of field measurements before fabrication might delay work only upon written approval from engineer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. STELCO INDUSTRIES, 1313 N I-35 E, WAXAHACHIE, TX 75165
B. EUREKA SHEET METAL INC. 550 DELGADO ST, SAN ANTONIO, TX 78207
C. BERGER IRON WORKS; Houston, Texas; Attn: Mr. James Speedy. Custom.

2.02 RAILINGS - GENERAL REQUIREMENTS
A. Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of ASTM E985 and applicable local code.
B. Design railing assembly, wall rails, and attachments to resist lateral force of 75 lbs at any point without damage or permanent set. Test in accordance with ASTM E 935.

C. Allow for expansion and contraction of members and building movement without damage to connections or members.

D. Dimensions: See drawings for configurations and heights.

E. Provide anchors and other components as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.

F. Provide welding fittings to join lengths, seal open ends, and conceal exposed mounting bolts and nuts, including but not limited to elbows, T-shapes, splice connectors, flanges, escutcheons, and wall brackets.

2.03 STEEL RAILING SYSTEM

A. Hot-dipped galvanized Steel Plates, Shapes and Bars. Where bars are indicated, furnish solid units with sharp unradiused corners.

B. Welding Fittings: Factory- or shop-welded from matching pipe or tube; seams continuously welded; joints and seams ground smooth.

C. Fittings: Elbows, T-shapes, wall brackets, escutcheons; Hot-dipped galvanized steel.

D. Concealed Fasteners: Hot-dipped galvanized screws or bolts; consistent with design of railing.

2.04 FABRICATION

A. Accurately form components to suit specific project conditions and for proper connection to building structure.

B. Fit and shop assemble components in largest practical sizes for delivery to site.

C. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.

D. Provide anchors and plates required for connecting railings to structure.

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

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

G. Exterior Components: Continuously seal joined pieces by continuous welds. Drill condensate drainage holes at bottom of members at locations that will not encourage water intrusion.

H. Interior Components: Continuously seal joined pieces by intermittent welds and plastic filler.

I. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

J. Accurately form components to suit specific project conditions and for proper connection to building structure.

K. Accommodate for expansion and contraction of members and building movement without damage to connections or members.

L. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain profile of member throughout entire bend without swelling, buckling, twisting or otherwise deforming exposed surfaces of handrail and railing components. Railing panel and grille configurations shall follow the curvature indicated for the handrail.

2.05 STEEL FINISHES

A. Sandblasted finish, touched up after fabrication as necessary to produce visual uniformity. Sandblasting and touching up to be produced by non-ferrous means in order to avoid superficial rust after installation.
PART 3 - EXECUTION

3.01 EXAMINATION
A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION
A. Supply items required to be cast into concrete or embedded in masonry with setting templates, for installation as work of other sections.
B. Apply one coat of bituminous paint to concealed aluminum surfaces that will be in contact with cementitious or dissimilar materials.

3.03 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Install components plumb and level, accurately fitted, free from distortion or defects, with tight joints.
C. Anchor railings securely to structure.
D. Conceal anchor bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.
E. Assemble with spigots and sleeves to accommodate tight joints and secure installation.

3.04 FABRICATION AND ERECTION TOLERANCES
A. Machine, field and shop assemble joints to fit within 1/32+/- . Install freestanding item to +/- 1/8" of indicated position, plumb and level. Size of each element of an assembly shall be correct within 1/8"; curved element maximum +/- 1/8" on the chord rise and maximum +/- 1/4" in chord length.
B. Maximum Variation From Plumb: 1/4 inch in four feet.
C. Maximum Offset From True Alignment: 1/4 inch.

END OF SECTION
SECTION 06 1000
ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Wall sheathing.
B. Subflooring.
C. Preservative treated wood materials.
D. Utility room mounting boards.
E. Concealed wood blocking, nailers, and supports.
F. Miscellaneous wood nailers, furring, and grounds.
G. Framing with dimensional lumber.
H. Roof strapping.

1.02 RELATED REQUIREMENTS
A. Section 06 2000 - Finish Carpentry
B. Section 07 6100 - Sheet Metal Roofing
C. Section 07 4623 - Wood Siding

1.03 REFERENCE STANDARDS
E. AWPA C2 - Lumber, Timber, Bridge Ties and Mine Ties -- Preservative Treatment by Pressure Processes; American Wood-Preservers' Association; 2002.
F. AWPA C20 - Structural Lumber -- Fire Retardant Treatment by Pressure Processes; American Wood-Preservers' Association; 2002.
H. PS 1 - Structural Plywood 2009 (Revised 2019).
K. SPIB (GR) - Grading Rules 2014.
L. WCLIB (GR) - Standard Grading Rules for West Coast Lumber No. 17 2018.

1.04 DEFINITIONS
A. Dimensional Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimensions.
B. Lumber grading agencies, and the abbreviations used to reference them, include the following:
   2. NLGA: National Lumber Grades Authority.
   3. RIS: Redwood Inspection Service.
   5. WCLIB: West Coast Lumber Inspection Bureau.
1.05 SUBMITTALS
   A. Product Data: Provide technical data on wood preservative materials and application instructions.
   B. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
      1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
      2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
      3. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
   C. Materials Certificates: For dimensional lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
   D. Forest Certification: For wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
   E. Manufacturer's Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.

1.06 QUALITY ASSURANCE
   A. Lumber: Comply with PS 20 and approved grading rules and inspection agencies.
   B. Plywood: Comply with PS 1.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.

1.08 PROJECT CONDITIONS
   A. Repair, alter, or replace existing work as indicated to comply with applicable portions of these specifications as for new work. Workmanship for existing materials to be repaired or altered, but not otherwise specified, shall conform to similar workmanship existing in or adjacent to area in which alterations are to be made.
   B. Coordination: Fit carpentry work to other work; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds and similar supports to allow attachment of other work.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS
   A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
      1. If no species is specified, provide any species graded by the agency specified; if no grading agency is specified, provide lumber graded by any grading agency meeting the specified requirements.
      2. Grading Agency: Any grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee (www.alsc.org) and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
   B. Lumber fabricated from old growth timber is not permitted.

2.02 EXPOSED DIMENSION LUMBER
   A. Grading Agency: West Coast Lumber Inspection Bureau; WCLIB (GR).
   B. Sizes: Nominal sizes as indicated on drawings.
   C. Moisture Content: S-dry or MC19.
D. Joist, Rafter, Small Beam, and Purlins Framing (2 by 6 through 4 by 16 (50 by 150 through 100 by 400 mm)):
   1. Species: Douglas Fir.
   2. Grade: Clear.

2.03 EXPOSED BOARDS
A. Submit manufacturer's certificate that products meet or exceed specified requirements, in lieu of grade stamping.
B. Moisture Content: Kiln-dry (15 percent maximum).
C. Surfacing: S4S.
D. Species: Douglas Fir.
E. Grade: B or Better. Vertical Grain

2.04 EXPOSED DECKING
A. Submit manufacturer's certificate that products meet or exceed specified requirements, in lieu of grade stamping.
B. Sizes: Typical 3/4” x 3 1/2” T&G Nominal sizes unless indicated on drawings otherwise.
C. Moisture Content: Kiln-dry (15 percent maximum).
D. Species: Douglas Fir.
E. Grade: B or Better. Vertical Grain

2.05 CONSTRUCTION PANELS
B. Trademark: Factory-mark each construction panel with APA trademark evidencing compliance with grade requirements.
C. Concealed APA Performance-Rated Panels: Where construction panels will be used for concealed types of applications, provide APA Performance-Rated Panels complying with requirements indicated for grade designation, exposure durability classification, veneer grade, species, and edge detail.
D. Thickness: As indicated on drawings, or if not indicated, as required to match thickness of original sheathing or underlayment material, as applicable.
E. Roof Sheathing: CDX Pine Plywood
   1. Grade: Exposure 1 rating.
   2. Size: 4 feet (1219 mm) wide by 8 feet (2438 mm) long.
   3. Performance Category: 3/4 PERF CAT.
   5. Edge Profile: Tongue and groove.
F. Wall Sheathing: Plywood, PS 1, Grade Marine for panels used in wet kitchen assemblies; Exterior Grade elsewhere.

2.06 ACCESSORIES
A. Fasteners and Anchors:

2.07 FACTORY WOOD TREATMENT
A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.

B. Fire Retardant Treatment:
1. Exterior Type: AWPA U1, Category UCFB, Commodity Specification H, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes both before and after accelerated weathering test performed in accordance with ASTM D2898.
   a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
   b. Treat exposed exterior rough carpentry items, including covered walkways
   c. Do not use treated wood in direct contact with the ground.

PART 3 EXECUTION

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

3.02 INSTALLATION - GENERAL
A. Select material sizes to minimize waste.
B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.03 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 AWC (WFCM) 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. Frame wall openings with two or more studs at each jamb; support headers on cripple studs.

3.04 INSTALLATION OF CONSTRUCTION PANELS
A. Subflooring: Glue and nail to framing; staples are not permitted.
B. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using screws. Nails and staples are not permitted.
C. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches (610 mm) on center on all edges and into studs in field of board.
   1. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
   2. Install adjacent boards without gaps.

3.05 SITE APPLIED WOOD TREATMENT
A. Apply preservative treatment compatible with factory applied treatment at site-sawn cuts, complying with manufacturer's instructions.
B. Allow preservative to dry prior to erecting members.
3.06 TOLERANCES
   A. Framing Members: 1/4 inch (6 mm) from true position, maximum.
   B. Surface Flatness of Attic Floor: 1/8 inch in 10 feet (1 mm/m) maximum, and 1/4 inch in 30 feet (7 mm in 10 m) maximum.
   C. Variation from Plane (Other than Floors): 1/4 inch in 10 feet (2 mm/m) maximum, and 1/4 inch in 30 feet (7 mm in 10 m) maximum.

3.07 CLEANING
   A. Waste Disposal: Comply with the requirements of Section 01 7419 - Construction Waste Management and 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 1510
HARDWOOD DECKING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Hardwood Decking and Dimension Lumber
B. Decking Accessories

1.02 RELATED REQUIREMENTS
A. Section 05 5200 - Handrails and Railings
B. Section 06 1000 - Rough Carpentry: Bearing support.
C. Section 09 9000 - Painting and Coating: Deck Stain & Sealer

1.03 REFERENCE STANDARDS
A. FSC - Forest Stewardship Council Certification
B. NFPA - Fire Safety Code

1.04 SYSTEM DESCRIPTION
A. IPE Decking:
   1. General Characteristics:
      a. Appearance: An extremely dense, tight grained wood. Generally a deep rich brown
         with some pieces displaying red and amber hues.
      b. Hardness: 3600 lbs
      c. Bending Strength: 22,560 psi
      d. Decay Resistance: Very durable and naturally resistant to decay and insects. Offers
         up to 75 plus year lifespan.
      e. Weight: Basic specific gravity (oven dry weight/green volume) 0.85 to 0.97, air dry
         density 66 to 75 pounds per cubic foot.
      f. Moisture Content of Decking:
         1) Ipe Decking is specially dried for use on exterior projects. DO NOT use kiln dried
            interior lumber in exterior projects as it will expand.
         2) Ipe lumber for indoor applications is kiln dried specifically for interior use. Ipe
            decking dried for exterior use will shrink inside.
      g. Janka side hardness: 3,060 lbs for green material and 3,680 lbs at 12 percent
         moisture content.
   2. Slip Resistance: ASTM C 1028 tested; Exceeds the Americans with Disabilities Act
      requirements for Static Coefficient of friction in a wet environment.
   3. Fire Rating:
      a. NFPA Class - A
   4. Span Chart for Ipe Decking:
      a. Nominal Dimension 1 x 4, Finish Dimension 3/4 inch by 3-1/2 inches, Joist Spacing
         16 inches
      b. Nominal Dimension 1 x 6, Finish Dimension 3/4 inch by 5-1/2 inches, Joist Spacing
         16 inches
      c. Nominal Dimension 5/4 x 6, Finish Dimension 1 inch by 5-1/2 inches , Joist Spacing
         24 inches
      d. Nominal Dimension 2 x 6, Finish Dimension 1-1/2 inches by 5-1/2 inches, Joist
         Spacing 32 inches

1.05 SUBMITTALS
A. Refer to Owner's Uniform General Conditions / Special Conditions for submittal procedures.
B. Product Data: Provide technical data on wood preservative materials.
C. Shop Drawings: Indicate deck framing system, loads and cambers, bearing details, and framed
   openings.
D. Samples of Wood Deck Exposed To View: Submit two samples, 3.5 by 6" inch (88.9 by 152.4 mm) in size illustrating wood grain, stain, and finish.

E. Documentation of compliance with Forestry Stewardship Council (FSC) Certification.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with at least five years of documented experience and certified by AITC.

B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with at least five years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect from soiling, damage and construction operations. Allow for proper on site acclimation of wood materials.

B. Prevent wrapping in tarp, which traps moisture.

PART 2 PRODUCTS

2.01 WOOD MATERIALS

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

B. Ipe Decking and Dimension Lumber:
   1. FSC Pregrooved Ipe Decking for use with clip fasteners
      a. 1 x 4 FSC Pregrooved, Net Finished Dimensions 3/4 inch by 3-1/2 inch.
      b. 1 x 4 FSC One Sided Pregrooved, Net Finished Dimensions 3/4 inch by 3-1/2 inch.

2.02 ACCESSORIES

A. Wood Plugs: 3/8 inch tapered wood plugs for plugging holes in face-screwed exotic wood decking planks.

B. Plugs: Premium plugs with numerous advantages over traditional wood plugs.
   1. Basis of design: DeckWise Extreme Plugs:
      2. Size:
         a. 3/8 inch
         b. 10 mm
         c. 12 mm
      3. Tapered 1 inch for easy installation
         a. Manufactured with Tolerance Absorbing Rings to help fill the void in a hole that is not drilled perfectly round.

C. Ipe Clip:
   1. Basis of design: IPE CLIP System is an edge mount deck fastening system No surface screws showing.
   2. Polymer molded and reinforced with a stainless steel insert, for use on 3/4 inch, 1 inch or thicker material.
   3. Comes with high grade 305 grade stainless steel screws with painted heads and a T15 torx drive.
   4. Recommended for salt water applications.

D. Joist Tape:
   1. Malleable polyethylene waterproof wood flashing material, using a rubberized asphalt mastic adhesive.
   2. Apply to decking joists, around deck support posts, and over ledger boards.
   3. Each roll contains: 3 inches wide by 75 feet long.
   4. Basis of Design: DeckWise Ledger Tape

E. Ledger Tape:
   1. Flexible polyethylene waterproof wood flashing material, using a rubberized asphalt mastic adhesive.
   2. Apply this to ledger boards and in-ground wooden deck posts.
3. Each roll contains: 12 inches wide by 25 feet long.
4. Basis of Design: DeckWise Ledger Tape

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that support framing is ready to receive decking.
B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION
A. Coordinate placement of bearing items.
B. Clean surfaces thoroughly prior to installation.

3.03 INSTALLATION - BOARD DECKING
A. Install decking perpendicular to framing members, with ends staggered over firm bearing. On sloped surfaces, lay decking with tongue upward.
B. Secure with manufacturer's proprietary fastener system.

END OF SECTION
SECTION 061516

WOOD ROOF DECKING

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 solid-sawn wood roof decking

B. Related Requirements:
   1. Section 061000 "Rough Carpentry" for dimension lumber items associated with wood roof decking.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. For glued-laminated wood roof decking, include installation instructions and data on lumber, adhesives, and fabrication.
   2. For preservative-treated wood products, include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.

B. Samples: 24 inches long, showing the range of variation to be expected in appearance of wood roof decking.

1.4 INFORMATIONAL SUBMITTALS

A. Research/Evaluation Reports: For glued-laminated wood roof decking indicated to be of diaphragm design and construction, from ICC-ES.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Schedule delivery of wood roof decking to avoid extended on-site storage and to avoid delaying the Work.

B. Store materials under cover and protected from weather and contact with damp or wet surfaces. Provide for air circulation within and around stacks and under temporary coverings. Stack wood roof decking with surfaces that are to be exposed in the final Work protected from exposure to sunlight.
PART 2 - PRODUCTS

2.1 WOOD ROOF DECKING, GENERAL

A. General: Comply with DOC PS 20 and with applicable grading rules of inspection agencies certified by ALSC’s Board of Review.

2.2 SOLID-SAWN WOOD ROOF DECKING

A. Standard for Solid-Sawn Wood Roof Decking: Comply with AITC 112.

B. Roof Decking Species: per Contract Drawings.

C. Roof Decking Nominal Size: per Contract Drawings.

D. Roof Decking Grade: per Contract Drawings.

E. Grade Stamps: Factory mark each item with grade stamp of grading agency. Apply grade stamp to surfaces that are not exposed to view.

F. Moisture Content: Provide wood roof decking with 15 percent maximum moisture content at time of dressing.

G. Face Surface: Smooth.

H. Edge Pattern: Vee grooved.

2.3 PRESERVATIVE TREATMENT

A. Pressure treat wood roof decking according to AWPA U1; Use Category UC2.

1. For laminated roof decking, treat lumber before gluing.

B. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

1. For exposed items indicated to receive a stained or natural finish, use products that do not contain colorants, bleed through, or otherwise adversely affect finishes.

C. Use process that includes water-repellent treatment.

D. Use process that does not include water repellents or other substances that might interfere with application of indicated finishes.

E. After treatment, redry materials to 19 percent maximum moisture content.

F. After dressing and fabricating roof decking, apply inorganic boron according to AWPA M4 to surfaces cut to a depth of more than 1/16 inch.
2.4 ACCESSORY MATERIALS

A. Fasteners for Solid-Sawn Roof Decking: Provide fastener size and type complying with AITC 112 for thickness of deck used.

B. Fasteners for Glued-Laminated Roof Decking: Provide fastener size and type complying with requirements in "Installation" Article for installing laminated roof decking.

C. Nails: Common; complying with ASTM F1667, Type I, Style 10.

D. Spikes: Round; complying with ASTM F1667, Type III, Style 3.

E. Fastener Material: Hot-dip galvanized steel.

F. Bolts for Anchoring Roof Decking to Walls: Carbon steel; complying with ASTM A307 with ASTM A563 hex nuts and, where indicated, flat washers, all hot-dip zinc coated.

G. Installation Adhesive: For glued-laminated wood roof decking indicated to be of diaphragm design and construction, provide adhesive that complies with research/evaluation report.

H. Sealants: Latex, complying with applicable requirements in Section 079200 "Joint Sealants" and recommended by sealant manufacturer and manufacturer of substrates for intended application.

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

   a. Bostik, Inc.
   c. Pecora Corporation.
   d. Permathane®/Acryl-R®; ITW Polymers Sealants North America.
   e. Tremco Incorporated.

I. Penetrating Sealer: Clear sanding sealer complying with Section 099300 "Staining and Transparent Finishing" and compatible with topcoats specified for use over it.

2.5 FABRICATION

A. Shop Fabrication: Where preservative-treated roof decking is indicated, complete cutting, trimming, surfacing, and sanding before treating.

B. Predrill roof decking for lateral spiking to adjacent units to comply with AITC 112.

C. Seal Coat: After fabricating and surfacing roof decking, apply a saturation coat of penetrating sealer in fabrication shop.

D. Apply indicated finish materials to comply with Section 099300 "Staining and Transparent Finishing" in fabrication shop.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and support framing in areas to receive wood roof decking for compliance with installation tolerances and other conditions affecting performance of wood roof decking.

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

3.2 INSTALLATION

A. Install solid-sawn wood roof decking to comply with AITC 112.
   1. Locate end joints for lay-up indicated.

B. Install laminated wood roof decking to comply with manufacturer's written instructions.
   1. Locate end joints for lay-up indicated.
   2. Nail each course of glued-laminated wood roof decking at each support with one nail slant nailed above the tongue and one nail straight nailed through the face.
      a. Use 12d nails for 2-by-6 and 2-by-8 roof decking.
      b. Use 30d nails for 3-by-6 and 3-by-8 roof decking.
      c. Use 60d nails for 4-by-6 and 4-by-8 roof decking. Predrill roof decking to prevent splitting.
      d. Use 30d tongue nails in bottom tongue and 3/8-inch face spikes for 5-by-6 and 5-by-8 roof decking. Predrill roof decking at spikes to prevent splitting.

3. Slant nail each course of glued-laminated wood roof decking to the tongue of the adjacent course at 30 inches o.c. and within 12 inches of the end of each unit. Stagger nailing 15 inches in adjacent courses.
   a. Use 8d nails for 3-by-6 and 3-by-8 roof decking.
   b. Use 10d nails for 4-by-6 and 4-by-8 roof decking.
   c. Use 16d nails for 5-by-6 and 5-by-8 roof decking.

4. Glue adjoining roof decking courses together by applying a 3/8-inch bead of adhesive to the top of tongues, according to research/evaluation report.

C. Anchor wood roof decking, where supported on walls, with bolts as indicated.

D. Where preservative-treated roof decking must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.
   1. For solid-sawn roof decking, use inorganic boron (SBX).
   2. For laminated roof decking, use copper naphthenate.

E. Apply joint sealant to seal roof decking at exterior walls at the following locations:
   1. Between roof decking and supports located at exterior walls.
   2. Between roof decking and exterior walls that butt against underside of roof decking.
   3. Between tongues and grooves of roof decking over exterior walls and supports at exterior walls.
3.3 ADJUSTING

A. Repair damaged surfaces and finishes after completing erection. Replace damaged roof decking if repairs are not approved by Architect.

3.4 PROTECTION

A. Provide water-resistive barrier over roof decking as the Work progresses to protect roof decking until roofing is applied.

B. If, despite protection, roof decking becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 1516
SECTION 061600
SHEATHING

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. Wall sheathing.
   2. Roof sheathing.
   3. Composite nail base insulated roof sheathing.
   4. Subflooring.
   5. Underlayment.

B. Related Requirements:
   1. Section 061000 "Rough Carpentry," Section 061053 "Miscellaneous Rough Carpentry" for plywood backing panels.
   2. Section 072500 "Weather Barriers" for water-resistant barrier applied over wall sheathing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review air-barrier and water-resistant glass-mat gypsum sheathing requirements and installation, special details, transitions, mockups, air-leakage testing, protection, and work scheduling that covers air-barrier and water-resistant glass-mat gypsum sheathing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
   2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5516.

4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

5. For air-barrier and water-resistant glass-mat gypsum sheathing, include manufacturer's technical data and tested physical and performance properties of products.

B. Shop Drawings: For air-barrier and water-resistant glass-mat gypsum sheathing assemblies.

1. Show locations and extent of sheathing, accessories, and assemblies specific to Project conditions.
2. Include details for sheathing joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
3. Include details of interfaces with other materials that form part of air barrier.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing and inspecting agency.

B. Product Certificates: From air-barrier and water-resistant glass-mat gypsum sheathing manufacturer, certifying compatibility of sheathing accessory materials with Project materials that connect to or that come in contact with the sheathing.

C. Product Test Reports: For each air-barrier and water-resistant glass-mat gypsum sheathing assembly, indicating compliance with specified requirements, for tests performed by a qualified testing agency.

D. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated plywood.
2. Fire-retardant-treated plywood.
3. Foam-plastic sheathing.

E. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer of air-barrier and water-resistant glass-mat gypsum sheathing.

1. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

B. Testing Agency Qualifications:

1. For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs
1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: As tested according to ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

B. Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing Performance: Air-barrier and water-resistant glass-mat gypsum sheathing assembly, and seals with adjacent construction, shall be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, tie-ins to other installed air barriers, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

2.2 WOOD PANEL PRODUCTS

A. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.

B. Factory mark panels to indicate compliance with applicable standard.

2.3 PRESERVATIVE-TREATED PLYWOOD

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
C. Application: Treat items indicated on Drawings and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

2.4 FIRE-RETARDANT-TREATED PLYWOOD

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.
4. Design Value Adjustment Factors: Treated lumber plywood shall be tested according to ASTM D5516 and design value adjustment factors shall be calculated according to ASTM D6305. Span ratings after treatment shall be not less than span ratings specified. For roof sheathing and where high-temperature fire-retardant treatment is indicated, span ratings for temperatures up to 170 deg F shall be not less than span ratings specified.

C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

E. Application: Treat plywood indicated on Drawings, and the following:

1. Roof and wall sheathing within 48 inches of fire walls.
2. Roof sheathing.
3. Subflooring and underlayment for raised platforms.

2.5 WALL SHEATHING

A. Plywood Sheathing: Exposure 1, Structural I sheathing.

1. Span Rating: Not less than 32/16.
2. Nominal Thickness: as indicated on the Contract Drawings

B. Oriented-Strand-Board Sheathing: DOC PS 2, Exposure 1, Structural I sheathing.

1. Span Rating: Not less than 24/16.
2. Nominal Thickness: as indicated on the Contract Drawings
2.6 ROOF SHEATHING

A. Plywood Sheathing: Exposure 1, Structural I sheathing.
   1. Span Rating: Not less than 32/16.
   2. Nominal Thickness: as indicated on the Contract Drawings

B. Oriented-Strand-Board Sheathing: DOC PS 2, Exposure 1, Structural I sheathing.
   1. Span Rating: Not less than 24/16.
   2. Nominal Thickness: as indicated on the Contract Drawings

2.7 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. For roof and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M of Type 304 stainless steel.
   2. For roof and wall sheathing, provide fasteners with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B117.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.

E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

2.8 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.
   1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches wide, 10 by 10 or 10 by 20 threads/inch, of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

B. Sheathing Tape for Foam-Plastic Sheathing: Pressure-sensitive plastic tape recommended by sheathing manufacturer for sealing joints and penetrations in sheathing.
PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:
   1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
   2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's International Residential Code for One- and Two-Family Dwellings.
   3. ICC-ES evaluation report for fastener.

D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 WOOD STRUCTURAL PANEL INSTALLATION


B. Fastening Methods: Fasten panels as indicated below:
   1. Wall and Roof Sheathing:
      a. Nail to wood framing. Apply a continuous bead of glue to framing members at edges of wall sheathing panels.
      b. Screw to cold-formed metal framing.
      c. Space panels 1/8 inch apart at edges and ends.

3.3 FIELD QUALITY CONTROL

A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA’s Quality Assurance Program.
B. Testing and Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Inspections: Air-barrier and water-resistant glass-mat gypsum sheathing, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
   1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
   2. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
   3. Termination mastic has been applied on cut edges.
   4. Strips and transition strips have been firmly adhered to substrate.
   5. Compatible materials have been used.
   6. Transitions at changes in direction and structural support at gaps have been provided.
   7. Connections between assemblies (sheathing and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
   8. All penetrations have been sealed.

D. Tests: As determined by testing agency from among the following tests:
   1. Air-Leakage-Location Testing: Air-barrier sheathing assemblies will be tested for evidence of air leakage according to ASTM E1186, chamber pressurization or depressurization with smoke tracers, or ASTM E1186, chamber depressurization using detection liquids.
   2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate according to ASTM E783 or ASTM E2357.

E. Air barriers will be considered defective if they do not pass tests and inspections.

F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

G. Prepare test and inspection reports.

END OF SECTION 06 1600
SECTION 06 1753
SHOP-FABRICATED WOOD TRUSSES

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. Wood roof trusses.
2. Wood girder trusses.

B. Related Requirements:

1. Section 313116 "Termite Control" for site application of borate treatment to wood trusses.

1.3 ALLOWANCES

A. Provide wood truss bracing under the Metal-Plate-Connected Truss Bracing Allowance as specified in Section 012100 "Allowances."

1.4 DEFINITIONS

A. Metal-Plate-Connected Wood Trusses: Planar structural units consisting of metal-plate-connected members fabricated from dimension lumber and cut and assembled before delivery to Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For metal-plate connectors, metal truss accessories, and fasteners.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification from treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.

2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to truss fabricator.

B. Shop Drawings: Show fabrication and installation details for trusses.

1. Show location, pitch, span, camber, configuration, and spacing for each type of truss required.

2. Indicate sizes, stress grades, and species of lumber.
3. Indicate locations of permanent bracing required to prevent buckling of individual truss members due to design loads.
4. Indicate locations, sizes, and materials for permanent bracing required to prevent buckling of individual truss members due to design loads.
5. Indicate type, size, material, finish, design values, orientation, and location of metal connector plates.
6. Show splice details and bearing details.

C. Delegated-Design Submittal: For metal-plate-connected wood trusses indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Material Certificates: For dimension lumber specified to comply with minimum specific gravity. Indicate species and grade selected for each use and specific gravity.

C. Product Certificates: For metal-plate-connected wood trusses, signed by officer of truss-fabricating firm.

D. Evaluation Reports: For the following, from ICC-ES:
   1. Wood-preservative-treated lumber.
   2. Fire-retardant-treated wood.
   3. Metal-plate connectors.
   4. Metal truss accessories.

1.7 QUALITY ASSURANCE

A. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that is a member of TPI and that complies with quality-control procedures in TPI 1 for manufacture of connector plates.
   1. Manufacturer's responsibilities include providing professional engineering services needed to assume engineering responsibility.
   2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Fabricator Qualifications: Shop that participates in a recognized quality-assurance program, complies with quality-control procedures in TPI 1, and involves third-party inspection by an independent testing and inspecting agency acceptable to Architect and authorities having jurisdiction.

C. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.
1.8 DELIVERY, STORAGE, AND HANDLING

A. Handle and store trusses to comply with recommendations in SBCA BCSI, "Building Component Safety Information: Guide to Good Practice for Handling, Installing, Restraining, & Bracing Metal Plate Connected Wood Trusses."

1. Store trusses flat, off of ground, and adequately supported to prevent lateral bending.
2. Protect trusses from weather by covering with waterproof sheeting, securely anchored.
3. Provide for air circulation around stacks and under coverings.

B. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal-plate-connected wood trusses.

B. Structural Performance: Metal-plate-connected wood trusses shall be capable of withstanding design loads within limits and under conditions indicated. Comply with requirements in TPI 1 unless more stringent requirements are specified below.

1. Design Loads: As indicated.
2. Maximum Deflection under Design Loads:
   a. Roof Trusses: as indicated.

C. Comply with applicable requirements and recommendations of TPI 1, TPI DSB, and SBCA BCSI.


2.2 DIMENSION LUMBER

A. Lumber: DOC PS 20 and applicable rules of any rules-writing agency certified by the American Lumber Standard Committee (ALSC) Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, omit grade stamp and provide certificates of grade compliance issued by grading agency.
3. Provide dressed lumber, S4S.
4. Provide dry lumber with 19 percent maximum moisture content at time of dressing.

B. Permanent Bracing: Provide wood bracing that complies with requirements for miscellaneous lumber in Section 061000 "Rough Carpentry."
2.3 METAL CONNECTOR PLATES

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

   1. Alpine Engineered Products, Inc.; a division of ITW Building Components Group, Inc.
   2. Cherokee Metal Products, Inc.; Masengill Machinery Company.
   3. CompuTrus, Inc.
   4. Eagle Metal Products.
   5. Jager Building Systems, Inc.
   6. MiTek Industries, Inc.
   7. Robbins Engineering, Inc.
   8. Truswal Systems Corporation.

B. Fabricate connector plates to comply with TPI 1.

C. Hot-Dip Galvanized-Steel Sheet: ASTM A653/A653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G60 coating designation; and not less than 0.036 inch thick.

   1. Use for interior locations unless otherwise indicated.

D. Hot-Dip Heavy-Galvanized-Steel Sheet: ASTM A653/A653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.

   1. Use for wood-preservative-treated lumber and where indicated.

E. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, and not less than 0.035 inch thick.

   1. Use for exterior locations and where indicated.

2.4 FASTENERS

A. Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

   1. Provide fasteners for use with metal framing anchors that comply with written recommendations of metal framing manufacturer.

   2. Where trusses are exposed to weather, in ground contact, made from pressure-preservative treated wood, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.

B. Nails, Brads, and Staples: ASTM F1667.

2.5 METAL FRAMING ANCHORS AND ACCESSORIES

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

   1. Cleveland Steel Specialty Co.
   2. KC Metals Products, Inc.
3. Phoenix Metal Products, Inc.
4. Simpson Strong-Tie Co., Inc.
5. USP Structural Connectors.

B. Allowable design loads, as published by manufacturer, shall comply with or exceed those of products of manufacturers listed. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency. Framing anchors shall be punched for fasteners adequate to withstand same loads as framing anchors.

   1. Use for interior locations unless otherwise indicated.

D. Hot-Dip Heavy-Galvanized-Steel Sheet: ASTM A653/A653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.
   1. Use for wood-preservative-treated lumber and where indicated.

E. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
   1. Use for exterior locations and where indicated.

F. Truss Tie-Downs (Hurricane or Seismic Ties): Bent strap tie for fastening roof trusses to wall studs below, 2-1/4 inches wide by 0.062 inch thick. Tie fits over top of truss and fastens to both sides of truss, top plates, and one side of stud below.

G. Roof Truss Clips: Angle clips for bracing bottom chord of roof trusses at non-load-bearing walls, 1-1/4 inches wide by 0.050 inch thick. Clip is fastened to truss through slotted holes to allow for truss deflection.

H. Roof Truss Bracing/Spacers: U-shaped channels, 1-1/2 inches wide by 1 inch deep by 0.040 inch thick, made to fit between two adjacent trusses and accurately space them apart, and with tabs having metal teeth for fastening to trusses.

I. Drag Strut Connectors: Angle clip with one leg extended for fastening to the side of girder truss.
   1. Angle clip is 3 by 3 by 0.179 by 8 inches with extended leg 8 inches long. Connector has galvanized finish.
   2. Angle clip is 3 by 3 by 0.239 by 10-1/2 inches with extended leg 10-1/2 inches long. Connector has painted finish.

2.6 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20, with dry film containing a minimum of 92 percent zinc dust by weight.

2.7 FABRICATION

A. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints.
B. Fabricate metal connector plates to sizes, configurations, thicknesses, and anchorage details required to withstand design loads for types of joint designs indicated.

C. Assemble truss members in design configuration indicated; use jigs or other means to ensure uniformity and accuracy of assembly, with joints closely fitted to comply with tolerances in TPI 1. Position members to produce design camber indicated.
   1. Fabricate wood trusses within manufacturing tolerances in TPI 1.

D. Connect truss members by metal connector plates located and securely embedded simultaneously in both sides of wood members by air or hydraulic press.

2.8 SOURCE QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform special inspections.
   1. Provide special inspector with access to fabricator's documentation of detailed fabrication and quality-control procedures that provide a basis for inspection control of the workmanship and the fabricator's ability to conform to approved construction documents and referenced standards.
   2. Provide special inspector with access to places where wood trusses are being fabricated to perform inspections.

B. Correct deficiencies in Work that special inspections indicate do not comply with the Contract Documents.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wood trusses only after supporting construction is in place and is braced and secured.

B. If trusses are delivered to Project site in more than one piece, assemble trusses before installing.

C. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.

D. Install and brace trusses according to TPI recommendations and as indicated.

E. Install trusses plumb, square, and true to line and securely fasten to supporting construction.

F. Space trusses as indicated; adjust and align trusses in location before permanently fastening.

G. Anchor trusses securely at bearing points; use metal truss tie-downs or floor truss hangers as applicable. Install fasteners through each fastener hole in metal framing anchors according to manufacturer's fastening schedules and written instructions.

H. Securely connect each truss ply required for forming built-up girder trusses.
   1. Anchor trusses to girder trusses as indicated.
I. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.

   1. Install bracing to comply with Section 061000 "Rough Carpentry."
   2. Install and fasten strongback bracing vertically against vertical web of parallel-chord floor trusses at centers indicated.

J. Install wood trusses within installation tolerances in TPI 1.

K. Do not alter trusses in field. Do not cut, drill, notch, or remove truss members.

L. Replace wood trusses that are damaged or do not comply with requirements.

   1. Damaged trusses may be repaired according to truss repair details signed and sealed by the qualified professional engineer responsible for truss design, when approved by Architect.

3.2 REPAIRS AND PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect wood trusses from weather. If, despite protection, wood trusses become wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

C. Repair damaged galvanized coatings on exposed surfaces according to ASTM A780/A780M and manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform special inspections to verify that temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed in accordance with the approved truss submittal package.

END OF SECTION 06 1753
PART 1 GENERAL

1.01 SECTION INCLUDES

1.02 RELATED REQUIREMENTS
   A. Section 06 1000 - Rough Carpentry: Support framing, grounds, and concealed blocking.
   B. Section 06 4100 - Cabinets and Casework: Shop fabricated custom cabinet work.
   C. Section 09 9000 - Paints and Coatings: Painting and finishing of finish carpentry items.

1.03 REFERENCE STANDARDS
   B. AWI (QCP) - Quality Certification Program Current Edition.
   C. AWMAC (GIS) - Guarantee and Inspection Services Program Current Edition.

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordinate the work with plumbing rough-in, electrical rough-in, and installation of associated and adjacent components.
   B. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

1.05 PERFORMANCE REQUIREMENTS
   A. Meet or exceed the minimum requirements specified with respect to surface smoothness and joint tolerances.
   B. Fabricator shall replicate existing profiles and methods of joinery for each type of original finish carpentry where repaired, extended, or rebuilt.

1.06 SUBMITTALS
   A. Product Data: Provide data on finish material.
   B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
   1. Scale of Drawings: 1-1/2 inch to 1 foot (125 mm to 1 m), minimum.
   C. Samples: Submit two samples of finish plywood, 12x12 inch in size illustrating wood grain and specified finish.
   D. Samples: Submit two samples of wood trim 12 inch (304 mm) long.

1.07 PROJECT CONDITIONS
   A. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.
   B. Coordinate the work with plumbing rough-in, electrical rough-in, and installation of associated and adjacent components.

PART 2 PRODUCTS

2.01 FINISH CARPENTRY ITEMS
   A. Interior Woodwork Items:
      1. Moldings, Bases, Casings, and Miscellaneous Trim:
      2. Valance Work: Clear fir; prepare for paint finish.

2.02 SHEET MATERIALS
A. Plywood Exposed to View: Species Baltic Birch, B/BB Grade, all-birch veneer core crossbanded and laminated with exterior grade glue, Grading certified in accordance with the Russian export GOST 3916.1-96.

2.03 ACCESSORIES
A. Asphalt-saturated organic felt conforming to the requirements of ASTM D226, type II (No.30).
   1. Provide where wood elements touch concrete or masonry.
B. Clear Finish: as specified in Section 09 9000.
C. Wood Filler: Oil base, tinted to match surface finish color.

2.04 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.
C. When necessary to trim a piece of material which as been back primed, reapply the priming material over the cut area and allow to dry prior to installation.

2.05 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
3.01 EXAMINATION
A. Verify adequacy of backing and support framing.
B. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

3.02 INSTALLATION
A. Set and secure materials and components in place, plumb and level.
B. Carefully scribe work abutting other components, with maximum gaps of 1/32 inch (0.79 mm). Do not use additional overlay trim to conceal larger gaps.

3.03 INSTALLATION - BASE
A. Distribute defects allow in quality grades specified to the best overall advantage. Refer uncertainties to Architect.
B. Install in a single unjointed length for runs less than maximum length of lumber available. For longer runs, use pieces which average a minimum of three feet less than maximum length available.
C. Cope at inside corners and miter at outside corners to produce tight fitting joints with full surface contact throughout length of joint. Use scarf joints for end-to-end joints. Maintain field joint tolerance equal to those specified in AWI Standards for shop prepared joints.
D. Blind nail where possible and use fine finishing nails where exposed. Pre-drill as required to eliminate splitting. Set exposed nailheads and fill flush, matching final finish where transparent finish is indicated.
   1. Install base with double nails at 8 inches on center maximum spacing.

3.04 PREPARATION FOR SITE FINISHING
A. Set exposed fasteners. Apply wood filler in exposed fastener indentations. Sand work smooth.
B. Before installation, prime paint surfaces of items or assemblies to be in contact with cementitious materials.

3.05 CLEANING AND PROTECTION

A. Clean finish carpentry work on exposed and semi-exposed surfaces. Touch-up and sand only as required to restore damaged, abraded, or soiled areas.

B. Protection: Installer of finish carpentry work shall advise Contractor of final protection and maintained conditions necessary to ensure that work will be without damage or deterioration at time of acceptance.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Special fabricated cabinet units.
   B. Hardware.
   C. Preparation for installing utilities.

1.02 RELATED REQUIREMENTS
   A. Section 06 1000 - Rough Carpentry: Support framing, grounds, and concealed blocking.
   B. Section 06 2000 - Finish Carpentry
   C. Section 06 4150 - Solid Surface Countertops
   D. Section 09 9000 - Paints and coatings.

1.03 ADMINISTRATIVE REQUIREMENTS
   A. Preinstallation Meeting: Convene a preinstallation meeting not less than one week before starting work of this section; require attendance by all affected installers.

1.04 SUBMITTALS
   A. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, accessories, hardware location and schedule of finishes.
   B. Product Data: Provide data for hardware accessories.
   C. Samples: Submit actual samples of architectural cabinet construction, minimum 12 inches (300 mm) square, illustrating proposed cabinet and shelf unit substrate and finish.
   D. Samples: Submit two panels, 12 x 12 inch in size, illustrating cabinet finish.
   E. Samples: Submit two samples of proposed drawer pulls, hinges, and shelf standards, demonstrating hardware design, quality, and finish.

1.05 QUALITY ASSURANCE
   A. Perform work in accordance with AWI Architectural Woodwork Quality Standards Illustrated, Premium quality.
   B. Manufacturer Qualifications: Company specializing in fabricating the products specified in this section with minimum three years of documented experience.

1.06 MOCK-UP
   A. Provide mock-up of full size face frame and door for cabinet, including hardware and finish.
   B. Mock-up may not remain as part of the Work.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Protect units from moisture damage.

1.08 FIELD CONDITIONS
   A. During and after installation of cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 PRODUCTS

2.01 COUNTERTOPS
   A. Solid surfacing as specified in Section 06 4150.
   B. Plywood as specified in Section 06 2000.

2.02 ACCESSORIES
   A. Adhesive: Type recommended by fabricator to suit application.
   B. Fasteners: Size and type to suit application.
C. Concealed Joint Fasteners: Threaded steel.

2.03 HARDWARE
A. Hardware: BHMA A156.9 types as indicated for quality grade specified.
B. Hardware Finish: Provide polished chrome steel.
C. Shelf standards: Knape & Vogt #85.
D. Door Pulls:
   1. Product: DP129-SSS by Doug Mocket & Company
   2. Finish: Stainless Steel
   3. Substitutions: See TPWD UGC for substitutions.
E. Catches: Touch type.
F. Drawer Slides:
   1. Type: Extension types as scheduled.
   2. Products:
G. Hinges: Butt type, steel with chrome finish

2.04 FABRICATION
A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.
B. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.
C. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify adequacy of backing and support framing.
B. Verify location and sizes of utility rough-in associated with work of this section.

3.02 INSTALLATION
A. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.
B. Use fixture attachments in concealed locations for wall mounted components.
C. Use concealed joint fasteners to align and secure adjoining cabinet units.
D. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch (0.79 mm). Do not use additional overlay trim for this purpose.
E. Secure cabinets to floor using appropriate angles and anchorages.
F. Countersink anchorage devices at exposed locations. Con Population with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.

3.03 ADJUSTING
A. Adjust installed work.
B. Adjust moving or operating parts to function smoothly and correctly.

3.04 CLEANING
A. Clean casework, counters, shelves, hardware, fittings, and fixtures.
SECTION 06 4150
SOLID SURFACE COUNTERTOPS

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Countertops.

1.02 RELATED REQUIREMENTS
   A. Section 06 1000 - Rough Carpentry.
   B. Section 06 4100 - Cabinets and Casework.

1.03 REFERENCE STANDARDS
   A. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2003.

1.04 SUBMITTALS
   A. Product Data: Manufacturer's data sheets on each product to be used, including:
      1. Preparation instructions and recommendations.
      2. Storage and handling requirements and recommendations.
      3. Specimen warranty.
   B. Shop Drawings: Complete details of materials and installation.
   C. Selection Samples: For each finish product specified, color chips representing manufacturer's full range of available colors and patterns.
   D. Verification Samples: For each finish product specified, minimum size 6 inches square, representing actual finished product, color, and patterns.
   E. Test Reports: Chemical/stain resistance testing, showing compliance with requirements.
   F. Installation Instructions: Manufacturer's installation instructions and recommendations.

1.05 QUALITY ASSURANCE
   A. Installer Qualifications: Fabricator approved.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Store products in manufacturer's unopened packaging until ready for installation.
   B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.07 PROJECT CONDITIONS
   A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.08 WARRANTY
   A. Provide manufacturer's standard warranty against staining when subjected to standing water and commercial cleaning chemicals for the following duration:
      1. Fifteen(15) years.

PART 2 PRODUCTS
2.01 COUNTERTOP ASSEMBLIES
   A. Solid Surface Countertops: Solid surfacing sheet or plastic resin casting, self-supporting over structural members.
      1. Flat Sheet Thickness: 3/4 inch, minimum.
2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISSFA-2; acrylic resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.

3. Sinks and Bowls: Separate units for undercounter mounting; minimum 3/4 inch wall thickness; comply with ANSI Z124.3


5. Basis of Design:
   a. Product:
   b. Color and Pattern:
   c. Substitutions:

### 2.02 ACCESSORY MATERIALS

A. Plywood for supporting substrate: PS 1 Exterior Grade, A-C veneer grade, minimum 5-ply; minimum 3/4 inch thick; join lengths using metal splines.

B. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.

C. Joint Sealant: Mildew-resistant silicone sealant, clear.

D. Grommets
   1. Basis of design: Mockett ABG3-94 -3-1/2" Aluminum Grommet with Brush.
   2. Install 1 per every 5 linear feet at office space Countertops

### 2.03 FABRICATION

A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
   1. Join lengths of tops using best method recommended by manufacturer.
   2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
   3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.

B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
   1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
   2. Height: As indicated on drawings

C. Solid Surfacing: Fabricate tops up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.

D. Wall-Mounted Counters: Provide brackets, and braces, as indicated on drawings and fabricated as specified in the referenced section.

### PART 3 EXECUTION

#### 3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

#### 3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

#### 3.03 INSTALLATION
A. Securely attach countertops to support structures using concealed fasteners. Make flat surfaces level; shim where required.
B. Seal joint between back/end splashes and vertical surfaces.
   1. Where applied cove molding is not indicated use specified sealant.

3.04 CLEANING AND PROTECTION
A. Clean countertops surfaces thoroughly.
B. Protect installed products until completion of project.
C. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Fiberglass reinforced plastic panels.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
A. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
B. Samples: Submit two samples 6 inches by 6 inches inch in size illustrating material and surface design of panels.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Store panels flat, indoors, on a clean, dry surface. Remove packaging and allow panels to acclimate to room temperature for 48 hours prior to installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Fiberglass Reinforced Plastic Panels:
   2.

2.02 PANEL SYSTEMS
A. Wall Panels: Standard FRP S 100 S/2/S White
   1. Panel Size: 4 by 8 feet (1.2 by 2.4 m).
   2. Panel Thickness: 0.10 inch (2.5 mm).
   5. Attachment Method: Adhesive only, sealant joints, no trim.

2.03 MATERIALS
A. Panels: Fiberglass reinforced plastic (FRP), complying with ASTM D5319.
   1. Surface Burning Characteristics: Maximum flame spread index of 25 and smoke developed index of 450; when system tested in accordance with ASTM E84.
B. Adhesive: Type recommended by panel manufacturer.
C. Sealant: Type recommended by panel manufacturer; white.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify existing conditions and substrate flatness before starting work.
B. Verify that substrate conditions are ready to receive the work of this section.

3.02 INSTALLATION - WALLS
A. Install panels in accordance with manufacturer’s instructions.
B. Cut and drill panels with carbide tipped saw blades, drill bits, or snips.
C. Apply adhesive to the back side of the panel using trowel as recommended by adhesive manufacturer.
D. Apply panels to wall with seams plumb and pattern aligned with adjoining panels.
E. Install panels with manufacturer's recommended gap for panel field and corner joints.
F. Seal gaps at floor, ceiling, and between panels with applicable sealant to prevent moisture intrusion.
G. Remove excess sealant after paneling is installed and prior to curing.

END OF SECTION
SECTION 07 1300
SELF-ADHESIVE AIR AND WATER BARRIER

PART 1 GENERAL

1.01 SECTION INCLUDES
  A. High-temperature, Self Adhesive Air and Water Barrier

1.02 RELATED SECTIONS
  A. Section 07 6100 - Sheet Metal Roofing
  B. Section 07 6200 - Sheet Metal Flashing and Trim

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
  A. Refer to Owner’s General Conditions and Special Conditions, for submittal procedures.
  B. Product Data: Provide data for membrane.
  C. Manufacturer's Installation Instructions: Indicate special procedures.

1.05 QUALITY ASSURANCE
  A. Membrane Manufacturer Qualifications: Company specializing in roof waterproofing sheet membranes with three years experience.
  B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.06 FIELD CONDITIONS
  A. Maintain ambient temperatures above 60 degrees F for 24 hours before and during application and until liquid or mastic accessories have cured.

1.07 WARRANTY
  A. Correct defective Work within a 1 year period after Date of Substantial Completion.
  B. Provide 5 year manufacturer material warranty for waterproofing failing to resist penetration of water and failing to adhere to substrate, except where such failures are the result of structural failures of building. Hairline cracking of concrete due to temperature change or shrinkage is not considered a structural failure.
  C. For warranty repair work, remove and replace materials concealing waterproofing.

PART 2 PRODUCTS

2.01 MANUFACTURERS ROOF UNDERLAYMENTS
  A. Grace Ice & Water Sheild - www.GCPAT.COM
  B. Henry Company - www.henry.com

2.02 MEMBRANE MATERIALS
  A. Modified Bituminous Membrane: Asphalt and polymer modifiers of styrene-butadiene-styrene (SBS) type, surfaced and reinforced with non woven polyester; 40-mil thick self-adhering sheet with release liner on adhesive side
     3. Tensile Strength: 620 psi minimum ASTM D 412.
     4. Ultimate Elongation: At least 125 percent, measured in accordance with ASTM D 412.
     5. Adhesion to Plywood: 9 lb/in (528 N/M) ASTM D 903.
  B. Membrane Sealant: As recommended by membrane manufacturer.
2.03 ACCESSORIES
   A. Flexible Flashings: Type recommended by membrane manufacturer.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify existing conditions are acceptable prior to starting this work.
   B. Verify substrate surfaces are durable; free of matter detrimental to adhesion or application of waterproofing system.
   C. Verify items that penetrate surfaces to receive waterproofing are securely installed.

3.02 PREPARATION
   A. Protect adjacent surfaces from damage not designated to receive waterproofing.
   B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions; vacuum substrate clean.
   C. Do not apply waterproofing to surfaces unacceptable to membrane manufacturer.

3.03 INSTALLATION - MEMBRANE
   A. Install membrane waterproofing in accordance with manufacturer's instructions and NRCA (WM) applicable requirements.
   B. Roll out membrane, and minimize wrinkles and bubbles.
   C. Self-Adhering Membrane: Remove release paper layer, and roll out onto substrate with a mechanical roller to provide full contact bond.
   D. Overlap edges and ends, minimum 3 inches (76 mm), seal permanently waterproof by method recommended by manufacturer, and apply uniform bead of sealant to joint edge.
   E. Weather lap joints on sloped substrate in direction of drainage, and seal joints and seams.
   F. Flexible Flashings: Seal items watertight that penetrate through waterproofing membrane with flexible flashings.
   G. Extend membrane over cants and up intersecting surfaces at membrane perimeter minimum 6 inches (150 mm) above horizontal surface for first ply and 6 inches at subsequent plies laid in shingle fashion.
   H. Seal membrane and flashings to adjoining surfaces.

3.04 FIELD QUALITY CONTROL
   A. Inspection by Manufacturer's Representative:
      1. Inspect finished surface preparation, application, and finished waterproofing and require further preparation or application to achieve appropriate result.
   B. Owner may provide testing and inspection services. Contractor shall provide temporary construction and materials for such testing.

3.05 PROTECTION
   A. Do not permit traffic over unprotected or uncovered membrane.

END OF SECTION
SECTION 07 1326
UNDERSLAB WATERPROOFING WITH INSECT BARRIER

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Surface preparation.
B. Application of underslab barrier system.
C. Accessory Products

1.02 RELATED SECTIONS
A. Section 07 6200 – Flashing and Sheet Metal.
B. Section 07 9005 – Joint Sealers.

1.03 REFERENCES
B. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-
Tension.
D. ASTM E96 (Method B) - Standard Test Methods for Water Vapor Transmission of
Materials.
E. ASTM E154- Standard Test Methods for Water Vapor Retarders Used in Contact with
Earth Under Concrete Slabs, on Walls, or as Ground Cover.
F. ASTM D882 - 02 Standard Test Method for Tensile Properties of Thin Plastic Sheeting
G. ASTM D1876 - 00 Standard Test Method for Peel Resistance of Adhesives (T Peel Test)
H. ASTM D1434 - Test Method for Determining Gas Permeability Characteristics of Plastic Film
and Sheeting.
I. ASTM D6574 - 00 Test Method for Determining the (in plane) Hydraulic Transmissivity of a
geosynthetic by radial flow.
K. ASTM D4716 - 01 Test Method for determining the (In plane) Flow Rate per Unit Width and
Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
Waterproofing Membranes.

1.04 SUBMITTALS
A. Product Data: Submit manufacturer’s product data, installation instructions, use limitations and
recommendations. Include certification of data indicating VOC (Volatile Organic Compound)
content of all components of waterproofing system.
B. Samples: Submit representative samples of the following for approval:
   1. Underslab Barrier
   2. Barrier Tape and Accessories.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Underslab Barrier System must be manufactured by a company
with a minimum of 10 years of experience in the production and sales of membrane
waterproofing materials, as well as technical and sales personnel with backgrounds in
entomology and/or pest control.
B. Applicator Qualifications: A firm having at least 5 years of experience in applying these types of
specified materials and specifically accepted in writing by the barrier system manufacturer.
C. Materials: For each type of material required to complete the work of this section, provide primary materials which are the products of a single manufacturer.

D. Pre-Application Conference: A pre-application conference shall be held to establish procedures and to review conditions, installation procedures and coordination with other related work. Meeting agenda shall include review of special details and flashing.

E. Manufacturer’s Representative: Arrange to have trained representative of the manufacturer on site periodically to review installation procedures. Representative(s) must be trained in pest control as well as waterproofing.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Store materials in a clean, dry area in accordance with manufacturer's instructions.

C. Store adhesives and Underslab barrier at temperatures of 40°F (5oC) and above to facilitate handling.

D. Store barrier cartons on pallets.

E. Do not store at temperatures above 90°F (32oC) for extended periods.

F. Keep away from sparks and flames.

G. Completely cover when stored outside. Protect from rain.

H. Protect materials during handling and application to prevent damage or contamination.

I. Avoid use of products which contain tars, solvents, pitches, polysulfide polymers, or PVC materials that may come into contact with waterproofing barrier system.

1.07 PROJECT CONDITIONS
A. Work should be performed only when existing and forecasted weather conditions are within the limits established by the barrier manufacturer. Barrier should only be installed when temperature is 40°F (4.44°C) and rising. Consult manufacturer for information concerning cooler temperatures.

B. Proceed with installation only when substrate construction and preparation work is complete. Ensure that subsoil is approved by architect or geotechnical firm.

C. Warn personnel against breathing of vapors and contact with skin and eyes; wear appropriate protective clothing and respiratory equipment.

D. Keep flammable products away from spark or flame. Post “No Smoking” signs. Do not allow spark producing equipment to be used during application and until all vapors have dissipated.

E. Maintain work area in a neat and workmanlike condition. Remove empty cartons and rubbish from the site daily.

1.08 WARRANTY
A. Provide a written 5 year material warranty from the manufacturer upon completion and acceptance of the installation.

PART 2 PRODUCTS
2.01 MANUFACTURER
A. Basis of Design: Polyguard Products Inc. P.O. Box 755 Ennis, TX 75120-0755; Phone: 214-515-5000 Fax: 972-875-9425 Email: info@polyguardproducts.com

B. Substitution:

2.02 SYSTEM MATERIALS
A. Basis of Design: High Strength Insect Barrier and Waterproofing: Polyguard TERM™ Underslab Waterproofing and Insect Barrier,
   1. A 95 mil rubberized asphalt membrane consisting of a strong sheet membrane with a double thickness high strength cross-laminated polyethylene backing topped with a 65 mil
thick layer of proprietary barrier sealant integrated into a high strength nonwoven geotextile fabric. On the fabric side, a 4" wide lap of waterproofing adhesive compound is left exposed along one edge with a removable silicone coated plastic release sheet, which creates a 4" wide self-adhesive overlap seam.

B. See Section 01 1600 for substitution.

2.03 PHYSICAL PROPERTIES OF UNDERSLAB BARRIER

A. Long Term Resistance to Termite and Insect Penetration 4 Field sites over five years vs controls 100% effective ASTM D 1758 - 06

B. Tensile Strength of 1" width Polypropylene Geotextile layer 80.0 lb. / 36.3 kg ASTM D 4632

C. Resistance to Penetration by Pesticides 0.0% ASTM F-2130

D. Lap peel adhesion 8.7 lb. /983 N/mm ASTM D 1876 (modified die C) lb./in width

E. Puncture Resistance minimum 224lb / 996N ASTM E 154 using 1" (24mm) Rod

F. In Plane Hydraulic Transmissivity of a Geosynthetic by Radial Flow No water flow ASTM D 6574

G. Peel adhesion to concrete 20 lb. /2275 N/mm ASTM D 903 lb./in width (N/mm)

H. Membrane Thickness .095 inches /2.41cm ASTM D-1000

I. Elongation, rubberized asphalt sealant/adhesive component 839% ASTM D-412

J. Water absorption, maximum .1% ASTM D 570
   1. Cycling Over Crack @ -10° 100 cycles No effect ASTM C-836 Tested @ -15°
   2. Low temperature flexibility No effect No Effect No effect ASTM D 1970 180° bend over 1" mandrel at -20°F (-29°C).
   3. Hydraulic Transmissivity of a Geosynthetic Using a Constant Head No measurable flow ASTM D 4716
   4. Self Sealability - Water Vapor Transmission,maximum .01 ASTM E-96 – B US perms (ng/(Pa x s x m2)
   5. Resistance to hydrostatic head, minimum 231 ft./ 70 m ASTM D 5385
   6. Breaking Strength of 1" width sample Polyethylene backing layer 5470 PSI / 37.72 (N/mm2) ASTM D 882 PSI

2.04 SYSTEM ACCESSORIES

A. Surface Roller Grade Adhesive or Sealant:
   1. Basis of Design: Polyguard® 650 LT Liquid Adhesive: A rubber based adhesive in solvent solution which is specifically formulated to provide excellent adhesion with Polyguard Membranes to prepare all TERM UnderSeal Barrier endlaps and areas around penetrations. Designed to be used on applications down to 25°F (-4°C).

B. Repairs and End Laps
   1. Basis of Design: Polyguard® TERM™ UVR Barrier: Fabric backed barrier used for repairs and end laps.

C. Detailing at Penetrations - WATERPROOFING

D. Detailing at Penetrations – INSECT Barrier
   1. Basis of Design: Polyguard® TERM™ Penetration Barrier: Gunnable sealant barrier used around pipe penetrations.

2.05 TERMINATIONS ONTO VERTICAL

A. Basis of Design: Polyguard Sill Plate / Detailing Barrier

PART 3 EXECUTION

3.01 EXAMINATION
A. Examine surfaces to receive membrane. Notify General Contractor if surfaces are not acceptable. Do not begin surface preparation or application until unacceptable conditions have been corrected.

3.02 SURFACE PREPARATION
A. Protect adjacent surfaces not designated to receive waterproofing and insect barrier.
B. Prepare surfaces to receive waterproofing and insect barrier in accordance with manufacturer's instructions.

3.03 APPLICATION
A. Horizontal Application shall be in accordance with manufacturer’s instructions and ASTM E 1634-98.
   1. Unroll barrier membrane with longest dimension parallel with direction of pour.
   2. Place high strength polyethylene backing to the soil underneath and fabric on top.
   3. Lap waterproofing barrier membrane over footings and seal to foundation walls.
   4. Overlap side seams using the maximum 4” edge trim seal. If polyethylene backing has become dirty, clean its surface with 30% Isopropyl Alcohol prior to application on the 4” edge seal.
   5. End laps should be overlapped a minimum of 4” and addressed by applying a coat of liquid adhesive or sealant approximately 150-200 sq. ft. per gallon to fabric side of barrier membrane and placing adjacent sheet on top.
   6. After application of end lap use liquid adhesive or sealant to prepare seam and apply a 12” piece of UV resistant barrier tape centered over seam to seal extend out 6” past side laps.
   7. Roll side seams and end laps with a minimum 75 lb. steel roller to assure full adhesion.
B. For penetrations – waterproofing:
   1. Apply liquid adhesive or sealant a minimum of 4” out from penetrations.
   2. Install Polyguard FastPitch™ around penetrations, with a minimum of 4” between all penetrations and the collar.
   3. Push up any sleeves on penetrations from the portion of the penetration where the pourable LM85 sealant and TERM Penetration Barrier Sealant will be applied (minimum of 3” up).
   4. Penetrations should have a clean surface (wire brush or sand) before pourable sealant is applied.
      a. Apply LM 85 Self Leveling Sealant at all penetrations extending a minimum of 4” onto underslab barrier membrane, and 2” in depth, completely filling the FastPitch collar.
      b. Allow LM 85 to cure until solid (30 minutes to 2 hours depending on conditions).
C. For penetrations – TERM Penetration Barrier (this step must be performed by a Polyguard approved pest control applicator):
   1. Apply minimum ½” width bead on gunnable TERM Penetration Barrier around the neck of each penetration.
   2. Steel reinforcements will be applied directly over the barrier membrane. It is of utmost importance that reinforcement (rebar) chairs that are used are compatible with the system. Steel chairs and bolsters should be plastic dipped or have plastic caps.
   3. Precaution should be taken to protect the barrier membrane during placement of reinforcing or concrete. Visually inspect barrier membrane prior to pouring of concrete for any punctures or damage to membrane which needs to be repaired. Patch any damaged areas by applying the liquid adhesive at a rate of 150-200 sq. ft. per gallon to fabric side of waterproofing barrier membrane and apply a patch of fabric tape.
   4. Prior to slab pour all standing water must be removed from the membrane.

END OF SECTION
SECTION 07 2100
THERMAL INSULATION

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Board insulation at over roof deck.
   B. Batt insulation in interior wall and ceiling construction.
   C. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements for submittal procedures.
   B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.

PART 2 PRODUCTS
2.01 APPLICATIONS
   A. Insulation in Wood Framed Walls: Batt insulation with no vapor retarder.
   B. Insulation Above Lay-In Acoustical Ceilings: Batt insulation with no vapor retarder.
   C. Insulation Over Roof Deck: Polyisocyanurate board.

2.02 FOAM BOARD INSULATION MATERIALS
   A. Polyisocyanurate (ISO) Board Insulation: Rigid cellular foam, complying with ASTM C1289.
      1. Classifications:
         a. Type I: Faced with aluminum foil on both major surfaces of the core foam.
            1) Class 1 - Non-reinforced core foam.
            2) Compressive Strength: 16 psi (110 kPa), minimum.
            3) Thermal Resistance, R-value (R-6): At 1 inch (25.4mm) thick; 9.0 (1.59), minimum, at 75 degrees F (24 degrees C).
      2. Board Size: 48 inch by 96 inch (1220 mm by 2440 mm).
      3. Board Thickness: 1.0 inch (25 mm).
      4. Products:
         a. DuPont de Nemours, Inc; Thermax Sheathing: building.dupont.com/#sle.
         b. GAF; EnergyGuard Polyiso Insulation: www.gaf.com/#sle.
         d. Rmax Inc; ECOMAXci FR: www.rmax.com/#sle.

2.03 BATT INSULATION MATERIALS
   A. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit.
1. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
2. Formaldehyde Content: Zero.
3. Thermal Resistance: R-value (RSI-value) of R-11 (1.9371).
4. Thickness: 3-1/2 inch (63.5 mm).
5. Facing: Aluminum foil, flame spread 25 rated; one side.
6. Products:
   b. Owens Corning Corporation; EcoTouch PINK FIBERGLAS Insulation: www.ocbuildingspec.com/#sle.

2.04 ACCESSORIES
A. Tape: Reinforced polyethylene film with acrylic pressure sensitive adhesive.
   1. Application: Sealing of interior circular penetrations, such as pipes or cables.
   2. Width: Are required for application.

B. Flashing Tape: Special reinforced film with high performance adhesive.
   2. Width: As required for application.

C. Tape joints of rigid insulation in accordance with roofing and insulation manufacturers' instructions.

D. Insulation Fasteners: Appropriate for purpose intended and approved by roofing manufacturer.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.
B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.02 BOARD INSTALLATION OVER LOW SLOPE ROOF DECK
A. Board Installation Over Roof Deck, General:
   1. See applicable roofing specification section for specific board installation requirements.
   2. Fasten insulation to deck in accordance with roofing manufacturer's written instructions and applicable Factory Mutual requirements.
   3. Do not apply more insulation than can be covered with roofing on the same day.

3.03 BATT INSTALLATION
A. Install insulation in accordance with manufacturer's instructions.
B. Install in exterior wall and ceiling spaces without gaps or voids. Do not compress insulation.
C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.

END OF SECTION
SECTION 07 2119
FOAMED-IN-PLACE INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Foamed-in-place insulation.
   1. In exterior framed walls.
   2. Below roof.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
A. See TPWD UGC - Uniform General Conditions. for submittal procedures.
B. Product Data: Provide product description, insulation properties, overcoat properties, and preparation requirements.
C. Certificates: Certify that products of this section meet or exceed specified requirements.
D. Manufacturer's Installation Instructions: Indicate special procedures, and perimeter conditions requiring special attention.

1.04 QUALITY ASSURANCE
A. Applicator Qualifications: Company specializing in performing work of the type specified, with minimum three years documented experience.

1.05 FIELD CONDITIONS
A. Do not apply foam when temperature is below that specified by the manufacturer for ambient air and substrate.
B. Closed-cell spray foam should be spray-applied to substrates when ambient air and surface temperatures fall within a range of 50F to 120F.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Closed Cell Foamed-In-Place Insulation:
   3. Substitutions: see the UGC - TPWD General Conditions See TPWD Uniform General Conditions for substitution procedures.

2.02 MATERIALS
A. Foamed-In-Place Insulation: Medium-density, rigid or semi-rigid, closed cell polyurethane foam; foamed on-site, using blowing agent of water or non-ozone-depleting gas.
   1. Thermal Resistance: R-value (RSI-value) of 5.0 (0.88), minimum, per 1 inch (25.4 mm) thickness at 75 degrees F (24 degrees C) mean temperature when tested in accordance with ASTM C518.
   2. Water Vapor Permeance: Vapor retarder; 2 perms (115 ng/(Pa s sqm)), maximum, when tested at intended thickness in accordance with ASTM E96/E96M, desiccant method.
   3. Water Absorption: Less than 2 percent by volume, maximum, when tested in accordance with ASTM D2842.
   4. Air Permeance: 0.04 cfm/sq ft (0.2 L/second sq meter), maximum, when tested at intended thickness in accordance with ASTM E2178 or ASTM E283 at 1.57 psf (75 Pa).
   5. Closed Cell Content: At least 90 percent.
   6. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/450, maximum, when tested in accordance with ASTM E84.
   7. Basis of Design:
   8. Other Acceptable Manufacturers:
   9. Substitutions: see the TPWD UGC - Uniform General Conditions.

2.03 ACCESSORIES
A. Primer: As required by insulation manufacturer.
   1. Provide primer for all substrates unless pre-construction adhesion testing indicates that a primer is not required and manufacturer confirms the test conclusion in writing.
      a. For modified B.U.R., concrete, wood, brick, metal (ferrous, not rusted). The primer must be approved by the foam and coating manufacturer, such as a water based epoxy primer, unseal from United Coatings or Swift Foamboard.
      b. For non-ferrous metals (cleaned aluminum, galvanized steel, copper, etc.) - a primer shall be required. Subject to approval by the manufacturer, such a primer Techno Adhesive's P199 Primer.

B. PART 3 EXECUTION
3.01 EXAMINATION
A. Verify work within construction spaces or crevices is complete prior to insulation application.
B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation or overcoat adhesion.

3.02 PREPARATION
A. Mask and protect adjacent surfaces from over spray or dusting.
B. Apply primer in accordance with manufacturer's instructions.
C. Damper controls shall be indentified in order to avoid the installation of insulation at these locations.
D. PVC or ABS pipe of three (3) inches or less in diameter must be braced every three (3) feet to prevent excessive deflection by the expanding foam.
E. Plumbing stacks which penetrate the exterior envelope are to be cut in so as to provide a minimum 1/2 inch space around the stack to permit the installation.
F. Cleanouts and valves shall be identified in order to avoid the installation of insulation at these locations.
G. Familiarize all installers with correct and safe application and handling procedures.
H. Fill, cover, or tape joints and cracks exceeding a width of 1/4 in substrate. Remove dust and dirt from joints and cracks before applying polyurethane foam.
I. Before starting to apply foam or coating, shut off all HVAC equipment and seal air intakes and exhausts. Seal other potential sources of air entry into the building.

J. Apply primer in accordance with manufacturer's instructions.

### 3.03 APPLICATION

A. Apply insulation in accordance with manufacturer's instructions.

B. Apply insulation by spray method, to a uniform monolithic density without voids.

C. Spray insulation to envelop entire area to be insulated and fill voids.

D. Apply to a thickness to fully fill the wall/roof cavity to match stud depth, infill in manufacturer suggested lift depths.

E. Seal airtight and light tight at transitions to dissimilar materials.

F. Remove foam insulation not meeting minimum surface-texture limitations.

G. Patch damaged areas.

H. Exothermic Caution:
   1. Spray closed cell polyurethane in minimum lifts of 1/2 inch (13 mm), and a maximum of 2 inches (51 mm), to avoid fire hazards resulting from excessive heat generation.
   2. When applying SPF on chlorinated polyvinyl chloride, the lift thickness must be limited to 1/2 inch (13 mm) on the first lift and 2 inches (51 mm) on additional lifts.
   3. The first lift must be allowed to cool before subsequent lifts can be applied. If a second lift is needed, wait 10 to 15 minutes to allow reaction heat to dissipate. Wait 30 minutes between lifts for subsequent lifts.

I. Framed Construction: To reduce the chance for shrink in the installed product, spray an initial pass around the perimeter of the frame cavity as a “picture frame” and allow to cool. Spray the remainder of area with second pass no more than 1 inch (25 mm) and allow to cool, then install remainder of foam into cavities formed by framing members to achieve fully filling the cavity.

J. Ventilate enclosed spray areas during installation and for 24 hours after spray application has ended.

### 3.04 FIELD QUALITY CONTROL

A. Field inspections and tests will be performed by an independent testing agency under provisions of Section 01 4000 - Quality Requirements.

B. Field inspections and tests will be performed by an independent testing agency under provisions of the TPWD UGC - Uniform General Conditions.

C. Inspection will include verification of insulation and overcoat thickness and density.

### 3.05 PROTECTION

A. Do not permit subsequent construction work to disturb applied insulation.

**END OF SECTION**
SECTION 07 4623
WOOD SIDING

PART 1  GENERAL

1.01  SECTION INCLUDES
   A. Wood siding for interior walls.
   B. Fastenings.

1.02  RELATED REQUIREMENTS
   A. Section 06 1000 - Rough Carpentry:
   B. Structural S101 - General Notes - Timber Framing
   C. Section 07 6200 - Sheet Metal Flashing and Trim: Product requirements for metal flashings and trim associated with wood siding for placement by this section.
   D. Section 07 9200 - Joint Sealants: Sealing joints between siding and adjacent construction and fixtures.

1.03  REFERENCE STANDARDS
   B. SPIB (GR) - Grading Rules 2014.

1.04  SUBMITTALS
   A. Product Data: Provide data indicating materials, component profiles, fastening methods, jointing details, sizes, surface texture, finishes, and accessories.
   B. Samples: Submit two samples 12 inch by 12 inch (305 mm by 305 mm) in size illustrating surface texture.
   C. Samples: Submit two samples 12 x 12 inch (300 x 300 mm) in size illustrating final finish.
   D. Documentation of compliance with Forestry Stewardship Council (FSC) Certification.

1.05  QUALITY ASSURANCE
   A. Grade lumber in accordance with the following:
      1. Grading Rules, Southern Pine Inspection Bureau, Inc. (SPIB)
   B. Forestry Stewardship Council (FSC) Certification: Wood siding is required to be obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, “FSC Principles and Criteria for Forest Stewardship.”
   C. Warranty: Provide Manufacturer's 5 year warranty against moisture damage, cracking, peeling, and blistering.

1.06  DELIVERY, STORAGE, AND HANDLING
   A. Store in ventilated areas with constant minimum temperature of 60 degrees F (16 degrees C) and maximum relative humidity of 55 percent.
   B. Inspect product prior to and during delivery, including the condition, profile, dimension, and finish.
   C. Prior to installation, protect from siding from direct sunlight, water saturation, dirt and other elements. Store the siding flat and off the ground on stickers at least 4” off the ground. Protect with a tented waterproof covering. Do not seal the unit, as good air circulation is required.
   D. Handle product with extreme care.

PART 2  PRODUCTS

2.01  MANUFACTURERS
   A. Basis of design:
   B. Substitutions:

2.02  SIDING

CONSTRUCTION DOCUMENTS
04/09/2021
Wood Siding 1 of 2
A. Board Siding: 1x6, Popular/Common, B grade. Number 2 lumber
   1. Size:
   2. Profiles: Ship lap
   3. Surface Texture: S4S.

2.03 ACCESSORIES

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrates are ready to receive work.
B. Do not begin until unacceptable conditions have been corrected.
C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 ACCLIMATION

A. Siding should be dried at the mill to 12-15% moisture content. Siding that has not been wetted prior to arrival on the job site may be applied upon arrival except in hot and dry conditions where a minimum of 3 to 5 days of well ventilated storage is generally required.

3.03 FASTENERS

A. No. 304 stainless splitless ring shank nails for general siding applications.
B. Hand nail to minimize overdriving and damage to the siding.
C. Use nails long enough so they penetrate into stud wall a minimum of 1 1/4 inches.

3.04 INSTALLATION

A. Fasten siding in place, level and plumb.
   1. Arrange for orderly nailing pattern, blind nail except over trim.
   2. Install siding for natural shed of water.
   3. Position cut ends over bearing surfaces, and sand cut edges smooth and clean.

B. Install board siding using single course method.
   1. Nail at 16 inches on center, at furring studs.
   2. Butt-joint at external and cope internal corners.

C. Touch-up prefinished surfaces that are disfigured. Unsightly touch-up will require removal and replacement of affected siding.

3.05 TOLERANCES

A. Maximum Variation From Plumb and Level: 1/4 inch per 10 feet (6 mm/3 m).
B. Maximum Offset From Joint Alignment: 1/16 inch (1.5 mm).

END OF SECTION
SECTION 07 6100
SHEET METAL ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Standing-seam roofing, trim and attached devices

1.02 RELATED REQUIREMENTS
A. Refer to Owner’s General Conditions and Special Conditions.
B. Section 06 1000 - Rough Carpentry
C. Section 07 1300 - Self-Adhesive Air and Water Barrier
D. Section 07 6200 - Sheet Metal Flashing and Trim: Flashing and other trim

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
A. Refer to Owner’s General Conditions and Special Conditions, for submittal procedures.
B. Product Data: Submit metal manufacturer's and fabricator's specifications, installation instructions, and general recommendations for roofing applications.
C. Shop Drawings: Show manner of forming, joining, and securing sheet metal roofing, and pattern of seams. Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details. Show expansion joint details and waterproof connections to adjoining work and at obstructions and penetrations. Show layout, jointing, cleat gauges and spacings, profiles, metal gages, support, relationship to adjoining work and other pertinent details.
   1. Produce plans and layouts at 1/4 inch scale, details at 3 inch scale.
D. Installation Samples: Submit two samples 12 x 12 inch in size illustrating metal roofing mounted on plywood backing illustrating typical seam, external corner, and internal corner.

1.05 QUALITY ASSURANCE
A. Perform work in accordance with SMACNA (ASMM) requirements and standard details, except as otherwise noted.
B. Installer Qualifications: Company specializing in performing sheet metal roof installations with minimum 10 years of experience.
C. Wind Uplift: Provide roof assemblies equivalent to the requirements of UL 580 for class 90 wind uplift resistance.

1.06 MOCK-UP
A. Before proceeding with final purchase of materials and fabrication of sheet metal roofing components, prepare mock-ups as follows:
   1. Ridge showing three seams and three sloping planes:
   2. Eave detail showing three seams, edge, apron, one sloping plane, and gutter.
   3. End detail showing crimped edge connection and fascia.
B. Locate Mock-ups where directed.
   1. Use materials and methods of fabrication and installation identical with project requirements
2. Retain existing mock-up as a quality standard for acceptance of completed sheet metal roofing.
C. Mock-up may remain as part of the Work.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Stack material to prevent twisting, bending, or abrasion, and to provide ventilation. Slope metal sheets to ensure drainage. Place protective layer between sheets to prevent scratching or damage.
B. Prevent contact with materials that could cause discoloration or staining.

1.08 WARRANTY
A. Refer to Owner’s General Conditions and Special Conditions, for additional warranty requirements.
B. Correct defective Work within a five year period after Date of Substantial Completion. Defective work includes degradation of metal finish.
C. Provide 5 year installers warranty for roof flashings, roof penetrations and roof curbs. Warranty shall include failure of watertightness or seals.
D. Provide 30 year manufacturer warranty for PVDF finish. Warranty shall include fading and coating failures.

PART 2 PRODUCTS
2.01 MANUFACTURERS
2.02
B. Alternate: Drexel Metals, Drexmet.com
C. Substitutions: Refer to Owner’s General Conditions and Special Conditions.

2.03 SHEET MATERIALS
A. Refer to drawings of roof type and location.
B. Pre-Finished Galvanized Steel Sheet (Galvalume): ASTM 792/A792M-97a, with 55% Aluminum-Zinc alloy coating; 26 gage, 0.0179 inch (0.45 mm) minimum base metal thickness, with factory coating for unpainted applications.

2.04 ACCESSORIES
A. Self-Adhesive Air and Water Barrier: refer to Section 07 1300
B. Threaded steel nails: minimum 1-1/2" hot-dipped galvanized , with minimum 3/8" head, for nailing concealed galvanized cleats to wood substrates, and sheet metal flanges built into membrane.
C. Sealant to be Concealed in Completed Work: type Neutral curing silicone sealant as recommended by manufacturer for substrates to be sealed.
   1. End Cap: Type B
   2. Finish: Finish to match roof.

2.05 FABRICATION
   1. Width of Pan: 18".
   2. Seam height: 1" refer to SMACNA (ASMM), Plate 85, detail 2.
   4. Ridge Detail: As indicated on drawings.
B. Form sections true to shape, accurate in size, square, and free from distortion or defects.
C. Fabricate cleats of same material as sheet, thickness to match roofing sheet, and at least 2 inch wide, interlockable with sheet. Provide fasteners to meet requirements of uplift, minimum of two fasteners per cleat.

D. Fabricate starter strips, interlockable with sheet.

E. Form pieces in longest practical lengths.

F. Hand hem exposed edges on underside 1/2 inch (13 mm) maximum, miter and seam corners.

G. Form material for joints with 1" standing seams, as indicated on drawings.

H. Fabricate corners from one piece with minimum 18 inch (450 mm) long legs; seam for rigidity, seal with sealant.

2.06 FINISHES
A. Factory Finish for Unpainted Applications: Transparent Resin Coating.

PART 3 EXECUTION

3.01 EXAMINATION
A. Inspect roof deck to verify deck is clean and smooth, free of depressions, waves, or projections, properly sloped to drains.

B. Verify roof openings, curbs, pipes, sleeves, ducts, or vents through roof are solidly set, reglets are in place, and nailing strips located.

C. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION
A. Clean surface to receive roofing. Substrate to be smooth and free of defects. Drive all projecting nails and fasteners flush with substrate.
   1. Place roofing felt and waterproofing over substrate as indicated. Refer Section 07 1300.
   2. Use adhesives for temporary anchorage, where possible to minimizes use of mechanical fasteners under roofing.
   3. Lap joints 6" minimum.

B. Install starter and edge strips, and cleats before starting installation.

C. Install surface mounted reglets true to lines and levels; seal top of reglets with sealant and refer to Section 07 9005 for placement of recessed-type reglets.

D. Back paint concealed metal surfaces and surfaces in contact with dissimilar metals with protective backing paint to a minimum dry film thickness of 15 mil (0.4 mm).

3.03 INSTALLATION - ROOFING
A. Apply underlayment over entire roof area.

B. Install 2x roof strapping as shown on drawings.

C. Cleat and seam all joints.

D. Use plastic cement for joints between metal and bitumen and for joints between metal and felts.

E. Provide formed metal pans for protrusions through roof. Fill pans watertight with plastic cement.

F. Provide gutters.

G. Solder lap joints. After soldering, wash metal clean with neutralizing solution, rinse with water.

3.04 INSTALLATION - STANDING SEAM ROOFING
A. Use only clean dry gloves during handling of roofing metal.

B. Do not have roof sheets slide over rough surfaces or each other.

C. Fasteners and other component parts should have equal corrosion resistance.

D. Lay sheets with long dimension perpendicular to eaves. Apply pans beginning at eaves.
E. Lock cleats into seams and flatten.
F. Stagger transverse joints of roofing sheets.
G. At eaves and gable ends, terminate roofing by hooking over edge strip.
H. Finish standing seams 1 inch (25 mm) high on flat surfaces.
I. Bend up one side edge 1-1/2 inches (38 mm) and other edge 1-3/4 inches (44 mm).
J. Make first fold 1/4 inch (6 mm) wide single fold and second fold 1/2 inch (13 mm) wide, providing locked portion of standing seam, 5 plies in thickness.
K. Fold lower ends of seams at eaves over at 45 degree angle.

3.05 INSTALLATION - BUILT-IN GUTTERS AND DOWNSPOUTS
A. Secure gutter lining to substrate with cleats spaced minimum 12 inches on center along edges of gutters.
B. Longitudinal joints not acceptable.
C. At roof edges, extend gutter lining under metal roofing 6 inches (152 mm) minimum and terminate in 3/4 inch (19 mm) folded edge secured by cleats; hook lower end of roofing into lock strip to form 3/4 inch (19 mm) wide loose-lock seam.
D. Seal gutters watertight, and seal joint of gutter to drain.
E. Set splash pads under downspouts.

3.06 PROTECTION
A. Do not permit traffic over unprotected roof surface.

END OF SECTION
SECTION 07 6200
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Fabricated sheet metal items, including flashings, counterflashings, gutters, downspouts, and other items indicated in Drawings.
B. Accessories.
C. Precast concrete splash pads.

1.02 RELATED REQUIREMENTS
A. Section 07 6100 - Sheet Metal Roofing.
B. Section 07 9005 - Joint Sealants: Sealing non-lap joints between sheet metal fabrications and adjacent construction.

1.03 REFERENCE STANDARDS
B. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.

1.04 SUBMITTALS
A. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

1.05 QUALITY ASSURANCE
A. Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.
B. Fabricator and Installer Qualifications: Company specializing in sheet metal work with ten years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
B. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS

2.01 MANUFACTURERS
B. Alternate: Drexel Metals, Drexmet.com
C. Substitutions: See Section 01 6000 - Product Requirements.

2.02 SHEET MATERIALS
A. Pre-Finished Galvanized Steel (Galvalume): ASTM A653/653M, with 55% Aluminum-Zinc alloy coating; minimum 24 gage (0.0239 inch) (0.61 mm) thick base metal, with factory coating for unpainted applications.
2.03 ACCESSORIES
A. Fasteners: Stainless steel, with soft neoprene washers.
B. Sealant to be Concealed in Completed Work: neutral

2.04 FABRICATION
A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
B. Fabricate cleats of same material as sheet, minimum 2 inches wide, interlocking with sheet.
C. Form pieces in longest possible lengths.
D. Hem exposed edges on underside 1/2 inch (13 mm); miter and seam corners.
E. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
F. Fabricate corners from one piece with minimum 18 inch (450 mm) long legs; seam for rigidity, seal with sealant.
G. Fabricate flashings to allow toe to extend 2 inches (50 mm) over roofing gravel. Return and brake edges.

2.05 GUTTER AND DOWNSPOUT FABRICATION
A. Gutters: SMACNA (ASMM) Rectangular profile.
B. Downspouts: Rectangular profile.
C. Gutters and Downspouts: Sizes indicated.
D. Accessories: Profiled to suit gutters and downspouts.
   1. Anchorage Devices: In accordance with SMACNA (ASMM) requirements.
   2. Gutter Supports: Straps.
      a. Basis of Design: Mastershield Gutter Guard
      b. Substitutions:
      c. Gutter guard must be removable
E. Splash Pads: Precast concrete type, of 11-1/2” x 20” x 3” and profiles indicated; minimum 3000 psi (21 MPa) at 28 days, with minimum 5 percent air entrainment.
F. Seal metal joints.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION
A. Install starter and edge strips, and cleats before starting installation.
B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil (0.4 mm).

3.03 INSTALLATION
A. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted..
B. Apply plastic cement compound between metal flashings and felt flashings.
C. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.
D. Secure gutters and downspouts in place with concealed fasteners.
E. Slope gutters 1/4 inch per 10 feet (2.1 mm per m), minimum.

F. Set splash pads under downspouts, and set in place with [____].

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sealants and joint backing.

1.02 RELATED SECTIONS

A. Section 06 2000 - Finish Carpentry
B. Section 08 1213 - Hollow Metal Doors and Frames
C. Section 08 4100 - Metal-Framed Storefronts.
D. Section 08 5113 - Aluminum Windows
E. Section 08 8000 - Glazing: Glazing sealants and accessories.
F. Section 09 3000 - Tiling: Sealant used as tile grout.
G. Section 09 9000 - Paints and Coatings

1.03 REFERENCE


1.04 PERFORMANCE REQUIREMENTS

A. Provide joint sealants that have been produced and installed to establish and to maintain watertight and airtight continuous seals without causing staining or deterioration of joint substrates.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with other sections referencing this section.

1.06 SUBMITTALS

A. Refer to Owner’s General Conditions and Special Conditions, for submittal procedures.
B. Product Data: Provide data indicating sealant chemical characteristics, substrate preparation, and color availability. Include material safety data sheets and certifications showing compliance with specified standards.
C. Samples: Submit two samples, 1/2 x 4 inch in size, illustrating sealant colors for selection.
D. Compatibility and adhesion test reports from elastomeric sealant manufacturer indicating that materials forming joint substrates and joint sealant backings have been tested for compatibility and adhesion with joint sealants. Include sealant manufacturer's interpretation of test results relative to sealant performance and recommendations for primer and substrate preparation needed to obtain adhesion.
E. Preconstruction field test reports indicating which products and joint preparation methods demonstrate acceptable adhesion to joint substrates
   1. Report whether or not sealant in joint 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 and joint substrate.
   2. Evaluation of Field Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.
F. Manufacturer's Installation Instructions: Indicate special procedures, surface preparation, and perimeter conditions requiring special attention.
1.07 QUALITY ASSURANCE
A. Maintain one copy of each referenced document covering installation requirements on site.
B. Deliver products in manufacturer's original containers clearly labeled with product identification, date of manufacture, and shelf life.
C. Store materials in a clean, dry area at temperatures below
D. Preconstruction Field Testing: Prior to installation of joint sealants, field-test their adhesion to joint substrates as follows:
   1. Locate test joints on mock-ups specified in reference sections and as directed by Architect.
   2. Notify Architect one week in advance of the dates and times when mock-ups will be erected and field adhesion test performed.
   3. Arrange for tests to take place with joint sealant manufacturer's technical representative present.
E. Test Method: Test joint sealants by hand pull method described below.
   1. Install joint sealants in 5-feet joint lengths using same materials and methods for joint preparation and joint sealant installation required for completed Work. Allow sealants to cure fully before testing.
   2. Make knife cuts horizontally from one side of joint to the other followed by 2 vertical cuts approximately 2 inches long at side of joint and meeting horizontal cut at top of 2-inch cuts. Place a mark 1 inch from top of 2-inch piece
   3. Use fingers to grasp 2-inch piece of sealant just above 1-inch mark; pull firmly down at 90-degree angle or more while holding a ruler along side of sealant. Pull sealant out of joint to the distance recommended by sealant manufacturer for testing adhesive capability, but not less than that equaling specified maximum movement capability in extension; hold this position for 1 seconds.
F. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
G. Applicator Qualifications: Company specializing in performing the work of this section with minimum three years experience.

1.08 MOCK-UP
A. Construct mock-up with specified sealant types and with other components noted.
B. Locate where directed.
C. Mock-up may remain as part of the Work.

1.09 FIELD CONDITIONS
A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.
B. Do not install sealants during inclement weather, strong winds, or when such conditions are expected. All wet surfaces must be dry and frost free.
C. Optimum sealant application temperature: Between 50 - 90 degrees F.

1.10 COORDINATION
A. Coordinate the work with all sections referencing this section.

1.11 WARRANTY
A. Correct defective work within a five year period after Date of Substantial Completion.
B. Warranty: Include coverage for installed sealants and accessories which fail to achieve airtight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Manufacturers that may have products that meet the specification requirements include:
1. Dow Corning Corp. www.dowcorning.com
2. Tremco. www.tremcosealants.com
3. Sonneborn. www.sonneborn.com

2.02 SEALANTS

A. Type-1: Exterior General - Silicone Sealant. Grade NS, Class 25
   3. Service temperature range: -65 to 180 degrees F (-54 to 82 degrees C).
   4. Applications: Use for:
      a. Sealant between window/door casing and exterior wall. Confirm compatibility with water/air barrier.
      b. Other exterior joints for which no other type of sealant is indicated.

B. Type-2: General Purpose Interior Sealant: Acrylic-Emulsion Latex; ASTM C834, Type OP, Grade NF single component, paintable.
   1. Provide manufacturer’s standard one-part, non-sag, mildew-resistant, paintable latex sealant that is recommended for exposed applications on interior and protected exterior locations and that accommodates joint width existing at time of installation without failing either adhesively or cohesively. Provide product complying with ASTM C834 that accommodates joint movement of not more than 5 percent in both extension and compression for a total of 10 percent.
   2. Applications: Use for:
      a. Interior wall and ceiling control joints
      b. Interior joints between door and window frames and wall surfaces.
      c. Other interior joints for which no other type of sealant is indicated.
   3. Available Products: Subject to compliance with requirements, latex joint sealants that may be incorporated in the Work include, but are not limited to, the following:
      c. "Tremflex Acrylic Latex 834," Tremco, Inc

C. Substitutions:

D. Type 3 - Interior: Tile Sealant: silicone; ASTM C920, Uses M and A; single component, mildew resistant, clear.
   1. Applications: Use for:
      a. Joints between plumbing fixtures and floor and wall surfaces.
      b. Joints between kitchen and bath countertops and wall surfaces.
      c. Joints between plumbing fixtures and countertop surfaces.

2.03 ACCESSORIES

A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Masking Tape: Non-staining, non-absorbent material compatible with joint sealants and surfaces adjacent to joints.

D. Sheathing Tape:
   1. Dow 1,2,3.
   2. Quick-Tape; Quick-Tape, Inc.
   3. Perma-Tite Tape- PGM 207A; PermaGlass-Mesh, Inc.

E. Joint Backing: Round foam rod compatible with sealant; ASTM D1056 sponge or expanded rubber; oversized 30 to 50 percent larger than joint width.
F. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that substrate surfaces are ready to receive work.
B. Ensure surfaces are clean, dry, and free of frost, dust, dirt, grease, oil, curing compounds, form release agents, laitance, efflorescence, mildew, and previous films and coatings.
C. Verify that joint backing and release tapes are compatible with sealant.
D. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
   1. Coordinate with Division 4 installers to establish the correct depth and configuration of masonry joints to be pointed with sealant.
E. Proceed with installation only after satisfactory conditions have been corrected.

3.02 PREPARATION
A. Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions and the following requirements:
   1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
   2. Clean porous joint substrate surfaces by brushing to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil free compressed air. Porous joint surfaces include the following:
      a. Stone
      b. Brick
      c. Wood
B. Remove loose materials and foreign matter that could impair adhesion of sealant.
C. Clean and prime joints in accordance with manufacturer's instructions.
   1. Joint Priming: Prime joint substrates 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.
D. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
E. Protect elements surrounding the work of this section from damage or disfigurement.
   1. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.03 INSTALLATION
A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
B. Perform installation in accordance with ASTM C1193.
C. Measure joint dimensions and size joint backers to achieve the following, unless otherwise indicated:
   2. Neck dimension no greater than 1/3 of the joint width.
3. Surface bond area on each side not less than 75 percent of joint width.

D. Install bond breaker where joint backing is not used.

E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

F. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

G. Tooling for Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Tool joints concave and slightly recessed at edges for vertical joints.
   2. Tool joints flush and slightly recessed at edges for paving and floor joint sealants.

H. Provide color break of sealant on vertical expansion joints as required to match adjacent stone color.

I. Provide appropriate curing and installation of sealants to prevent color bleeding.

J. Provide joint configuration per shield manufacturer's literature and details on drawings for recess depth and sealant overlap at locations indicated to receive lead 'tee' shield.
   1. Use masking tape to protect adjacent surfaces of capped joints. Form shield by notching back flange at 3-4" intervals to tightly follow masonry surface contour.

3.04 FIELD QUALITY CONTROL

A. When directed by Architect, perform field-adhesion tests in locations and numbers required. Cost of tests will be paid by Contractor for first 10 tests. Additional tests will be paid:
   1. by Contractor if sealant fails test, or
   2. by Owner if sealant passes test.

B. Field-Adhesion Testing: Field-test joint-sealant adhesion to joint substrates as follows:
   1. Test Method: Test joint sealants by hand-pull method described below:
      a. Make knife cuts from one side of joint to the other, followed by two cuts approximately 2 inches (50 mm) long at sides of joint and meeting cross cut at one end. Place a mark 1 inch (25 mm) from cross-cut end of 2-inch (50-mm) piece
      b. Use fingers to grasp 2-inch (50-mm) piece of sealant between cross-cut end and 1-inch (25-mm) mark; pull firmly at a 90-degree angle or more in direction of side cuts while holding a ruler along side of sealant. Pull sealant out of joint to the distance recommended by sealant manufacturer for testing adhesive capability, but not less than that equaling specified maximum movement capability in extension; hold this position for 10 seconds.
      c. For joints with dissimilar substrates, check adhesion to each substrate separately. Do this by extending cut along one side, checking adhesion to opposite side, and then repeating this procedure for opposite side.
   2. 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.
   3. 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 and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria
      b. Whether sealants filled joint cavities and are free from voids.
      c. Whether sealant dimensions and configurations comply with specified requirements.
   4. Record test results in a field adhesion test log. 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.
   5. Repair sealants pulled from test area by applying new sealants following same procedures used to originally seal joints. Ensure that original sealant surfaces are clean and new sealant contacts original sealant.
C. Evaluation of Field-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements, will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.05 CLEANING
   A. Remove masking tape and excess sealant.
   B. Clean adjacent soiled surfaces.

3.06 PROTECTION
   A. Protect sealants until cured.

END OF SECTION
SECTION 08 1213
HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Non-fire-rated steel doors and frames.

1.02 RELATED REQUIREMENTS
A. Section 07 9005 - Joint Sealers.
B. Section 08 7110 - Door Hardware.
C. Section 08 8000 - Glazing: Glass for doors and borrowed lites.
D. Section 09 9000 - Paints & Coatings: Field painting.

1.03 REFERENCE STANDARDS
B. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2014.
F. BHMA A156.115 - American National Standard for Hardware Preparation in Steel Doors and Steel Frames; 2014. (ANSI/BHMA A156.115)

1.04 SUBMITTALS
A. See TPWD UGC/Special Conditions, for submittal procedures.
B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced grade standard.
C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and identifying location of different finishes, if any.

1.05 QUALITY ASSURANCE
A. Maintain at the project site a copy of all reference standards dealing with installation.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Store in accordance with NAAMM HMMA 840.
B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Steel Doors and Frames:
   4. Substitutions: See Section 01 6000 - Product Requirements.
2.02 DOORS AND FRAMES

A. Requirements for All Doors and Frames:
   1. Accessibility: Comply with ICC A117.1 and ADA Standards.
   2. Door Top Closures: Flush with top of faces and edges.
   3. Door Edge Profile: Beveled on both edges.
   5. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.
   6. Hardware Preparation: In accordance with BHMA A156.115, with reinforcement welded in place, in addition to other requirements specified in door grade standard.
   7. Galvanizing exterior units: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with manufacturer’s standard coating thickness.

B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with all the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 STEEL DOORS

A. Exterior Single Doors: Non-Fire-Rated:
   1. Grade: ANSI/SDI A250.8 (SDI-100); Level 3 - Extra Heavy-Duty, Physical Performance Level A, Model 3 - Stile and Rail.
   2. Core: Polurethane.
   3. Thickness: 1-3/4" (44.5 mm)
   5. Insulating Value: U-Value of 0.50, when tested in accordance with ASTM C1363.
   6. Weather Stripping: Separate see Section 08 7100.
   7. Finish: Factory primed and Field Painted.

B. Interior Doors Non-Fire-Rated:
   1. Grade: ANSI/SDI A250.8 (SDI-100); Level 3 - Extra Heavy-Duty, Physical Performance Level A, Model 3 - Stile and Rail.
   2. Core: Polurethane.
   3. Thickness: 1-3/4 inch (44.5 mm).
   4. Finish: Factory primed, for field finishing.

2.04 STEEL FRAMES

A. General:
   1. Comply with the requirements of grade specified for corresponding door.
   2. Finish: Factory primed, for field finishing.

B. Exterior Door Frames: Fully welded:
   2. Weatherstripping: Separate, see Section 08 7100.

C. Interior Door Frames, Non-Fire-Rated: Slip-on drywall type.
   1. Finish: Factory primed, for field finishing.

D. Frames for Interior Glazing or Borrowed Lights: Construction and face dimensions to match door frames, and as indicated on drawings.

E. Transom Bars: Fixed, of profile same as jamb and head.

2.05 ACCESSORY MATERIALS

A. Louvers: Roll formed steel with overlapping frame; finish same as door components; factory-installed.
1. In Fire-Rated Doors: UL (Underwriters Laboratories) - UL (BMD) listed fusible link louver, same rating as door.
2. Style: Sightproof inverted V blade.
3. Product: Titus T-700L.

B. Glazing: As specified in Section 08 8000, factory installed.

C. Removable Stops: Formed sheet steel, shape as indicated on drawings, mitered or butted corners; prepared for countersink style tamper proof screws.

D. Silencers: Resilient rubber, fitted into drilled hole; 3 on strike side of single door, 3 on center mullion of pairs, and 2 on head of pairs without center mullions.

E. Temporary Frame Spreaders: Provide for all factory- or shop-assembled frames.

F. Supports and Anchors: Fabricated from not less than 0.042-inch- (1.0-mm-) thick, electrolytic zinc-coated or metallic-coated steel sheet.

G. Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where zinc-coated items are to be built into exterior walls, comply with ASTM A 153/A 153M, Class C or D as applicable.

2.06 FABRICATION

A. Fabricate steel door and frame units to comply with ANSI A250.8 and to be rigid, neat in appearance, and free from defects including warp and buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.

B. Exterior Door Construction: For exterior locations and elsewhere as indicated, fabricate doors, panels, and frames from metallic-coated steel sheet. Close top and bottom edges of doors flush as an integral part of door construction or by addition of 0.053-inch- (1.3-mm-) thick, metallic-coated, inverted steel channels with channel webs placed even with top and bottom edges.

C. Interior Door Faces: Fabricate exposed faces of doors and panels, including stiles and rails of nonflush units, from the following material:
   1. Cold-rolled steel sheet.

D. Core Construction: Manufacturer's standard core construction that produces a door complying with SDI standards.

E. Clearances for Non-Fire-Rated Doors: Not more than 1/8 inch (3.2 mm) at jambs and heads, except not more than 1/4 inch (6.4 mm) between pairs of doors. Not more than 3/4 inch (19 mm) at bottom.

F. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

G. Fabricate concealed stiffeners, reinforcement, edge channels, louvers, and moldings from either cold- or hot-rolled steel sheet.

H. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.

I. Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware according to final door hardware schedule and templates provided by hardware supplier.
   1. In addition to typical door and frame hardware, coordinate and factory prepare doors and frames as required for security devices and all other building systems devices.
   2. Comply with applicable requirements in ANSI A250.6 and ANSI A115 Series specifications for door and frame preparation for hardware.
   3. For concealed overhead door closers, provide space, cutouts, reinforcement, and provisions for fastening in top rail of doors or head of frames, as applicable.

J. Frame Construction: Fabricate frames to shape shown.
   1. Fabricate frames with mitered or coped and continuously welded corners and seamless face joints, unless otherwise indicated.
   2. Provide welded frames with temporary spreader bars.
K. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at Project site.

L. Locate hardware as indicated on Shop Drawings or, if not indicated, according to ANSI A250.8.

2.07 FINISH MATERIALS

A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.
B. Verify that opening sizes and tolerances are acceptable.

3.02 INSTALLATION

A. Install in accordance with the requirements of the specified door grade standard and NAAMM HMMA 840.
B. Coordinate frame anchor placement with wall construction.
C. Placing Frames: Comply with provisions in SDI 105, unless otherwise indicated. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
   1. Place frames before construction of enclosing walls and ceilings.
   2. For openings 90 inches (2286 mm) or more in height, install an additional anchor at hinge and strike jambs.
D. Door Installation: Comply with ANSI A250.8. Fit hollow-metal doors accurately in frames, within clearances specified in ANSI A250.8. Shim as necessary to comply with SDI 122 and ANSI/DHI A115.1G.
E. Trim door height by cutting bottom edges to a maximum of 3/4 inch (19 mm).
   1. Use machine tools and jigs to precisely cut metal doors.
   2. After cutting, deburr edges and prime metal surfaces with specified primer before hanging.
   3. Site finishing is specified in section 09 9000.
F. Coordinate installation of hardware.
G. Coordinate installation of glazing.
H. Touch up damaged factory finishes.

3.03 TOLERANCES

A. Clearances Between Door and Frame: As indicated in ANSI/SDI A250.8 (SDI-100).
B. Maximum Diagonal Distortion: 1/16 in (1.5 mm) measured with straight edge, corner to corner.

3.04 ADJUSTING

A. Adjust for smooth and balanced door movement.

3.05 SCHEDULE

A. Refer to Door and Frame Schedule on the drawings.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Wood doors, stile and rail design; non-fire rated.
   B. Panels of wood, glass, and louvers.

1.02 RELATED REQUIREMENTS
   A. Section 08 1213 - Hollow Metal Frames.
   B. Section 08 7100 - Door Hardware.
   C. Section 08 8000 - Glazing.
   D. Section 09 9000 - Painting & Coating

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
   A. See Section TPWD UGC/Special Conditions, for submittal procedures.
   B. Product Data: Indicate stile and rail core materials and construction; veneer species, type and characteristics.
   C. Shop Drawings: Illustrate door opening criteria, elevations, sizes, types, swings, undercuts required, special beveling, special blocking for hardware, factory machining criteria, factory finishing criteria, identify cutouts for glazing and louvers.
   D. Samples: Submit two samples of door construction, 12" x 12" inch (304.8 x 304.8 mm) in size cut from top corner of door.
   E. Manufacturer's Qualification Statement.
   F. Installer's Qualification Statement.

1.05 QUALITY ASSURANCE
   A. Maintain one copy of specified door quality standard on site for review during installation and finishing.
   B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section, with not less than three years of documented experience.
   C. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Package, deliver, and store doors in accordance with quality standard specified.
   B. Accept doors on site in manufacturer's packaging, and inspect for damage.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Stile and Rail Wood Doors:
      3. VT Industries, Inc; [____]: www.vtindustries.com/#sle.
2.02 DOORS
A. Exterior Doors: Red Oak, 1-3/4 inches (44.45 mm) thick unless otherwise indicated; solid lumber construction; mortise and tenon joints; water repellent treated. Transparent finish as indicated on drawings.
B. Interior Doors: 1-3/4 inches (44.45 mm) thick unless otherwise indicated; solid lumber construction; mortise and tenon joints. Transparent finish as indicated on drawings.

2.03 DOOR AND PANEL FACINGS
A. Adhesive: Type I - Waterproof.

2.04 DOOR CONSTRUCTION
A. Astragals for Double Doors: Wood, [___] shaped, overlapping and recessed at face edge, specifically for double doors.
B. Vertical Exposed Edge of Stiles: Hardwood for transparent finish.
C. Panels: Raised, solid wood.
D. At exterior doors, provide aluminum flashing at the top and bottom rail for full thickness and width of door.
E. Factory machine doors for finish hardware in accordance with hardware requirements and dimensions. Do not machine for surface hardware.
F. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.
G. Factory install glazing in doors in compliance with quality standards specified, using manufacturer's standard elastomeric glazing sealant.

2.05 ACCESSORIES
A. Glazing: As specified in Section 08 8000.
B. Door Hardware: As specified in Section 08 7100.
C. Wood Louvers: Wood, of same species as door facing, oval style, and at least [___] percent louver free area.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify existing conditions before starting work.
B. Verify that opening sizes and tolerances are acceptable.
C. Do not install doors in frame openings that are not plumb or are out of tolerance for size or alignment.

3.02 INSTALLATION
A. Install doors in accordance with manufacturer's instructions and specified quality standards.
B. Field-Finished Doors: Trimming to fit is acceptable.
   1. Adjust width of non-rated doors by cutting equally on both jamb edges.
   2. Trim door height by cutting bottom edges to a maximum of 3/4 inch (19 mm).
C. Machine cut for hardware.
D. Coordinate installation of doors with installation of frames and hardware.

3.03 TOLERANCES
A. Comply with specified quality standard for fit, clearance, and joinery tolerances.
B. Maximum Width Distortion (Cup): 1/8 inch (3.2 mm) measured with straight edge or taut string, edge to edge, over an imaginary 36 by 84 inch (915 by 2130 mm) surface area.

3.04 ADJUSTING
A. Adjust doors for smooth and balanced door movement.
B. Adjust closers for full closure.

3.05 SCHEDULE - SEE DRAWINGS

END OF SECTION
SECTION 08 4100
METAL-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Aluminum-framed storefront, with vision glass.
B. Storefront accessories, including perimeter trims, stools, accessories, shims and anchors.
C. Aluminum doors and frames.
D. Weatherstripping.
E. Exterior door hardware.
F. Perimeter sealant.

1.02 RELATED REQUIREMENTS
A. Section 07 9005 - Joint Sealers: Perimeter sealant and back-up materials.
B. Section 08 5113 - Aluminum Windows
C. Section 08 8000 - Glazing: Glass and glazing accessories.

1.03 REFERENCE STANDARDS
A. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site; American Architectural Manufacturers Association; 2004.
B. AAMA 501.2 - Field Check of Metal Storefronts, Curtain Walls, and Sloped Glazing Systems for Water Leakage; American Architectural Manufacturers Association; 2009 (part of AAMA 501).


1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with installation of other components that comprise the exterior enclosure.

B. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

A. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, internal drainage details.

B. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.

C. Design Data: Provide framing member structural and physical characteristics, engineering calculations, dimensional limitations. Data should be certified by a Professional Structural Engineer experienced in design of this Work and licensed in Texas.

D. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.

E. Samples:
   1. Submit two samples 12 x 12 inches in size illustrating finished aluminum surface, glass, infill panels, glazing materials, joinery, and anchorage.
   2. Submit samples of standard factory anodized finishes for selection by Architect.

F. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.

G. Report of field testing for water leakage.

H. Warranty: Submit manufacturer warranty and ensure forms have been registered with manufacturer.

I. Entrance Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

1.06 QUALITY ASSURANCE

A. Designer Qualifications: Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at Texas.

B. Manufacturer and Installer Qualifications: Company specializing in manufacturing aluminum glazing systems with minimum three years of documented experience.

C. Source Limitations: Obtain aluminum-framed storefront system through one source from a single manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Handle products of this section in accordance with AAMA CW-10.
B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.08 FIELD CONDITIONS
A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.09 PROJECT CONDITIONS
A. Verify actual dimensions of aluminum-framed openings by field measurements before fabrication and indicate field measurements on Shop Drawings.

1.10 WARRANTY
A. Correct defective Work within a five year period after Date of Substantial Completion.
B. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
C. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Basis of Design for Storefront: Kawneer TriFab 601T
B. Basis of Design for Exterior Doors: Kawneer AA 250 Thermal Entrance Door
C. Substitutions:

2.02 STOREFRONT
A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
   2. Vertical Mullion Dimensions: 2 1/2 inches wide x 6 inches deep.
   3. Water Leakage Test Pressure Differential: As recommended by manufacturer.
   4. Air Infiltration Test Pressure Differential: 1.57 psf.
B. Framing System:
   1. Brackets and Reinforcing: Manufacturer’s standard high strength aluminum with non-staining, non-ferrous shims for aligning system components.
   2. Fasteners and Accessories: Manufacturer’s standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.
   3. Perimeter Anchors: When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.
C. Performance Requirements:
   1. Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
      a. Design Wind Loads: Comply with requirements of 2012 IBC.
      b. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
   2. Movement: Accommodate movement between storefront and perimeter framing and deflection of lintel, without damage to components or deterioration of seals.
   3. Air Infiltration: Limit air infiltration through assembly to 0.06 cu ft/min/sq ft of wall area, measured at specified differential pressure across assembly in accordance with ASTM E283.
   4. Condensation Resistance Factor: Measure in accordance with AAMA 1503 with 1 inch insulating glass installed.
5. Water Leakage: None, when measured in accordance with ASTM E331 at specified pressure differential.
6. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
7. Air and Vapor Seal: Maintain continuous air barrier and vapor retarder throughout assembly, primarily in line with inside pane of glass and inner sheet of infill panel and heel bead of glazing compound.
8. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.

2.03 COMPONENTS
A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
   2. Cross-Section: As indicated on drawings.
B. Doors: Glazed aluminum.
   1. Thickness: 2-1/4 inches.
   2. Top Rail: 2-1/2 inches wide.
   5. Glazing Stops: Beveled.
   6. Finish: Same as storefront.
   7. Weather strip: Manufacturer's thermoplastic elastomer weatherstrip at jams, headers, and bottom.

2.04 MATERIALS
C. Fasteners: Nonmagnetic Stainless Steel
D. Exposed Flashings: 0.032 inch thick aluminum sheet; finish to match framing members.
E. Concealed Flashings: 0.018 inch thick galvanized steel.
F. Perimeter Sealant: As specified in Section 07 9000.
G. Glass: As specified in Section 08 8000.
   2. Glass in Doors: Insulated Safety Glass
H. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.
I. Glazing Accessories: As specified in Section 08 8000.

2.05 FINISHES
A. Class I Color Anodized Finish: AAMA 611 AA-M12C22A42 Integrally colored anodic coating or AAMA 612 electrolytically deposited colored anodic coating with electrolytically deposited organic seal; not less than 0.7 mils thick.

2.06 HARDWARE
A. Door Hardware: Storefront manufacturer's standard type to suit application. Reference Door Hardware Schedule 08 7100.
   1. Finish on Hand-Contacted Items:
   2. Include for each door weatherstripping, sill sweep strip, threshold, pivots, and narrow stile handle latch.
2.07 FABRICATION
A. Fabricate components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.
B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.
C. Prepare components to receive anchor devices. Fabricate anchors.
D. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.
E. Arrange fasteners and attachments to conceal from view.
F. Reinforce components internally for door hardware.
G. Reinforce framing members for imposed loads.
H. Finishing: Apply factory finish to all surfaces that will be exposed in completed assemblies.
   1. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.

PART 3 EXECUTION
3.01 DELIVERY AND STORAGE
A. Package, Shipping, Handling and Unloading: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
B. Storage and Protection: Store materials protected from exposure to harmful conditions. Handle components to avoid damage. Protect material against damage from the elements, construction activities, and other hazards before, during, and after installation.

3.02 EXAMINATION
A. Verify dimensions, tolerances, and method of attachment with other work.
B. Verify that wall openings and adjoining air and vapor seal materials are ready to receive work of this section.

3.03 INSTALLATION
A. Install wall system in accordance with manufacturer's instructions.
B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
C. Provide alignment attachments and shims to permanently fasten system to building structure.
D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
E. Provide thermal isolation where components penetrate or disrupt building insulation.
F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
H. Coordinate attachment and seal of perimeter air and vapor barrier materials.
I. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
J. Set thresholds in bed of mastic and secure.
K. Install hardware using templates provided.
L. Install glass in accordance with Section 08 8000, using glazing method required to achieve performance criteria.
M. Install perimeter sealant in accordance with Section 07 9005 - Joint Sealers.
N. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.
3.04 TOLERANCES
   A. Maximum Variation from Plumb: 0.06 inches every 3 ft non-cumulative or 1/16 inches per 10 ft, whichever is less.
   B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.05 ADJUSTING
   A. Adjust operating hardware for smooth operation.

3.06 CLEANING
   A. Remove protective material from pre-finished aluminum surfaces.
   B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.
   C. Remove excess sealant by method acceptable to sealant manufacturer.

3.07 PROTECTION
   A. Protect installed products from damage during subsequent construction.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Extruded aluminum windows with fixed sash, operating sash, and infill panels.
B. Factory glazing.
C. Operating hardware.
D. Insect screens.

1.02 RELATED REQUIREMENTS
A. Section 06 1000 - Rough Carpentry
B. Section 07 9005 - Joint Sealers: Sealing joints between window frames and adjacent construction.
C. Section 08 8000 - Glazing.

1.03 SUBMITTALS
A. Shop Drawings: Indicate opening dimensions, elevations of different types, framed opening tolerances, method for achieving air and vapor barrier seal to adjacent construction, anchorage locations, and installation requirements.
B. Samples: Submit two samples, 12 by 12 inch (300 by 300 mm) in size illustrating typical corner construction, accessories, and finishes.
C. Samples: Manufacturer's standard range of finishes, for Architect selection.
D. Submit two samples of operating hardware.
E. Manufacturer's Installation Instructions: Include complete preparation, installation, and cleaning requirements.
F. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Comply with requirements of AAMA CW-10.
B. Protect finished surfaces with wrapping paper or strippable coating during installation. Do not use adhesive papers or sprayed coatings that bond to substrate when exposed to sunlight or weather.

1.05 FIELD CONDITIONS
A. Do not install sealants when ambient temperature is less than 40 degrees F (5 degrees C).
B. Maintain this minimum temperature during and 24 hours after installation of sealants.

1.06 WARRANTY
A. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
B. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Basis of Design: Kawneer Thermal Windows. www.kawneer.com

2.02 ALUMINUM WINDOWS
A. Aluminum Windows: Extruded aluminum frame and sash, factory fabricated, factory finished, with operating hardware, related flashings, and anchorage and attachment devices.
   1. Include Nail Flange.
2. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors; fasteners and attachments concealed from view; reinforced as required for operating hardware and imposed loads.

3. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

4. Movement: Accommodate movement between window and perimeter framing and deflection of lintel, without damage to components or deterioration of seals.

5. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.

B. Fixed, Non-Operable Type:
   1. Basis of Design: [Kawneer NX-380 series Thermal Windows. ]
   2. Frame Depth: 3-1/4".
   4. Glazing: Double; clear; low-e.
   5. Exterior Finish: Class I color anodized. #29 Black AA-M10C21A44 (.7 mils minimum)
   6. Interior Finish: Class I color anodized. #29 Black AA-M10C21A44 (.7 mils minimum)

C. Single-Hung Type:
   2. Frame Depth: 3-1/4"
   4. Glazing: Double; gray tinted; low-e.
   5. Exterior Finish: Class I color anodized. #29 Black AA-M10C21A44 (.7 mils minimum)
   6. Interior Finish: Class I natural anodized. #29 Black AA-M10C21A44 (.7 mils minimum)

2.03 COMPONENTS

A. Frames: 2-1/4" inch (57 mm) wide by 4-5/8" inch (83 mm) deep profile, of 3-1/4" inch (83 mm) thick section thermally broken with interior portion of frame insulated from exterior portion; flush glass stops of snap-on type.

B. Glazing: As specified in Section 08 8000.

C. Insect Screens: Extruded aluminum frame with mitered and reinforced corners; screen mesh taut and secure to frame; secured to window with adjustable hardware allowing screen removal without use of tools.
   1. Hardware: Spring loaded steel pins; four per screen unit.
   2. Screen Mesh: metal mesh
   3. Frame Finish: Same as frame and sash.

D. Operable Sash Weatherstripping: Wool pile; permanently resilient, profiled to achieve effective weather seal.

E. Glazing Materials: As specified in Section 08 8000.

F. Sealant for Setting Sills and Sill Flashing: Non-curing butyl type.

2.04 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper.

2.05 HARDWARE

A. Sash lock: Lever handle with cam lock; provide pole handle 6 feet long (; provide pole handle 1828.8 mm long).

B. Operator: Lever action handle fitted to projecting sash arms with limit stops.

C. Projecting Sash Arms: Cadmium plated steel, friction pivot joints with nylon bearings, removable pivot clips for cleaning.

D. Pulls: Manufacturer's standard type.

E. Limit Stops: Resilient rubber.
PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that wall openings and adjoining air and vapor seal materials are ready to receive aluminum windows.

3.02 INSTALLATION
   A. Install windows in accordance with manufacturer's instructions.
   B. Attach window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities.
   C. Align window plumb and level, free of warp or twist. Maintain dimensional tolerances and alignment with adjacent work.
   D. Install sill and sill end angles.
   E. Provide thermal isolation where components penetrate or disrupt building insulation. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
   F. Install operating hardware not pre-installed by manufacturer.
   G. Install glass and infill panels in accordance with requirements specified in Section 08 8000.

3.03 TOLERANCES
   A. Maximum Variation from Level or Plumb: 1/16 inches every 3 ft (1.5 mm/m) non-cumulative or 1/8 inches per 10 ft (3 mm/3 m), whichever is less.

3.04 ADJUSTING
   A. Adjust hardware for smooth operation and secure weathertight closure.

END OF SECTION
SECTION 08 7100
DOOR HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes items known commercially as finish or door hardware that are required for swing, sliding, and folding doors, except special types of unique hardware specified in the same sections as the doors and door frames on which they are installed.
   1. Provide cylinders keyed to building system and with finish to match adjacent surfaces.

1.02 RELATED SECTIONS:

A. Section 08 1213 - Hollow Metal Doors and Frames.
B. Section 08 4100 - Metal - Framed Storefront.

1.03 COORDINATION

A. Coordinate the work of this Section with work of other sections that interface with hardware.
B. Submit templates for doors, frames, and other work specified to be factory prepared for the installation of door hardware to the appropriate trades. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
C. Coordination: Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thickness, profile, swing security and similar requirements indicated, as necessary for the proper installation and function, regardless of omissions or conflicts in the information on the Contract Documents.

1.04 SUBMITTALS

A. In accordance with the requirements of the Owner’s General Conditions and Special Conditions, submit a complete listing of all manufacturers, products, model numbers, and designs proposed for use in the Work of this Section.
B. Maintain one copy of all shop drawings, product data, and samples, manufacturer's specifications, recommendations, installation instructions, and maintenance data at the Project Site.
   1. At Project Closeout, turn over copy to the Architect who will transmit to the Owner.
C. Submit only the items listed below to the Architect for review in accordance with Conditions of the Contract and the Owner’s General Conditions and Special Conditions sections.
D. Submit final hardware schedule in the manner and format indicated below. Coordinate hardware with doors, frames, and related work to ensure proper size thickness, hand, function, and finish of hardware.
   1. Use same identifying "set numbers" given in this Section. Coordinate submittal with doors and frames submittals and use same "opening number" identification as given on Drawings and in the Door Schedule.
      a. Submittals not using numbering identification system shown on Architect's Drawings and Schedules will be rejected.
   2. Final Hardware Schedule Content: Based on hardware indicated, organize schedule into "hardware sets" indicating complete designations of every item required for each door or opening. Include the following information:
      a. Type, style, function, size, and finish of each hardware item.
      b. Name and manufacturer of each item.
      c. Fastenings and other pertinent information.
      d. Location of each hardware set cross referenced to indications on Drawings both on floor plans and in door and frame schedule.
      e. Explanation of all abbreviations, symbols, and codes contained in schedule.
      f. Mounting locations for hardware and showing the swing degree for each door.
      g. Door and frame sizes and materials.
3. Submittal Sequence: Submit final schedule at earliest possible date particularly where acceptance of hardware schedule must precede fabrication of other work that is critical in the Project construction schedule. Include with schedule the product data, samples, shop drawings of other work affected by door hardware, and other information essential to the coordinated review of schedule.

1.05 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain each type of hardware (latch and lock sets, hinges, closers, etc.) from a single manufacturer.

B. Supplier Qualifications: A recognized architectural door hardware supplier, with warehousing facilities in the Project's vicinity, that has a record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that employs an experienced architectural hardware consultant (AHC) who is available to Owner, Architect, and Contractor, at reasonable times during the course of the Work, for consultation.

1. Require supplier to meet with Owner to finalize keying requirements and to obtain final instructions in writing.

1.06 PRODUCT HANDLING

A. Inventory door hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.

B. Deliver individually packaged door hardware items promptly to place of installation (shop or Project site).

C. Provide secure lock-up for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable so that completion of the Work will not be delayed by hardware losses both before and after installation.

1.07 MAINTENANCE

A. Maintenance Tools and Instructions: At completion of the work, provide a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

1.08 WARRANTY:

A. Provide guarantee from hardware supplier as follows:

1. Hinges: Life of the Building
2. Exit Devices: Five Years
3. Locksets: Seven years
4. Closers: Ten Years
5. All other Hardware: Two years

PART 2 PRODUCTS

2.01 SCHEDULED HARDWARE

A. Acceptable Manufacturers: To establish standards of manufacture, operation, performance, and appearance, drawings and specifications are based on products of the manufacturer listed first for each device in the Hardware Recap in Part 3 of this Section. Provided compliance with project requirements, products of the other listed manufacturers will also be acceptable.

B. Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of finish hardware are indicated in the "Hardware Recap and Schedule" at the end of this Section. Products are identified by using hardware designation numbers of the following:

1. Manufacturer's Product Designations: The product designation and name of one manufacturer are listed for each hardware type required for the purpose of establishing minimum requirements. Provide either the product designated or, where more than one manufacturer is specified for each hardware type, the comparable product of one of the other manufacturers that complies with requirements.
2. ANSI/BHMA designations used elsewhere in this Section or in schedules to describe hardware items or to define quality or function are derived from the following standards. Provide products complying with these standards and requirements specified elsewhere in this Section.
   c. Exit Devices: ANSI/BHMA A156.3.
   d. Door Controls - Closers: ANSI/BHMA A156.4.
   e. Auxiliary Locks and Associated Products: ANSI/BHMA A156.5.
   g. Template Hinge Dimensions: ANSI/BHMA A156.7.
   h. Door Controls - Overhead Holders: ANSI/BHMA A156.8.
   i. Interconnected Locks and Latches: ANSI/BHMA A156.12.
   m. Auxiliary Hardware: ANSI/BHMA A156.16.
   o. Materials and Finishes: ANSI/BHMA A156.18.

2.02 MATERIALS AND FABRICATION

A. Manufacturer's Name Plate: Do not use manufacturers’ products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise acceptable to Architect.
   1. Manufacturer's identification will be permitted on rim of lock cylinders only.

B. Base Metals: Produce hardware units of basic metal and forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units by applicable ANSI/BHMA A156 series standards for each type of hardware item and with ANSI/BHMA A156.18 for finish designations indicated. Do not furnish "optional" materials or forming methods for those indicated, except as otherwise specified.

C. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated.

D. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.

E. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of reinforcing the work adequately to fasten the hardware securely. Where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use screw fasteners.

2.03 HINGES, BUTTS, AND PIVOTS

A. Provide only template-produced units.

B. Screws: Provide Phillips flat-head screws complying with the following requirements:
   1. For metal doors and frames install machine screws into drilled and tapped holes.
   2. Finish screw heads to match surface of hinges or pivots.

C. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
   2. Out-Swing Corridor Doors with Locks: Non-removable pins.
   3. Interior Doors: Non-rising pins.
4. Tips: Flat button and matching plug, finished to match leaves.

D. Number of Hinges: Provide number of hinges indicated but not less than 3 hinges per door leaf for doors 90 inches or less in height and one additional hinge for each 30 inches of additional height.

2.04 LOCK CYLINDERS AND KEYING

A. All lock cylinders shall be equipped with 7-pin tumbler interchangeable core lock cylinders by Best Lock Corporation; No Substitutes. The interchangeable core shall be removable by a special control key. The control key shall have no cuts in common with grandmaster keys which operate with a shear line completely independent from the shear line of the grandmaster, master, and operating keys. All cores shall have a special limited keyway and shall be removable without removing the cylinder, knob, or core housing of any type lock or lockset. The removable core shall be instantly interchangeable without modification for use in any lock throughout the system.

B. All parts of the interchangeable removable core shall be of brass with 26D or 613 finish for exposed-to-view surfaces. All pin segments that come in contact with the inserted key shall be of nickel-silver metal. All cores shall be re-combineable by removing pin segments of one individual barrel of the same core. Cores shall be designed so that when the key is inserted into core, spacing of the key bits beneath the proper core barrels is by the location of the nose of the key against a key stop on the rear of the core. All interchangeable cores shall be marked on the side to conceal marking until removed by special control key. All cut keys shall be identified with corresponding marking.

C. Cylinders shall be provided with plastic for construction cores.

D. Permanent cores shall be installed by the Contractor.
   1. Provide Best Model _1E-74 unless otherwise scheduled.
   2. Do not install set screw inside the cylinder.

2.05 LOCKS, LATCHES, AND BOLTS

A. Strikes: Provide manufacturer's standard wrought box strike for each latch or lock bolt, with curved lip extended to protect frame, finished to match hardware set, unless otherwise indicated.
   1. Provide flat lip strikes for locks with 3-piece, antifriction latch bolts as recommended by manufacturer.
   2. Provide recess type top strikes for bolts locking into head frames, unless otherwise indicated.
   3. Provide dust-proof strikes for foot bolts, except where special threshold construction provides non-recessed strike for bolt.
   4. Provide metal or plastic strike boxes for all strikes.

   1. Provide 3/4-inch minimum throw of latch for mortise locks. Provide 1-inch minimum throw for all dead bolts.

C. Flush Bolt Heads: Minimum of 1/2-inch-diameter rods of brass, bronze, or stainless steel with minimum 12-inch-long rod for doors up to 7'-0" in height. Provide longer rods as necessary for doors exceeding 7'-0" in height.

2.06 PUSH/PULL UNITS

A. Exposed Fasteners: Provide manufacturer's standard exposed fasteners for installation, thru-bolted for matched pairs but not for single units.

B. Concealed Fasteners: Provide manufacturer's special concealed fastener system for installation, thru-bolted for matched pairs but not for single units.

2.07 CLOSERS AND DOOR CONTROL DEVICES

A. Size of Units: Except as otherwise specifically indicated, provide adjustable units complying with ANSI A117.1 provisions for door opening force and delayed action closing. Comply with
the manufacturer's recommendations for size of door control unit depending on size of door, exposure to weather, and anticipated frequency of use.

1. At interior doors, adjust closers for door opening force not to exceed 5 foot-pounds of force.
2. At exterior doors, adjust closers for door opening force not to exceed 8.5 foot-pounds of force.
3. Where parallel arms are indicated for closers, provide closer unit one size larger than recommended for use with standard arms.

B. Provide all door closers with provisions for through-bolted installation with sex bolts.

2.08 DOOR TRIM UNITS

A. Fasteners: Provide manufacturer's standard exposed fasteners for door trim units consisting of either machine screws or self-tapping screws.

B. Fabricate edge trim of stainless steel to fit door thickness in standard lengths or to match height of protection plates.

2.09 HARDWARE FINISHES

A. Match items to the manufacturer's standard color and texture finish for the latch and lock sets (or push-pull units if no latch or lock sets).

B. The designations used in schedules and elsewhere to indicate hardware finishes are those listed in ANSI/BHMA A156.18, "Materials and Finishes," including coordination with the traditional U.S. finishes shown by certain manufacturers for their products.

1. Rust-Resistant Finish: For iron and steel base metal required for exterior work and in "High Humidity" areas (and also when designed with the suffix -RR), provide 0.2-mil-thick copper coating on base metal before applying brass, bronze, nickel, or chromium plated finishes.

C. Finishes: Unless otherwise indicated, provide all hardware items fabricated and finished in accordance with the following schedule:

1. Hinges: All exterior, wet, humid, and corrosive locations and all non-temperature conditioned spaces;
2. Hinges: All interior temperature conditioned spaces;
3. Locksets: All exterior, wet, humid, and corrosive locations and all non-temperature conditioned spaces;
4. Locksets: All interior temperature conditioned spaces;
5. Closers: Full cover, painted, or plated as noted.
6. Exit Devices:
7. All other devices, unless otherwise indicated:

D. Trim: Unless otherwise schedule, provide lever trim and rose for all lock and latch sets of the following design:

1. Schlage: “Athens”

PART 3 EXECUTION

3.01 INSTALLATION

A. Mount hardware units at heights indicated in following applicable publications, except as specifically indicated or required to comply with governing regulations and except as otherwise directed by Architect.

1. "Recommended Locations for Builders Hardware for Standard Steel Doors and Frames" by the Door and Hardware Institute.
2. Compliance with NFPA 0.
4. Compliance with TAS 404.2.7.

B. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and
reinstallation or application of surface protection with finishing work specified in the Division 9 Sections. Do not install surface-mounted items until finishes have been completed on the substrates involved.

C. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

D. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

E. Set thresholds for exterior doors in full bed of butyl-rubber or polyisobutylene mastic sealant complying with requirements specified in Division 7 Section "Joint Sealers."

F. Weather stripping and Seals: Comply with manufacturer's instructions and recommendations to the extent installation requirements are not otherwise indicated.

1. Where adhesive applied items are indicated, abrade or otherwise prepare the substrate for complete adhesion to ensure the items will not delaminate.

3.02 ADJUSTING, CLEANING, AND DEMONSTRATING

A. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.

1. Where door hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

B. Adjust closers to comply with TAS 404.2.8.1.

C. Clean adjacent surfaces soiled by hardware installation.

3.03 HARDWARE SETS

A. Misc. Hardware section for Future Maintenance:

1. Spare Locksets/Etc.
2. Key blanks
3. Spare closers
4. Extra Silencers
5. Key Control software
6. Key cabinet

B. Manufacturer's Abbreviations:

1. IVE - Ives
2. SCH - Schlage
3. LCN - LCN
4. NGP - National Guard Products
5. VON - Von Duprin
6. KAWN - Kawneer

HARDWARE SCHEDULE:

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04.09.21

SOUTH LLANO RIVER STATE PARK
HEADQUARTERS BUILDING RENOVATION AND EXPANSION

CONSTRUCTION DOCUMENTS
DOOR HARDWARE

08 7100

FPC #92706
04.09.2021

CONSTRUCTION
FPC
TPWD
HEADQUARTERS BUILDING RENOVATION AND EXPANSION
NORTH LLANO RIVER STATE PARK

SOUTH LLANO RIVER STATE PARK
HEADQUARTERS BUILDING RENOVATION AND EXPANSION

CONSTRUCTION DOCUMENTS
DOOR HARDWARE

08 7100

FPC #92706
04.09.2021

CONSTRUCTION
FPC
TPWD
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CONSTRUCTION DOCUMENTS
04.09.2021
DOOR HARDWARE
08.7100
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Door Numbers: 104C, 115

### Hardware Set: 14 TUBE STORAGE DOOR

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<th>Occ</th>
<th>Description</th>
<th>Model</th>
<th>Finish</th>
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<td>FS18S/FS18L (AS REQUIRED)</td>
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<td>DRIP CAP</td>
<td>165S-FRAME WIDTH PLUS 4&quot; (WHERE REQD)</td>
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Door Numbers: 121

### MISC ITEMS

- PROVIDE THE FOLLOWING:
  - (12) CONSTR MYKYS BY HARDWARE SUPPLIER
  - (3) CONSTR CONTROL BY HARDWARE SUPPLIER
  - (1) XTRA KY PER CORE KEY
  - (6) MKYS (PER SET) KEY
  - KEY STAMPING STAMPING (AS DIRECTED BY THE OWNER)
  - 1 EA KEY CABINET 1200-SERIES (PLUS 50% CAPACITY) GRY
  - 1 EA INSTALLATION REVIEW BY DISTRIBUTER AHC, AFTER INSTALLATION
  - 1 EA HARDWARE SCHEDULE BY HARDWARE SUPPLIER
SECTION 08 8000
GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Flat Glass Materials.
B. Insulating glass units.
C. Glazing compounds and accessories.

1.02 RELATED REQUIREMENTS
A. Section 06 2000 - Finish Carpentry.
B. Section 08 4100 - Metal Framed Storefront
C. Section 08 1213 - Hollow Metal Doors and Frames
D. Section 08 5113 - Aluminum Windows: Glazing furnished by window manufacturer.

1.03 REFERENCE STANDARDS

1.04 DEFINITIONS
A. Sealed Insulating Glass Unit Surfaces:
   1. Side 1 - Exterior surface of outer pane.
   2. Side 2 - Interior surface of outer pane.
   3. Side 3 - Interior surface of inner pane.
   4. Side 4 - Exterior surface of inner pane.

1.05 SUBMITTALS
A. See Owner’s General Conditions and Special Conditions for submittal procedures.
B. Product Data on Glass Types: Provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements.
C. Product Data on Glazing Compounds: Provide chemical, functional, and environmental characteristics, limitations, special application requirements. Identify available colors.
D. Samples: Submit two samples 12x12 inch in size of glass and plastic units, showing coloration and design.
E. Samples: Submit two samples 12x12 inch in size of sealed insulating glass units.
F. Certificates: Certify that products meet or exceed specified requirements.
G. Manufacturer’s Certificate: Certify that sealed insulated glass meets or exceeds specified requirements.

1.06 QUALITY ASSURANCE
A. Fabricator Qualifications, Sealed Insulating Glass Units: Minimum five (5) years of documented experience producing sealed insulating glass units of the type specified in this section.
B. Installer Qualifications: Company specializing in performing the work of this section with minimum five years documented experience and approved by manufacturer.

1.07 FIELD CONDITIONS
A. Do not install glazing when ambient temperature is less than 50 degrees F (10 degrees C).
B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.
C. Field Measurements: When construction schedule permits, verify field measurements with drawing dimensions prior to fabrication of glass products.

1.08 WARRANTY
A. Sealed Insulating Glass Units: Provide a five (5) year warranty to include coverage for seal failure, interpane dusting or misting, including replacement of failed units.

PART 2 PRODUCTS
2.01 MANUFACTURERS:
A. Sealed Insulating Glass Units:
   1. Basis of Design: PPG Solarban 70XL (2) + clear
   2. Substitutions:

2.02 GLAZING UNITS
A. TYPE 1 -Sealed Insulated Glass Units.
   2. Type: <> float glass.
   3. Tint: Clear.
   4. Thickness: 1/4 inch (6 mm).
   5. Low-e coating
   6. Outboard Lite: Annealed float glass, 1/4 inch (6 mm) thick, minimum.
   7. Inboard Lite: Annealed float glass, 1/4 inch (6 mm) thick.
   8. Total Thickness: 1 inch (25 mm).
B. TYPE 2 -Safety Sealed Insulating Glass Units:
   1. Application: Storefront, storefront doors, and exterior doors.
   2. Type: Fully tempered float glass.
   3. Tint: Clear.
   4. Thickness: 1/4 inch (6 mm).
   5. Low-e coating
   6. Outboard Lite: Tempered float glass, 1/4 inch (6 mm) thick, minimum.
   7. Inboard Lite: Tempered float glass, 1/4 inch (6 mm) thick.
   8. Total Thickness: 1 inch (25 mm).
C. TYPE 3 -Tempered translucent single-pane:
   1. Application: HM doors, interior applications only.
   2. Type: Fully tempered float glass.
   3. Tint: Translucent.
   4. Thickness: 1/4 inch (6 mm).

2.03 GLASS MATERIALS
B. Substitutions: Refer to the Owner’s General Conditions and Special Conditions.
C. Float Glass: Provide float glass based glazing unless noted otherwise.
   1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality-Q3.
   2. Heat-Strengthened and Fully Tempered Types: ASTM C1048, Kind HS and Kind FT.
   3. Thicknesses: 1/4 inch, unless otherwise indicated on Drawings.

2.04 GLAZING COMPOUNDS
A. Glazing Putty: Polymer modified latex recommended by manufacturer for outdoor use, paintable, knife grade consistency; grey color.

B. Silicone Sealant: Single component; neutral curing; capable of water immersion without loss of properties; non-bleeding, non-staining, paintable; ASTM C 920, Type S, Grade NS, Class 25, Uses M, A, and G; cured Shore A hardness of 15 to 25; grey color.

C. Silicone Sealant: Neutral curing, pure silicone as specified in Section 07 9000; paintable.

2.05 GLAZING ACCESSORIES

A. Setting Blocks: Neoprene, 80 to 90 Shore A durometer hardness; ASTM C 864 Option I. Length of 0.1 inch for each square foot (25 mm for each square meter) of glazing or minimum 4 inch (100 mm) x width of glazing rabbit space minus 1/16 inch (1.5 mm) x height to suit glazing method and pane weight and area.

B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness; ASTM C 864 Option I. Minimum 3 inch (75 mm) long x one half the height of the glazing stop x thickness to suit application, self adhesive on one face.

C. Glazing Tape, Back Bedding Mastic Type: Preformed, butyl-based, 100 percent solids compound with integral resilient spacer rod applicable to application indicated; hardness range of 5 to 30 cured Shore A durometer; coiled on release paper; black color.

D. Glazing Tape: Closed cell polyvinyl chloride foam, coiled on release paper over adhesive on two sides, maximum water absorption by volume of 2 percent, designed for compression of 25 percent to effect an air barrier and vapor retarder seal, black color; widths required for specified installation.

2.06 FABRICATION

A. Heat-Strengthened Glass:
   1. Cut float glass materials to indicated sizes and provide cut-outs and holes, if indicated, before heat strengthening.
   2. Heat strengthen float glass materials in accordance with ASTM C 1048, Kind HS.

B. Sealed Insulating Glass Units:
   1. Fabricate units in accordance with ASTM E 774, Class CBA:  
      a. Outer Pane:  
         1) Glass Type: Uncoated Float Glass.  
         2) Glass Thickness: 1/4 inch.  
         4) Low E Coating: Surface 2.  
         5) Spacer: Metal  
      b. Air Space: 1/2 inch wide, hermetically sealed, argon gas filled, dehydrated air space.  
      c. Inner Pane:  
         1) Glass Type: Clear Uncoated Float Glass.  
         2) Glass Thickness: 1/4 inch.  
   2. Provide unit edge seals meeting requirements of ASTM E 773, with aluminum spacers, black anodized, having mitered corners, and silicone sealant for glass-to-spacer seals.

C. Safety Sealed Insulating Glass Units:
   1. Fabricate units in accordance with ASTM E 774, Class CBA:  
      a. Outer Pane:  
         1) Glass Type: Uncoated Float Glass.  
         2) Glass Thickness: 1/4 inch.  
         4) Low E Coating: Surface 2.  
         5) Spacer: White  
      b. Air Space: 1/2 wide, hermetically sealed, argon gas filled, dehydrated air space.  
      c. Inner Pane:  
         1) Glass Type: Clear Uncoated Float Glass.
2) Glass Thickness: 1/4 inch.
3) Heat Treating: Tempered
4) Provide unit edge seals meeting requirements of ASTM E 773, with aluminum spacers, black anodized, having mitered corners, and silicone sealant for glass-to-spacer seals.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that openings for glazing are correctly sized and within tolerance.
B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and ready to receive glazing.

3.02 PREPARATION
A. Clean contact surfaces with solvent and wipe dry.
B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
C. Prime surfaces scheduled to receive sealant in accordance with manufacturer's instructions.
D. Install sealants in accordance with ASTM C1193 and GANA Sealant Manual.
E. Install sealants in accordance with manufacturer's instructions.

3.03 INSTALLATION - EXTERIOR WET METHOD (SEALANT AND SEALANT)
A. Place setting blocks at 1/4 points and install glazing pane or unit.
B. Install removable stops with glazing centered in space by inserting spacer shims both sides at 24 inch (610 mm) intervals, 1/4 inch (6.4 mm) below sight line.
C. Fill gaps between glazing and stops with glazing putty type sealant to depth of bite on glazing, but not more than 3/8 inch (9 mm) below sight line to ensure full contact with glazing and continue the air and vapor seal.
D. Apply sealant to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

3.04 INSTALLATION - INTERIOR WET/DRY METHOD (TAPE AND SEALANT)
A. Install Sealant in accordance with Section 07 9005.
B. Apply glazing tape to glass; butt-joint tape edges; seal joints with sealant.
C. Cut glazing tape to length and install against permanent stops, projecting 1/16 inch (1.6 mm) above sight line.
D. Place setting blocks at 1/4 points with edge block no more than 6 inch (152 mm) from corners.
E. Rest glazing on setting blocks and push against tape to ensure full contact at perimeter of pane or unit.
F. Install removable stops, spacer shims inserted between glazing and applied stops at 24 inch (610 mm) intervals, 1/4 inch (6 mm) below sight line.
G. Fill gaps between pane and applied stop with sealant to depth equal to bite on glazing, to uniform and level line.
H. Trim protruding tape edge.

3.05 CLEANING
A. Remove glazing materials from finish surfaces.
B. Remove labels after Work is complete.
C. Clean glass and adjacent surfaces.

3.06 PROTECTION
A. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.

END OF SECTION
SECTION 09 2116
GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Performance criteria for gypsum board assemblies.
B. Cementitious backing board.
C. Gypsum wallboard.
D. Joint treatment and accessories.

1.02 RELATED REQUIREMENTS
A. Section 06 1000 - Rough Carpentry

1.03 REFERENCE STANDARDS
H. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness 2018.

1.04 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate special details associated with fireproofing.
C. Product Data: Provide data on structural properties of metal framing, gypsum board, accessories, and joint finishing system.
D. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.
E. Product Data: Submit manufacturer's product data for acoustical insulation, acoustical sealants, acoustical sheet caulk, and acoustical accessories.

F. Test Reports: For stud framing products that do not comply with ASTM C645 or ASTM C754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.

G. Samples: Submit two samples of gypsum board finished with proposed texture application, 12 by 12 inches (300 by 300 mm) in size, illustrating finish color and texture.

1.05 MOCK-UP

A. As soon as sample approvals are obtained, erect and finish a room mock-up. Mock-up will be used to evaluate paint finish quality and sheen and shall remain partially painted as a reference standard. Prior to completion, the whole mock-up shall be repainted with the entire approved paint finish system to achieve visual uniformity.

1.06 QUALITY ASSURANCE

A. Perform in accordance with ASTM C 840.

B. Installer Qualifications: Company specializing in performing gypsum board installation and finishing, with minimum 3 years of experience.

C. Copies of Documents at Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

PART 2 PRODUCTS

2.01 BOARD MATERIALS

A. Backing Board For Wet Areas:
   1. Application: Surfaces behind tile in wet areas including lavatories including painted wall areas above tile.
   2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
   3. Glass Mat Faced Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178/C1178M.
      a. Regular Type: Thickness 1/2 inch (12.7 mm).
      b. Edges: Tapered where exposed to view.

2.02 GYPSUM WALLBOARD ACCESSORIES

A. Finishing Accessories: ASTM C1047, galvanized steel or rolled zinc, unless noted otherwise.
   1. Types: As detailed or required for finished appearance.
   2. Special Shapes: In addition to conventional corner bead and control joints, provide detailed metal shape at exposed panel edges. Demonstrate special shape conditions (if any) on samples and mock-up.

B. Edge Trim: Bead type(s) as detailed.

C. Joint Materials for Paper-Faced gypsum board: ASTM C475 and as recommended by gypsum board manufacturer for project conditions.
   1. Fiberglass Tape: 2 inch (50 mm) wide, coated glass fiber tape for joints and corners, except as otherwise indicated.
   2. Paper Tape: 2 inch (50 mm) wide, creased paper tape for joints and corners, except as otherwise indicated.
   4. Chemical hardening type compound.
   5. Joint Compound: Setting type, field-mixed.

D. Joint Materials for Glass Mesh faced backer board: ASTM C475 and as recommended by gypsum board manufacturer for project conditions.
   1. Tape: 2 inch (50 mm) wide, coated glass fiber tape for joints and corners, except as otherwise indicated.
   2. Chemical hardening type compound.

E. Nails for Attachment to Wood Members: ASTM C514.
PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that project conditions are appropriate for work of this section to commence.

3.02 FRAMING INSTALLATION
   A. Wood Framing: Install in accordance with ASTM C754 and manufacturer's instructions.
   B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
      1. Level ceiling system to a tolerance of 1/600.
   C. Studs: Space studs at 16 inches on center (at 406 mm on center).
      1. Extend partition framing to structure in all locations.
      2. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.
      3. Extend stud framing through ceiling to structure above. Maintain clearance under structural building members to avoid deflection transfer to studs. Provide extended leg ceiling runners.
   D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
   E. Standard Wall Furring: Install at concrete walls scheduled to receive gypsum board, not more than 4 inches (100 mm) from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 24 inches (600 mm) on center.
   F. Blocking: Install wood blocking for support of:
      1. Framed openings.
      2. Toilet partitions.
      3. Toilet accessories.
      4. Wall mounted door hardware.
      5. Shelving
      6. Cabinetry

3.03 BOARD INSTALLATION
   A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
   B. Single-Layer Non-Rated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.
      1. Exception: Tapered edges to receive joint treatment at right angles to framing.

3.04 INSTALLATION OF TRIM AND ACCESSORIES
   A. Control Joints: Place control joints consistent with lines of building spaces and as indicated on the Drawings.
   B. Corner Beads: Install at external corners, using longest practical lengths.
   C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

3.05 JOINT TREATMENT
   A. Glass Mat Faced Gypsum Board: Use fiberglass joint tape, bedded and finished with chemical hardening type joint compound. Full-float finish all exposed glass mat-faced gypsum panels.
      1. Install using only joint materials duplicating products approved on samples and mockups.
   C. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
      1. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
a. All joints and interior angles shall have tape embedded in joint compound. Surface shall be free of excess joint compound, plus three separate coats of compound at joints, angles, fasteners, and accessories. Compound shall be smooth and free of tool marks and ridges.

2. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
   a. All joints and interior angles shall have tape embedded in joint compound and one separate coat of joint compound applied over all joints, angles, fastener heads, and accessories. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable.

3. Level 1: 3” and higher above finished ceilings, whether or not accessible in the completed construction.
   a. All joints and interior angles shall have tape embedded in joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable.

D. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
   1. Feather coats of joint compound so that camber is maximum 1/32 inch (0.8 mm).

3.06 TOLERANCES
   A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet (3 mm in 3 m) in any direction.

END OF SECTION
SECTION 09 3000
TILING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Tile for wall applications.
   B. Ceramic accessories.
   C. Setting materials: adhesives, mortars, grouts, and sealants

1.02 RELATED REQUIREMENTS
   A. Section 07 9005 - Joint Sealers: Sealing joints between tile work and adjacent construction and fixtures.
   B. Section 09 2116 - Gypsum Board Assemblies: Tile backer board.

1.03 REFERENCE STANDARDS
   D. ANSI A118.4 - American National Standard Specifications for Modified Dry-Set Cement Mortar 2012 (Revised).

1.04 SUBMITTALS
   A. Samples: Mount tile and apply grout on two 5/8" thick specified tile backer board panels, 24x48 inches in size illustrating each pattern, color variations, and grout joint size and color variations.
   B. Samples: Submit color samples of uncoupling membrane and corner movement profile from manufacturer's standard color range for selection by Architect.

1.05 MOCK-UP
   A. Refer to Owner’s General Conditions and Special Conditions, for general requirements for mockup.
   B. Construct tile mock-up where indicated on drawings, incorporating all components specified for the location.
      1. Minimum size of mock-up is indicated on drawings.
      2. Provide 3 foot wide x wainscot height tall mock-up of each wall tile type.
      3. Approved mock-up may remain as part of the Work.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Protect adhesives from freezing or overheating in accordance with manufacturer’s instructions.

1.07 FIELD CONDITIONS
   A. Maintain ambient and substrate temperature above 50 degrees F (10 degrees C) and below 100 degrees F (38 degrees C) during installation and curing of setting materials.

PART 2 PRODUCTS

2.01 TILE
A. Manufacturers: All products by the same manufacturer.

B. Basis of Design:
   2. Substitutions:

C. Glazed Wall Tile, Type 1:
   1. Product: Color Wheel Collection - Classic
   2. Size: 3" x 6".
   4. Surface Finish: Glossy

2.02 TRIM AND ACCESSORIES
   A. Non-Ceramic Trim: Satin brass anodized extruded aluminum, style and dimensions to suit application, for setting using tile mortar or adhesive.
      1. Applications:
         a. Open edges of wall tile.
      2. Manufacturers:
         b. See Owners Genral Conditions and Special Conditions

2.03 SETTING MATERIALS
      1. Applications: Use this type of bond coat where Large and Heavy Tile (LHT) mortar is indicated.
      2. Products:
         b. See Owners Genral Conditions and Special Conditions

2.04 GROUTS
   A. Basis of Design:
      1. LATICRETE International, Inc; LATICRETE PERMACOLOR Grout:
         www.laticrete.com/#sle.
         a. Color:
         b. Substitutions: See Owners Genral Conditions and Special Conditions

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive tile.
   B. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of setting materials to surfaces.
   C. Verify that required wall-mounted utilities are in correct location.

3.02 PREPARATION
   A. Protect surrounding work from damage.
   B. Vacuum clean surfaces and damp clean.
   C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.

3.03 INSTALLATION - GENERAL
   A. Install tile and grout in accordance with applicable requirements of ANSI A108.1A thru A108.13, manufacturer's instructions, and TCNA (HB) recommendations.
   B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
   C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.
E. Form internal angles square and external angles bullnosed.
F. Install non-ceramic trim in accordance with manufacturer's instructions.
G. Sound tile after setting. Replace hollow sounding units.
H. Keep control and expansion joints free of mortar, grout, and adhesive.
I. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
J. Grout tile joints unless otherwise indicated. Use standard grout unless otherwise indicated.
K. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

3.04 INSTALLATION - FLOORS - THIN-SET METHODS

3.05 INSTALLATION - WALL TILE
A. Over cementitious backer units on studs, install in accordance with TCNA (HB) Method W244, using membrane at toilet rooms.
B. Over coated glass mat backer board on studs, install in accordance with TCNA (HB) Method W245.

3.06 CLEANING
A. Clean tile and grout surfaces.

3.07 PROTECTION
A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION
SECTION 09 5100
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Suspended metal grid ceiling system.
B. Acoustical units.

1.02 REFERENCE STANDARDS

1.03 ADMINISTRATIVE REQUIREMENTS
A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
B. Do not install acoustical units until after interior wet work is dry.

1.04 SUBMITTALS
A. Shop Drawings: Indicate grid layout and related dimensioning, junctions with other ceiling finishes, and mechanical and electrical items installed in the ceiling.
B. Product Data: Provide data on suspension system components and acoustical units.
C. Samples: Submit two samples 4 by 4 inch in size illustrating material and finish of acoustical units.
D. Samples: Submit two samples each, 12 inches (304.8 mm) long, of suspension system main runner, cross runner, and perimeter molding.
E. Architect's review will be for color and texture only. Compliance with all other requirements is the exclusive responsibility of the Contractor.
F. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

1.05 FIELD CONDITIONS
A. Maintain uniform temperature of minimum 60 degrees F (16 degrees C), and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

1.06 EXTRA MATERIALS
A. Provide no less than 5 percent of total acoustical unit area of each type of acoustical unit for Owner's use in maintenance of project.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Acoustic Tiles/Panels:
   1. Basis of Design: Armstrong World Industries, Inc; [____]:
      www.armstrongceilings.com/#slc.
   2. Substitutions: See Owners Unified General Conditions / Special Conditions

2.02 ACOUSTICAL UNITS
A. Acoustical Units - General: ASTM E1264, Class A.
B. Acoustical Panels Type ACT 1:
2.03 SUSPENSION SYSTEM(S)
   A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.
   B. Suspension System for Type ACT 1:

2.04 ACCESSORIES
   A. Support Channels and Hangers: Galvanized steel; size and type to suit application and ceiling system flatness requirement specified.
   B. Hanger Wire: 12-gage 0.08 inch (2 mm) galvanized steel wire.
   C. Hangers: Steel wire, of size and type to suit application, to support ceiling components in place to deflection limits as indicated.
   D. Perimeter Moldings: Same metal and finish as grid.
      1. At Concealed, Tegular, or Reveal Grid: Provide concealed molding.
   E. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify existing conditions and substrate flatness before starting work.
   B. Verify that layout of hangers will not interfere with other work.

3.02 INSTALLATION - SUSPENSION SYSTEM
   B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
   C. Locate system on room axis according to reflected plan.
   D. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
      1. Use longest practical lengths.
   E. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.
   F. Provide hanger clips during steel deck erection. Provide additional hangers and inserts as required.
   G. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
   H. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
   I. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
   J. Support fixture loads using supplementary hangers located within 6 inches (152 mm) of each corner, or support components independently.
K. Do not eccentrically load system or induce rotation of runners.
L. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
   1. Use longest practical lengths.
   2. Miter corners.
   3. Provide at junctions with other interruptions.

3.03 INSTALLATION - ACOUSTICAL UNITS
A. Install acoustical units in accordance with manufacturer's instructions.
B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
C. Fit border trim neatly against abutting surfaces.
D. Install units after above-ceiling work is complete.
E. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
F. Cutting Acoustical Units:
   1. Make field cut edges of same profile as factory edges.
   2. Double cut and field paint exposed reveal edges.

3.04 TOLERANCES
A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet (3 mm in 3 m).
B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Resilient base.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
   A. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
   B. Product Data: Provide data on adhesive recommended by resilient base manufacturer for installation of specified base.
   C. Selection Samples: Submit manufacturer's complete set of color samples for Architect's initial selection.
   D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      1. Extra Wall Base: 10 linear feet (3 linear meters) of each type and color.

1.04 DELIVERY, STORAGE, AND HANDLING
   A. Protect roll materials from damage by storing on end.

1.05 FIELD CONDITIONS
   A. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F (21 degrees C) to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F (13 degrees C).

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
   B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.

3.02 PREPARATION
   A. Prepare substrates as recommended by flooring and adhesive manufacturers.
   B. Clean substrate.

3.03 INSTALLATION - GENERAL
   A. Starting installation constitutes acceptance of substrate conditions.
   B. Install in accordance with manufacturer's written instructions.
   C. Spread only enough adhesive to permit installation of materials before initial set.
   D. Fit joints and butt seams tightly.
   E. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.
   F. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.

3.04 CLEANING
   A. Remove excess adhesive from floor, base, and wall surfaces without damage.
   B. Clean in accordance with manufacturer's written instructions.

END OF SECTION
SECTION 09 9000  
PAINTING AND COATING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surface preparation.
B. Field application of paints.
C. Surfaces to be finished are indicated in this section and on the Drawings.
D. Do Not Paint or Finish the Following Items:
   1. Items fully factory-finished unless specifically so indicated; materials and products having factory-applied primers are not considered factory finished.
   2. Items indicated to receive other finishes.
   3. Items indicated to remain unfinished.
   4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
   5. Stainless steel, anodized aluminum, bronze, teme, and lead items.
   6. Floors, unless specifically so indicated.
   7. Ceramic and other tiles.
   9. Glass.
   10. Concealed pipes, ducts, and conduits.

1.02 RELATED REQUIREMENTS

A. Structural Drawings
B. Section 05 5200 - Handrails and Railing
C. Section 06 1000 - Rough Carpentry
D. Section 06 2000 - Finish Carpentry
E. Section 06 4100 - Cabinets and Casework
F. Section 08 1213 - Hollow Metal Doors and Frames
G. Section 09 2116 - Gypsum Board Assemblies

1.03 DEFINITIONS

A. Conform to ASTM D16 for interpretation of terms used in this section.

1.04 REFERENCE STANDARDS


1.05 SUBMITTALS

A. Product Date: Provide data on all finishing products, including VOC content.
B. Samples for Initial Selection: For each paint or stain system, submit color options to Architect for selection.
C. Samples: Submit two painted samples for each paint or stain system, illustrating selected colors and textures for each color and system selected with specified coats cascaded. Submit on actual material substrate, 12x12 inch in size.
D. Manufacturer's Instructions: Indicate special surface preparation procedures and substrate conditions requiring special attention.
E. Maintenance Data: Submit data including finish schedule showing where each product/color/finish was used, care and cleaning instructions, touch-up procedures, and repair of painted and coated surfaces.
F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Extra Paint and Coatings: 1 gallon (4 L) of each color; store where directed.
   3. Label each container with color in addition to the manufacturer's label.

1.06 QUALITY ASSURANCE
   A. Coordination of Work: Review other sections in which primers are provided to ensure compatibility of the total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
   B. Material Quality: Material containers not displaying manufacturer's product identification will not be acceptable.
   C. Applicator Qualifications: Company specializing in performing the type of work specified with minimum three years experience.

1.07 REGULATORY REQUIREMENTS
   A. Conform to applicable code for flame and smoke rating requirements for products and finishes.

1.08 MOCK-UP
   A. Provide panels, 4 feet long by 2 feet wide, illustrating each coating color, texture, and finish. A maximum of two re-paintings may be required to establish standards to color, texture, sheen, and washability.
   B. Provide door and frame assembly illustrating paint coating color, texture, and finish.
   C. Mock-ups will be used to test paint finish quality including adhesion, hiding power, texture, accepted range of sheen and color variability and other tangible and intangible qualities and shall remain partially painted as a reference standard until direct by the Architect to be completed. At this time the whole mock-up shall be repainted with the entire approved paint finish system to achieve visual uniformity with the adjacent surfaces.
      1. Adhesion test will be performed by the Contractor in the Owner's presence on the mock-up. The owner may perform additional adhesion tests as the construction progresses.
   D. Locate where directed.
   E. Mock-up may not remain as part of the work.

1.09 DELIVERY, STORAGE, AND HANDLING
   A. Conform to manufacturer's instructions.
   B. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
   C. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
   D. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.10 FIELD CONDITIONS
   A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
   B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
   C. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
   D. Minimum Application Temperatures for Latex Paints: 45 degrees F (7 degrees C) for interiors; 50 degrees F (10 degrees C) for exterior; unless required otherwise by manufacturer's instructions.
E. Minimum Application Temperature for Varnish Finishes: 65 degrees F (18 degrees C) for interior or exterior, unless required otherwise by manufacturer's instructions.

F. Provide lighting level of 80 ft candles (860 lx) measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide all paint and coating products used in any individual system from the same manufacturer; no exceptions.

B. Basis of Design:

Paints, Stains and Transparent Finishes:

C. Substitutions:

2.02 PAINTS AND COATINGS - GENERAL

A. Paints and Coatings: Ready mixed, unless intended to be a field-catalyzed coating.
1. Provide paints and coatings of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
2. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
3. Supply each coating material in quantity required to complete entire project's work from a single production run.
4. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
5. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Primers: As follows unless other primer is required or recommended by manufacturer of top coats; where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.

2.03 PAINT SYSTEMS - EXTERIOR

A. Paint WE-TR-VS - Exposed Rough Carpentry:
1. Wood, Transparent, Varnish, Stain:
2. One coat of stain; SW 3518 Hawthorne.
3. Satin: One coat of varnish; [____].
   a. Basis of Design: Minwax Helmsman Spar Urethane

B. Paint WE-TR-S - Wood Decking:
1. Wood, Transparent, Sealer, Stain:
2. One coat of stain; [____].
3. One coat of clear sealer; [____].

C. Paint HWE-TR-S - Hardwood Decking:
1. Wood, Transparent, Sealer, Stain:
2. One coat of stain; [____].
   a. Basis of Design: Deck wise Ipe Oil Hardwood Oil Finish
3. One coat of clear sealer; [____].
   a. Basis of Design: Deckwise Ipe Seal

D. Paint ME-OP-3L - Exterior Steel Doors and Frames, Unprimed, Latex, 3 Coat:
2.04 PAINT SYSTEMS - INTERIOR

A. Paint I-OP - All Interior Surfaces Indicated to be Painted, Unless Otherwise Indicated: Including gypsum board.
   1. Two top coats and one coat primer.
   2. Top Coat(s): Institutional Low Odor/VOC Interior Latex; MPI #143-148.
   3. Flat: MPI gloss level 1; use this sheen for ceilings and other overhead surfaces.
   4. Eggshell: MPI gloss level 3; use this sheen at walls.
   5. Top Coat Product(s):
   6. Primer(s): As recommended by manufacturer of top coats.

B. Paint I-OP-MD-DT - Medium Duty Door/Trim: For surfaces subject to frequent contact by occupants, including metals:
   1. Medium duty applications include door frames.
   2. Two top coats and one coat primer.
   3. Top Coat(s): Interior Epoxy-Modified Latex; MPI #115, 215.
   4. Semi-Gloss: MPI gloss level 5; use this sheen at all locations.
   5. Top Coat Product(s):
   6. Primer(s): As recommended by manufacturer of top coats.

C. Paint I-TR -W - Transparent Finish on Wood, and Wood Doors Unless Otherwise Indicated:
   1. 2 top coats over stain.
   2. Stain: Semi-Transparent Stain for Wood; MPI #90.
   3. Top Coat(s): Polyurethane Varnish, High Build.
   5. Top Coat Product(s):

2.05 ACCESSORY MATERIALS

A. Accessory Materials: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required to achieve the finishes specified whether specifically indicated or not; commercial quality.

B. Patching Material: Latex filler.

C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin application of coatings until substrates have been properly prepared.
B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
D. Test shop-applied primer for compatibility with subsequent cover materials.
E. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
   1. Gypsum Wallboard: 12 percent.
   2. Interior Wood: 15 percent, measured in accordance with ASTM D4442.

3.02 PREPARATION

A. Clean surfaces thoroughly and correct defects prior to coating application.
B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
C. Remove or repair existing coatings that exhibit surface defects. Sand and feather out transitions between infill work and existing painted surfaces.
D. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
E. Seal surfaces that might cause bleed through or staining of topcoat.
F. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
G. Provide barrier coats over incompatible primers and paints or remove and reprime. Notify architect in writing of problems anticipated with using the specified finish-coat material with substrates painted or primed by others.
H. Touch-up bare areas where finish removals have exposed substrates. Wire-brush, clean with solvents recommended by the paint manufacturer, and touch up with a suitable primer as specified herein.
I. Gypsum Board Surfaces to be Painted: Fill minor defects with filler compound. Spot prime defects after repair.
J. Galvanized Surfaces to be Painted: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.
K. Interior Wood Surfaces to Receive Transparent Finish: Wipe off dust and grit prior to sealing, seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after sealer has dried; sand lightly between coats. Prime concealed surfaces with gloss varnish reduced 25 percent with thinner.
L. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.03 APPLICATION
A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
B. Apply products in accordance with manufacturer's instructions.
C. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.
D. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
E. Apply each coat to uniform appearance. Apply additional coats where undercoats, stains, or other conditions show through final coat of paint until paint film is of uniform finish, color, and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.
F. Use applications and methods best suited for substrate and type of material being applied and according to manufacturer's instructions.
G. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.
H. Sand wood surfaces lightly between coats to achieve required finish.
I. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
J. Wood to Receive Transparent Finishes: Tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.
K. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 CLEANING
A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.05 PROTECTION
A. Protect finished coatings until completion of project.
B. Touch-up damaged coatings after Substantial Completion.

3.06 SCHEDULE - SURFACES TO BE FINISHED
A. Do not paint or finish the following items, unless otherwise noted:
   1. Fire rating labels, equipment serial numbers and capacity labels.
   2. Gold leaf, metallic paint, galvanized steel, aluminized steel, prefinished wood work, copper chrome, stainless steel, galvalume, or brass items
   3. Items fully factory finished unless otherwise noted
   4. Exterior storefront door and frame systems.
      a. Wood doors in storefront system to be stained.
B. PT-1: Painted ceilings, interior walls, interior door trim.
   1. Color: (White) SW 7005 Pure White
   2. Manufacturer: Sherwin-Williams
C. PT-2: Painted Interior HM doors.
   1. Color: (Green) Match Buck House Exterior trim
      a. Default SW 6731 - Picnic
   2. Manufacturer: Sherwin-Williams
D. PT-3: Stained Interior Wood Doors
   1. Color: Espresso MW 273
   2. Manufacturer: Sherwin-Williams
E. PT-4: Painted Exterior Walls, Corner and Base Trim.
   1. Color: (White) Match Buck House Exterior Wall Color
      a. Default SW 7005 Pure White
   2. Manufacturer: Sherwin-Williams
F. PT-5: Painted Exterior HM doors, door & window trim.
   1. Color: (Green) Match Buck House Exterior trim
      a. Default SW 6731 - Picnic
   2. Manufacturer: Sherwin-Williams
G. PT-6: Stained Exterior Rough Carpentry
   1. Color: SW
   2. Manufacturer: Sherwin-Williams

END OF SECTION
SECTION 10 1400
SIGNAGE

PART 1 GENERAL

1.01 REFERENCE STANDARDS

1.02 SUBMITTALS
A. Refer to Owner’s General Conditions and Special Conditions, for submittal procedures.
B. Samples: Submit two samples of each type of sign, of size similar to that required for project, illustrating sign style, font, and method of attachment.
C. Selection Samples: Where colors are not specified, submit two sets of color selection charts or chips.

1.03 DELIVERY, STORAGE, AND HANDLING
A. Package signs as required to prevent damage before installation.
B. Package room and door signs in sequential order of installation, labeled by room name.
C. Store tape adhesive at normal room temperature.

1.04 FIELD CONDITIONS
A. Do not install tape adhesive when ambient temperature is lower than recommended by manufacturer.
B. Maintain this minimum temperature during and after installation of signs.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Flat Signs:
   1. Modulex
   2. Refer to Owner’s General Conditions and Special Conditions, for substitutions.
B. Restroom Signage
   1. Matthews Architectural Products

2.02 SIGNAGE APPLICATIONS
A. Accessibility Compliance: Signs are required to comply with ADA Standards and ICC A117.1 [_______], unless otherwise indicated; in the event of conflicting requirements, comply with the most comprehensive and specific requirements.
B. Room and Door Signs: Provide a sign for doors where indicated in schedule.
C. Sign Type: Flat signs with engraved panel media as specified.
   1. Provide "tactile" signage, with letters raised minimum 1/32 inch (0.8 mm) and Grade II braille.
   2. Character Height: 1-1/2 inch (37 mm).
   3. Sign Height: 3 inches (75 mm), unless otherwise indicated.
   4. Service Rooms: Identify with the room names.
   5. Rest Rooms: Identify with pictograms, the names "MEN" and "WOMEN", and braille.
      Bronze Sign Type.

2.03 SIGN TYPES
A. Flat Signs: Signage media without frame.
   1. Edges: Square.
   2. Corners: Square.

B. Bronze Signs
   1. Etched Bronze sign with ADA compliant raised lettering and braille
   2. Size: 6" x 8" Rectangular

C. Color and Font: Unless otherwise indicated:
   1. Character Font: Helvetica, Arial, or other sans serif font.
   2. Character Case: Upper case only.

2.04 TACTILE SIGNAGE MEDIA
A. Engraved Panels: Laminated colored plastic; engraved through face to expose core as background color:
   1. Total Thickness: 1/16 inch (1.6 mm).

2.05 SCHEDULE

<table>
<thead>
<tr>
<th>Door Number</th>
<th>Text</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Door 101</td>
<td>REGISTRATION (Braille)</td>
<td>Flat Sign</td>
</tr>
<tr>
<td>B. Door 103</td>
<td>OFFICE MANAGER (Braille)</td>
<td>Flat Sign</td>
</tr>
<tr>
<td>C. Door 105</td>
<td>PARK MANAGER (Braille)</td>
<td>Flat Sign</td>
</tr>
<tr>
<td>D. Door 107</td>
<td>FISCAL CONTROL (Braille)</td>
<td>Flat Sign</td>
</tr>
<tr>
<td>E. Door 108</td>
<td>MECHANICAL (Braille)</td>
<td>Flat Sign</td>
</tr>
<tr>
<td>F. Door 110</td>
<td>ELECTRICAL (Braille)</td>
<td>Flat Sign</td>
</tr>
<tr>
<td>G. Door 111</td>
<td>CONFERENCE (Braille)</td>
<td>Flat Sign</td>
</tr>
<tr>
<td>H. Door 118</td>
<td>STORAGE (Braille)</td>
<td>Flat Sign</td>
</tr>
<tr>
<td>I. Door 119</td>
<td>MEN'S RESTROOM (with pictogram &amp; Braille)</td>
<td>Bronze Sign</td>
</tr>
<tr>
<td>J. Door 120</td>
<td>WOMEN'S RESTROOM (with pictogram &amp; Braille)</td>
<td>Bronze Sign</td>
</tr>
</tbody>
</table>

2.06 ACCESSORIES
A. Tape Adhesive: Double sided tape, permanent adhesive.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that substrate surfaces are ready to receive work.

3.02 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Install neatly, with horizontal edges level.
C. Protect from damage until Date of Substantial Completion; repair or replace damaged items.

END OF SECTION
SECTION 10 2113.19
PLASTIC TOILET COMPARTMENTS

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Solid plastic toilet compartments.
   B. Urinal screens.

1.02 RELATED REQUIREMENTS
   A. Section 06 1000 - Rough Carpentry: Blocking and supports.
   B. Section 10 2800 - TOILET ACCESSORIES.

1.03 REFERENCE STANDARDS
   A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordination: Coordinate the work with placement of support framing and anchors in walls and ceilings.

1.05 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data on panel construction, hardware, and accessories.
   C. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall supports, door swings.
   D. Samples: Submit two samples of partition panels, 1 by 1 inch (25.4 by 25.4 mm) in size illustrating panel finish, color, and sheen.

PART 2 PRODUCTS
2.01 MANUFACTURERS
   A. Solid Plastic Toilet Compartments:
      2. Substitutions: Refer to Owner's General and Special Conditions

2.02 PLASTIC TOILET COMPARTMENTS
   A. Solid Plastic Toilet Compartments: Factory fabricated doors, pilasters, and divider panels made of solid molded high density polyethylene (HDPE), tested in accordance with NFPA 286; floor-mounted unbraced.
      1. Doors:
         a. Thickness: 1 inch (25 mm).
         b. Width: 24 inch (610 mm).
         c. Width for Handicapped Use: 36 inch (915 mm), out-swinging.
         d. Height: 55 inch (1397 mm).
      2. Panels:
         a. Thickness: 1 inch (25 mm).
         b. Height: 55 inch (1397 mm).
      3. Pilasters:
         a. Thickness: 1 inch (25 mm).
         b. Width: As required to fit space; minimum 3 inch (76 mm).
      4. Screens: Without doors; to match compartments; mounted to wall with two panel brackets.

2.03 ACCESSORIES
A. Pilaster Shoes: Stainless steel, satin finish, 3 inches (76 mm) high; concealing floor fastenings.
B. Wall and Pilaster Brackets: Stainless steel; continuous type.
C. Attachments, Screws, and Bolts: Stainless steel, tamper proof type.
D. Hinges: Stainless steel, manufacturer’s standard finish.
   1. Continuous-type hinge, self closing.
E. Door Hardware: Stainless steel, manufacturer's standard finish.
   1. Door Latch: Slide type with exterior emergency access feature.
   2. Door Strike and Keeper with Rubber Bumper: Mount on pilaster in alignment with door latch.
   3. Provide door pull for outswinging doors.
F. Coat Hook: One per compartment, mounted on door.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that field measurements are as indicated.
B. Verify correct spacing of and between plumbing fixtures.
C. Verify correct location of built-in framing, anchorage, and bracing.

3.02 INSTALLATION
A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.
B. Maintain 3/8 inch to 1/2 inch (9 mm to 13 mm) space between wall and panels and between wall and end pilasters.
C. Attach panel brackets securely to walls using anchor devices.
D. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.
E. Field touch-up of scratches or damaged finish will not be permitted. Replace damaged or scratched materials with new materials.

3.03 TOLERANCES
A. Maximum Variation From True Position: 1/4 inch (6 mm).
B. Maximum Variation From Plumb: 1/8 inch (3 mm).

3.04 ADJUSTING
A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch (5 mm).
B. Adjust hinges to position doors in partial opening position when unlatched. Return out-swinging doors to closed position.
C. Adjust adjacent components for consistency of line or plane.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Commercial toilet accessories.
   1. Toilet Paper Disposal
   2. Grab Bars
   3. Mirrors
   4. Hook & bumper
   5. Electric Hand Dryer
   6. Purse Hook
   7. Recessed Paper Towel Disposal/Dispenser
   8. Mop and Broom Holder
   9. Soap Dispenser
  10. Baby Changing Station

B. Electric hand dryers.

1.02 RELATED REQUIREMENTS

A. Section 06 1000 - Rough Carpentry
B. Section 10 2113.19 - Plastic Toilet Compartments.

1.03 REFERENCE STANDARDS

E. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

1.05 SUBMITTALS

A. Refer to Owner’s General Conditions and Special Conditions, for submittal procedures.
B. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.
C. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

1.06 WARRANTY

A. Provide fifteen year manufacturer warranty against silver spoilage for reflective coating on mirrors and replacement of same.
B. Refer to Owner’s General Conditions and Special Conditions, for additional warranty requirements.
PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Commercial Toilet, Shower, and Bath Accessories:
   3. Bobrick: www.bobrick.com
   5. Substitutions: See Owners General & Special Conditions.

B. Electric Hand Dryers:
      a. Model: Slim Dri L-971
      b. Finish: Brushed Stainless Steel
   2. Substitutions: See Owners General & Special Conditions.

2.02 MATERIALS

A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete
   with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
   1. Grind welded joints smooth.
   2. Fabricate units made of metal sheet of seamless sheets, with flat surfaces.

B. Keys: Provide 2 keys for each accessory to Owner; master key lockable accessories.

C. Stainless Steel Sheet: ASTM A666, Type 304.

D. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.

E. Galvanized Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with
   G90/Z275 coating.

F. Mirror Glass: Annealed float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering,
   protective and physical characteristics complying with ASTM C1503.

G. Adhesive: Contact type, waterproof.

H. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.

I. Expansion Shields: Fiber, lead, or rubber as recommended by accessory manufacturer for
   component and substrate.

2.03 FINISHES

A. Stainless Steel: No. 4 Brushed finish, unless otherwise noted.

B. Galvanizing for Items Other than Sheet: Comply with ASTM A123/A123M; galvanize ferrous
   metal and fastening devices.

C. Back paint components where contact is made with building finishes to prevent electrolysis.

2.04 COMMERCIAL TOILET ACCESSORIES

   1. Serves two compartments, dispensing two standard core 9” diameter rolls per
      compartment.

B. TA-2. Grab Bars: Stainless Steel, nonslip grasping surface
   1. Standard Dudy Grab Bars:
      a. Push/Pull Point Load: 250 pound-force (1112 N), minimum.
      b. Dimensions: 1-1/4 inch (32 mm) outside diameter, minimum 0.05 inch (1.3 mm) wall
         thickness, concealed flange mounting, 1-1/2 inch (38 mm) clearance between wall
         and inside of grab bar.
      c. Length and Configuration: As indicated on drawings.
      d. Products:
         1) Basis of Design: B-5806 manufactured by Bobrick.
2) Substitutions: See Owners General & Special Conditions

C. TA-4 Mirrors: Stainless steel framed, 1/4" thick float glass mirror protected on edges with neoprene tubing.
   1. Size: 2'-0" x 3'-0".
   2. Frame: 0.05 inch channel shapes, with mitered continuously stiffened corners, and tamperproof hanging system; No.4 finish.
   3. Backing: Full-mirror sized, minimum 0.05 inch galvanized steel sheet with nonabsorptive filler material between backing and mirror.
   4. Provide concealed mounting brackets fabricated of 0.05 inch thick cold rolled steel. Provide two brackets for mirrors over 30" wide.
   5. Product: Equivalent to Series 781 manufactured by Bradley.

D. TA-5 Hook and Bumper: Heavy-duty cast aluminum, double-prong, rubber bumper protected top hook, and bracket and backplate for exposed attachment on the inside of the door, satin finish.
   1. Product: Equivalent to B 212 manufactured by Bobrick.
   2. Projection: 3 3/4" including bumper.
   3. Provide four 1/8" x 1/2" long non-magnetic stainless steel screws for anchorage to partition doors. No hardware shall be visible on the opposite side of door.

E. TA-7. Electric Hand Dryer:
   1. World Dryer
      a. Operation: automatic activation.
      b. Finish: Brushed Stainless Steel
      c. Mounting: wall mounted using mounting bracket supplied by manufacturer
      d. Drainage: not applicable.
      e. Air Velocity: 140 mph
      f. Air Volume: 70 cfm
      g. Total Wattage: 950 watts maximum

   1. Product: Equivalent to 9125 manufactured by Bradley.
   2. Vandal-resistant escutcheon size: 2"W x 2"H.
   3. Material and Finish: Bright polished stainless steel

G. TA-9 Waste receptacle, wall mounted.
   1. Product: Equivalent to 3565 manufactured by Bradley.
   2. Capacity: 12 gallon.

H. TA-10 Mop and Broom Holder, wall mounted.
   1. Product: Equivalent to 9953 manufactured by Bradley.

I. TA-11 Soap Dispenser
   1. Product: Equivalent to B-4112 manufactured by Bobrick.

J. TA-12 Baby Changing Station
   1. Product: KOALABEAR KB110-SSRE
   2. Material: Stainless Steel
   3. Mounting: Recessed

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.
B. Verify exact location of accessories for installation.
C. Verify that field measurements are as indicated on product data.
D. See Section 06 1000 - Rough Carpentry for installation of blocking, reinforcing plates, and concealed anchors in walls and ceilings.

3.02 PREPARATION
A. Deliver inserts and rough-in frames to site for timely installation.
B. Provide templates and rough-in measurements as required.

3.03 INSTALLATION
A. Install accessories in accordance with manufacturers’ instructions, except where more stringent requirements are mandated by governing authorities, and except where the project conditions require extra precautions or provisions.
B. Install plumb and level, securely and rigidly anchored to substrate.
   1. For baby changing stations, at stud walls, verify that at least one side of changing station is located so fasteners will be installed directly into stud. If stud spacing is other than 16 inches on center, use toggles for installation at opposite side.
C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.
D. At solid masonry walls, drill pilot holes for installation of expansion-type fasteners.

3.04 PROTECTION
A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION
SECTION 10 4400
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Fire extinguishers.
   B. Accessories.

1.02 RELATED REQUIREMENTS
   A. Section 06 1000 - Rough Carpentry: Wood blocking product and execution requirements.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
   A. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.
   B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
   C. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.05 FIELD CONDITIONS
   A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 PRODUCTS
2.01 MANUFACTURERS
   A. Fire Extinguishers and Accessories:
      2.

2.02 FIRE EXTINGUISHERS
   A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
   B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
      2. Size: 10 pound (4.54 kg) min.
      3. Temperature range: Minus 40 degrees F (Minus 40 degrees C) to [___] degrees F (____) degrees C).

2.03 ACCESSORIES
   A. Extinguisher Brackets: Formed steel, chrome-plated.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify existing conditions before starting work.

3.02 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Install extinguisher 48 inches from finished floor to bottom of extinguisher.
   C. Secure rigidly in place.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Aluminum Flagpoles.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
   A. See TPWD UGC/Special Conditions, for submittal procedures.
   B. Product Data: Provide data on pole, accessories, and configurations.
   C. Shop Drawings: Indicate detailed dimensions, base details, anchor requirements, and imposed loads.

PART 2 PRODUCTS

2.01 FLAGPOLES
   A. Flagpoles: Designed in accordance with NAAMM FP 1001
      1. Material: Aluminum.
      2. Design: Cone tapered.
      3. Mounting: Ground mounted type.
      4. Nominal Height: 30 ft (9.144 m); measured from nominal ground elevation.
      5. Halyard: External type.

2.02 POLE MATERIALS
   A. Aluminum: ASTM B241/B241M, 6063 alloy, T6 temper.

2.03 ACCESSORIES
   A. Finial Ball: Stainless steel, 6 inch (150 mm) diameter.
   B. Cleats: 9 inch (230 mm) size, aluminum with galvanized steel fastenings, two per halyard.
   C. Halyard: 5/16 inch (8 mm) diameter polypropylene, braided, white.

2.04 MOUNTING COMPONENTS
   A. Pole Base Attachment: Flush; steel base with base cover.
   B. Lighting Ground Rod: 10" inch (254 mm) long copper rod, 3/4 inch (19 mm) diameter.

2.05 FINISHING
   A. Metal Surfaces in Contact With Concrete: Asphaltic paint.
   B. Aluminum: Mill finish.
   C. Stainless Steel: No. 4 satin finish.
   D. Gold Anodized LED light see electrical

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that concrete foundation is ready to receive work and dimensions are as indicated on shop drawings.
   B. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION
   A. Install flagpole, base assembly, and fittings in accordance with manufacturer's instructions.
B. Install foundation plate and centering wedges for flagpoles base set in concrete base and fasten.

3.03 TOLERANCES
A. Maximum Variation From Plumb: 1 inch (25 mm).

3.04 ADJUSTING
A. Adjust operating devices so that halyard and flag function smoothly.

END OF SECTION
SECTION 12 2400
WINDOW SHADES - MECHOSHADE SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Manual roller shades and accessories.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
   A. Refer to Owner's General Conditions and Special Conditions, for submittal procedures.
   B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product to be used including materials, finishes, fabrication details, dimensions, profiles, mounting requirements, and accessories.
   C. Shop Drawings: Include shade schedule indicating size, location and keys to details.
   D. Selection Samples: Include fabric samples in full range of available colors and patterns.
   E. Operation and Maintenance Data: List of all components with part numbers, and operation and maintenance instructions; include copy of shop drawings.
   F. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

1.04 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than ten years of documented experience.
   B. Installer Qualifications: Company specializing in performing work of this type with minimum ten years of documented experience with shading systems of similar size, type, and complexity; manufacturer's authorized representative.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. Deliver shades in manufacturer's unopened packaging, labeled to identify each shade for each opening.
   B. Handle and store shades in accordance with manufacturer's recommendations.

1.06 WARRANTY
   A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
   B. Provide manufacturer's standard, non-depreciating warranty, for interior shading only, covering the following:
      1. Shade Hardware: 10 years unless otherwise indicated.
      2. Shade Fabric: 10 years unless otherwise indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Basis of Design: MechoShade Systems LLC; www.mechoshade.com/#sle.
   B. Substitutions: [See Owner's General Conditions and Special Conditions]

2.02 ROLLER SHADES
   A. General:
      1. Provide shade system components that are capable of being removed or adjusted without removing mounted shade brackets or cassette support channel.
      2. Provide shade system that operates smoothly when shades are raised or lowered.
   1. Description: Single roller, manually operated fabric window shades.
   2. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
   3. Roller Tubes:
      b. Size: As recommended by manufacturer; selected for suitability for installation conditions, span, and weight of shades.
      c. Fabric Attachment: Utilize extruded channel in tube to accept vinyl spline welded to fabric edge. Shade band to be removable and replaceable without removing roller tube from brackets or inserting spline from the side of the roller tube.
      d. Roller tubes to be capable of being removed and reinstalled without affecting roller shade limit adjustments.
   4. Hembars: Designed to maintain bottom of shade straight and flat.
   5. Clutch Operator: Manufacturer's standard material and design integrated with bracket/brake assembly.
      a. Provide a permanently lubricated brake assembly mounted on a oil-impregnated hub with wrapped spring clutch.
      b. Brake must withstand minimum pull force of 50 pounds (22.7 kg) in the stopped position.
      c. Mount clutch/brake assembly on the support brackets, fully independent of the roller tube components.
   6. Drive Chain: Continuous loop stainless steel beaded ball chain, 95 pound (43 kg) minimum breaking strength. Provide upper and lower limit stops.
      a. Chain Retainer: Chain tensioning device complying with WCMA A100.1.

2.03 SHADE FABRIC
   A. Fabric - Type [_____]: Non-flammable, color-fast, impervious to heat and moisture, and able to retain its shape under normal operation.
      1. Performance Requirements:
         a. Flammability: Pass NFPA 701 large or small scale test.
      2. Products:

PART 3 EXECUTION
3.01 EXAMINATION
   A. Examine finished openings for deficiencies that may preclude satisfactory installation.
   B. Start of installation shall be considered acceptance of substrates.

3.02 INSTALLATION
   A. Install in accordance with manufacturer's instructions and approved shop drawings, using mounting devices as indicated.
   B. Adjust level, projection, and shade centering from mounting bracket. Verify there is no telescoping of shade fabric. Ensure smooth shade operation.

3.03 CLEANING
   A. Clean soiled shades and exposed components as recommended by manufacturer.
   B. Replace shades that cannot be cleaned to "like new" condition.

3.04 PROTECTION
   A. Protect installed products from subsequent construction operations.
   B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION
SECTION 22 0100

SPECIAL CONDITIONS FOR ALL PLUMBING WORK

PART 1- GENERAL

1.1 DESCRIPTION OF WORK

A. This section covers the general provisions of the plumbing specifications applicable to the following systems:
   1. Plumbing.

B. The use of the word plumbing in the body of the various specifications sections shall be interpreted to include all the aspects of all of the systems referenced in the Plumbing Specifications.

1.2 DRAWINGS

A. These specifications are accompanied by drawings of the building and details of the installations showing the locations of equipment, piping, etc. The drawings and these specifications are complementary to each other; requirements described in one or the other shall be considered binding as if described in both.

B. If any departures from the drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted to the Owner’s Representative for approval. No departures shall be made without prior written approval by the Owner’s Representative.

C. There are intricacies of construction which are impractical to specify or indicate in detail; means and methods for performing such work shall adhere to commonly accepted industry standards.

D. It is the Contractor’s responsibility to properly use all information found on the Architectural, Structural, Mechanical, Plumbing and Electrical drawings and applicable shop drawings where such information affects his work.

E. For new buildings, all final dimensions shall be scaled from the drawings, unless otherwise noted. For work associated with existing buildings (renovations and additions), all final dimensions shall be field verified.

1.3 CONSTRUCTION REQUIREMENTS

A. The architectural, civil, structural, mechanical, electrical, plumbing, and fire protection drawings, and specifications are all part of the Contract Documents. In many instances there are details described in another trade’s drawings that are not necessarily included or referenced in the plumbing drawings. It is the Contractor’s responsibility to review in detail all parts of the Contract Documents prior to submitting a bid. Failure to comply with this requirement shall not relieve the Contractor of responsibility or be used as cause for additional compensation because architectural, structural, or electrical details were not included in the plumbing drawings.

B. It is the intent of the Contract Documents to provide complete and fully functional installation in every respect. Material and/or construction details not specifically described in the Contract Documents, but commonly considered incidental to the industry, are required by the Contractor.
C. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to comply with Codes, to facilitate the work of other trades, to conform to the details of the installation supplied by the manufacturer of the equipment to be installed, and thereby to provide an integrated satisfactory operating installation.

D. The plumbing, electrical and mechanical drawings are schematic in nature and do not show every connection in detail or every pipe or conduit in its exact location. These details are subject to the requirements of ordinances and structural and architectural conditions.

E. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases and above suspended ceilings, etc. in finished portions of the building, unless specifically noted to be exposed. Work shall be installed to avoid compromising 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. All work shall be installed parallel or perpendicular to building lines unless otherwise noted.

F. When the plumbing drawings do not give exact details as to the elevation of pipe or equipment, physically arrange the systems to fit in the space available at the elevations intended with the proper grades for the functioning of the system involved. Piping and exposed conduit, are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner. The plans do not show all required offsets, control lines, pilot lines, and other location details. Work shall be concealed in all finished areas. Piping specified to be insulated shall be supported in a manner that will allow the insulation to be installed without gaps. Insulated piping in concealed areas shall be offset with fittings as necessary to permit installation of insulation. Bending of pipes or installing pipes in a strain to insulate will not be permitted.

G. Final placement of serviceable equipment shall be carefully coordinated with all other trades to ensure sufficient clearance for maintenance according to manufacturer’s recommendations. Lubricating orifices and adjustable components shall be easily accessible. Piping, conduit, valve stems, cabling and other building systems shall not interfere with service space.

H. Location of Exposed Devices
   1. All exposed devices (sprinkler heads, medical gas outlets, plumbing rough-ins, lights, outlets, communication devices, etcetera) shall be referenced to fixed data points that are coordinated with all trades; shall be located to present symmetrical arrangements with respect to the fixed data point; and shall facilitate the proper arrangements of acoustical ceiling tiles. Fixed data points shall include such features as wall and ceiling lines, soffits, balanced border widths, masonry joints, etc. Devices located in acoustical ceiling tiles shall occur symmetrically in tile joints or in the centers of whole tiles. The final determination of the exact location of each outlet and the arrangements to be followed shall be acceptable to the Owner's Representative.
   2. The drawings schematically indicate locations of the exposed devices. Final locations shall be determined by carefully coordinating the drawings pertaining to each trade. Where conflicts are identified, Owner's Representative shall determine final location. The Owner reserves the right to make any reasonable change in location of any device before installation, without additional cost to the Owner or the Architect.

1.4 QUALIFICATIONS

A. Contractor must have minimum of five years experience installing commercial, plumbing and piping systems similar to those described in these Contract Documents.
B. Contractor must be licensed and hold a current contracting license that has been valid for a
minimum of five years in the State of Texas.

C. Contractor must be able to bond work for payment and performance of work being bid. Contractor's bonding agency shall have a Best's insurance rating of A or A+.

1.5 MATERIAL AND EQUIPMENT REQUIREMENTS

A. Manufacturer’s Instructions: The manufacturer’s published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufacturer materials or equipment, unless otherwise indicated. The Contractor shall promptly notify the Owner’s Representative in writing of any conflict between the requirements of the Contract Documents and the manufacturer’s direction and shall obtain the clarification of the Owner’s Representative before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer’s directions or such clarification by the Owner’s Representative, he shall bear all costs arising in connection with the correction of the deficiencies.

B. Storage at Site: The Contractor shall not receive material or equipment at the jobsite until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage and from surrounding work.

C. Capacities shall be not less than those indicated and shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

D. Conformance to Agency Requirements: Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriters Laboratories, Inc., or constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers, the Contractor shall submit proof that the items furnished under this section of the specifications conform to such requirements. The label of Underwriters Laboratories, Inc. applied to the item will be acceptable as sufficient evidence that the items conform to such requirements. The ASME stamp or the AMCA label will be acceptable as sufficient evidence that the items conform to the respective requirements.

E. Nameplates: Each major component of equipment shall have the manufacturer’s name, address, and model-identification 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. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise surfaces of ferrous metal shall be given a rust-inhibiting coating. The treatment shall withstand 200 hours in salt-spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen shall show no signs of wrinkling or cracking and no signs of rust creepage beyond 1/8 inch on either side of the scratch mark. Where rust inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified, except that coal tar or asphalt-type coatings will not be acceptable unless so stated for a specific item. Where steel is specified to be hot-dip galvanized, mill-galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-26915.

G. Protection from Moving Parts: Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts located so that any person can come in close proximity thereto, shall be fully enclosed or properly guarded.

H. Drive Guards: For machinery and equipment, provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears, and other moving parts regardless of height above the floor. Drive guards may be excluded where motors and drives are inside factory-
fabricated air handling units casings. Guards shall be constructed of sheet steel, cast iron, expanded metal, or wire mesh rigidly secured so as to be removable without disassembling pipe duct or electrical connection to equipment. Provide a 1-inch diameter hole in each drive guard at each shaft center to allow access for speed measurement.

I. Verifications of Dimensions: The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. The Contractor shall visit the premises and thoroughly familiarize himself with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Owner's Representative of any discrepancy before performing any work. Adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner, Architect, or Engineer.

J. Standard Products: Materials and equipment to be provided 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.

K. Spare Parts Data: As soon as practicable after approval of materials and equipment and, if possible, not later than four months prior to the date of beneficial occupancy, the Contractor shall furnish spare parts data for each different item of equipment listed. The data shall include a complete list of parts and supplies with current unit prices and sources of supply, a list of parts and supplies that are either normally furnished at no extra cost with the purchase of the equipment or specified hereinafter to be furnished as part of the Contract, and a list of additional items recommended by the manufacturer to assure efficient operation for a period of 120 days at the particular installation. The foregoing shall not relieve the Contractor of any responsibilities under the warranty specified.

1.6 INSPECTION OF THE SITE

A. The Contractor shall visit the site, verifying all existing items indicated on drawings and/or specified, and familiarize himself with the existing work conditions, hazards, grades, actual formations, soil conditions, structures, utilities, equipment, systems, facilities, and local requirements. The submission of bids shall be deemed evidence of such visits. All proposals shall take these existing conditions into consideration, and the lack of specific information shall not relieve the Contractor of any responsibility.

1.7 UTILITY LOCATIONS AND ELEVATIONS

A. Locations and elevations of the various utilities included within the scope of this work have been obtained from substantially reliable sources and are offered separately from the Contract Documents, as a general guide only, without guarantee as to accuracy. Examine the site, the locations, and availability of all utilities and services required for their relation to the work. Verify the location of all existing site utilities with each responsible utility company or applicable party. The Contractor shall repair all damage to existing utilities, whether indicated on the drawings or not, at his sole expense.

1.8 PERMITS, UTILITY CONNECTIONS, AND INSPECTIONS

A. Permitting Fees: Contractor shall pay for all fees associated with permits required by municipal authorities having jurisdiction.

B. Tapping and Impact Fees: Contractor shall pay for all fees associated with tapping into municipal utility mains, including sanitary sewer, natural gas and domestic water. Impact fees will be paid for by the Owner.
C. Compliance: The Contractor shall comply in every respect with all requirements of local authorities having jurisdiction, including building inspections, fire marshal, local ordinances and codes, and utility company requirements. In no case does this relieve the Contractor of the responsibility of complying with these specifications and drawings where specified conditions are of a higher quality than the requirements of the above-specified authorities. Where requirements of the specifications and drawings are below the requirements of the above offices having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above authorities.

D. Utilities: The Contractor shall coordinate with the various utility companies involved in this project and shall provide required utility relocations, extensions, modifications, and/or changes (complete in all respects) as described in the Contract Documents. Contractor shall verify the location of all existing utilities with the applicable Utility Company. The Contractor shall be responsible for all damages to existing utilities, whether indicated on drawings or not, and repair all damage to existing utilities as acceptable to the affected Utility Company.

E. Certification: Prior to final acceptance, the Contractor shall furnish a certificate of acceptance from the inspection departments having jurisdiction over the work for any and all work installed under this Contract. Any additional labor costs incurred as a result of a substitution shall be the Contractor's responsibility.

1.9 EXISTING FACILITIES

A. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection, and in-service maintenance of all plumbing, heating, air conditioning, and ventilating services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

B. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being performed under this project.

C. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, light fixtures, air conditioning ductwork and equipment, etc. to provide this access and shall reinstall same upon completion of work in the areas affected.

D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed, all Contractors shall remove and reinstall in locations approved by the Architect/Engineer all devices required for the operation of the various systems installed in the existing construction. This is to include but is not limited to temperature controls system devices, electrical switches, relays, fixtures, piping, conduit, etc.

E. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner two weeks in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, shall be included in the contract amount.

1.10 DEMOLITION AND RELOCATION
A. The Contractor shall modify, remove, and/or relocate all materials and items so indicated on the drawings or required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination or otherwise disposed of as directed by the Owner. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition. The Contractor may, at his discretion, and upon the approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.

B. All items which are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved.

C. When 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.

D. Service lines and wiring to items to be removed, salvaged, or relocated shall be removed to points indicated on the drawings, specified, or acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied off or disconnected in a safe manner acceptable to the Owner. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities which must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner as hereinbefore specified.

1.11 SUBSTITUTION OF MATERIALS AND EQUIPMENT

A. No substitution of materials or equipment herein specified or called for on the drawings will be permitted, except by written permission of the Owner’s Representative. Where several makes of equipment or material are mentioned, any item named may be bid upon provided it meets space, capacity specifications, and other requirements.

1.12 SUBMITTALS

A. Submittals for Review:
   1. As soon as practical or within 30 days after the date of contract award or notice to proceed, and before purchasing or starting installation of any materials or equipment, the Contractor shall submit for review sufficient material and equipment data to indicate that all requirements of the specifications have been met and samples shall be furnished when requested. All manufacturer's data used as part of the submittal shall have all non-applicable features crossed out or deleted in a manner that will clearly indicate exactly what is to be furnished.
   2. Four (4) copies of the submittal list and detailed submittals (for the Owner's and A/E's use) shall be submitted to the Owner's Representative. The Contractor is requested to include a minimum of three (3) additional copies for insertion in the project's Owner's Manuals at the completion of the project, and the number of additional copies the Contractor requires for his and his subcontractor's use during the project's construction. The detailed
submittals shall be accompanied by the same number of sets of pictorial and descriptive data derived from the manufacturer's catalogs and sales literature, or incorporated in the shop drawings. The Contractor may provide a detailed submittal on any item even though not required by the Owner's Representative.

B. Format
1. Submittals shall be bound in a BLACK hardback three-ring binder with clear-view sleeves on the spine and front. Binders larger than 3-inches shall be divided into two volumes. The front sleeve shall have a cover sheet inserted with the title “PLUMBING SUBMITTALS” centered in large print. Below the title shall be printed the name of the project, the date, the project location, the name and address of the contractor, the name and address of the subcontractor and the name and address of the engineer(s) in smaller print.
2. Provide a Table of Contents at the beginning of the binder that summarizes the information being submitted according to specification section.
3. Submittals shall be tab divided by specification section; all sections identified in the project specifications shall have a tab. When no information is being provided concerning a particular specification section, insert a single dated sheet that explains the circumstances.
4. **Loose-leaf or piecemeal submittals are not acceptable and subject to rejection unless prior approval has been granted by the Engineer.**
5. Email/Digital Submittals are acceptable.

C. Content:
1. The Contractor shall prepare or cause to be prepared shop drawings, product data, materials and equipment lists, diagrams, data, samples, and other submittals as required by the contract documents, hereinafter referred to as “Submittal Data.” The Contractor shall review and approve all submittal data for compliance with the contract documents, manufacturer's recommendations, adequacy, clearances, code compliance, safety, and coordination with associated work.
2. The Contractor shall submit approved submittal data to the Owner's Representative for review and comment as to general conformance with the design concept and general compliance with information given in the contract documents. Owner's Representative's review shall not include review of quantities, dimensions, weights or gauges, fabrication processes, construction methods, coordination with other trades or work, or construction safety and precautions, all of which are the sole responsibility of the Contractor.
3. The Contractor shall clearly and specifically identify and call to the attention of the Owner's Representative any deviation from the contract documents for which Owner acceptance is desired. The responsibility for such a deviation accepted by the Owner shall remain with the Contractor.
4. **Timeliness:** The burden of timeliness in the complete cycle of submittal data is on the Contractor. The Contractor shall allow a minimum of two (2) weeks' time frame for review of each submission by the Owner's Representative. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all re-submission cycles on nonconforming materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not justify any request for scheduled construction time extensions or extra compensation.
5. Work performed in accordance with approved submittal data that is not in accordance with the Contract Documents and did not have the specific acceptance of the Owner’s Representative shall be replaced at Contractor’s cost.

D. Re-submittals
1. Re-submit entire submittal in accordance with afore mentioned format and content requirements. **Loose-leaf or piecemeal re-submittals are not acceptable.** New and/or revised data for each section shall be prefaced with a colored (yellow, pink, orange, etc)
cover sheet that identifies (in a word or two) the materials and/or equipment being re-submitted. Typeset the words “REVISED SUBMITTAL NO. 1 (or 2, 3 as applicable)” centered at the bottom of the cover sheet.

2. Subsequent re-submittals (second and third, if necessary) shall have different colored cover sheets to distinguish between the various re-submittals.

3. Include a cover letter at front of binder that specifically responds to each “REVISE AND RE-SUBMIT COMMENT” or “REJECTED” comment by number. Example responses would include the following:
   a. RESPONSE: “Please see attached re-submittal.”
   b. RESPONSE: “Will be re-submitted at a latter date.”
   c. RESPONSE: “Requirement for (xxxxxx) was deleted in Addendum No. 2.”
   d. RESPONSE: “Exception requested based on Section xx, Paragraph x.x.x.

E. These paragraphs related to Plumbing submittal data supersede any conflicting requirements contained in Division 01 sections.

1.13 CONTRACTOR CERTIFICATION OF SUBMITTAL DATA

A. The Contractor shall provide the following certification with all submittal data furnished to the Owner's Representative for review and comment.

   Project Title:

   Description of Submittal Data:

   This is to certify that the above-described submittal data has been reviewed and is approved for compliance with the Contract Documents, manufacturer's recommendation, adequacy, clearances, code compliance, safety, and coordination with other trades and/or work except as follows: (list “none” or itemize and explain). In addition, the Contractor shall submit to the Owner's Representative a signed statement from each representative certifying as follows:

   “I certify that the materials and/or equipment listed below have been personally inspected by the undersigned authorized manufacturer's representative and is properly installed and operating in accordance with the manufacturer's recommendations and are asbestos free.”

   Name and Company

1.14 ACCEPTANCE OF MATERIALS AND EQUIPMENT

A. All equipment installed on this project shall have local (within 125 miles) representation, local factory-authorized service, and a local stock of repair parts. This requirement is essential and will be strictly reviewed by the Owner's Representative prior to concurrence with the Contractor's approval for all submittals covered by Plumbing Division of this Specification.

B. NOTICE: The Contractor is responsible for providing materials and equipment that conform to the requirements of the project manual in every respect unless a deviation has been “accepted” in writing. Removal of any nonconforming materials and equipment and the replacement with conforming materials and equipment shall be at the Contractor's sole expense, regardless of when nonconformance was discovered.

C. Approval of materials and equipment shall be based on manufacturer's published data and shall be tentatively subject to the submission of complete shop drawings which comply with the
contract documents. Approval is also dependent upon the existence of adequate and acceptable clearances for entry, servicing, and maintenance.

D. Approval of materials and equipment under this provision shall not be construed as authorizing any deviations from the specifications, unless the attention of the Owner’s Representative has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.

E. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of approved manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.

1.15 SITE OBSERVATION

A. Site observation by the Architect, Engineer, and/or Owner’s Representative is for the express purpose of verifying compliance by the Contractor with the contract documents, and shall not be construed as construction supervision nor indication of approval of the manner or location in which the work is being performed as being a safe practice or place.

1.16 SUPERVISION

A. In addition to the Superintendent required under the conditions of the contract, each subcontractor shall keep a competent superintendent or foreman on the job at all times.

B. It shall be the responsibility of each superintendent to study all plans and familiarize himself with the work to be done by other trades. He shall coordinate his work with other trades and, before material is fabricated or installed, make sure that his work will not cause an interference with another trade. Where interferences are encountered, they shall be resolved at the jobsite by the superintendents involved. Where interferences cannot be resolved without major changes to the plans, the matter shall be referred to the Owner’s Representative for comments.

1.17 OPERATION PRIOR TO COMPLETION

A. When any piece of equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation and has the written permission of the Owner’s Representative to do so. The warranty period shall not commence, however, until such time as the equipment is operated for the beneficial use of the Owner or date of substantial completion, whichever occurs first.

B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, properly adjust, and complete all deficiency list items before final acceptance by the Owner. The date of acceptance and the start of the warranty may not be the same date.

1.18 MANUFACTURER’S RECOMMENDATIONS

A. The manufacturer’s published directions shall be followed in the delivery, storage, protection, installation, piping, and wiring of all equipment and material. The Contractor shall promptly notify the Owner’s Representative, in writing, of any conflict between the requirements of the contract documents and the manufacturer’s directions, and shall obtain the Owner’s Representative’s comments before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer’s directions or applicable comments from the Owner’s Representative, he shall bear all costs arising in connection with the correction of such deficiencies.
1.19 CHECKING AND TESTING MATERIALS AND/OR EQUIPMENT

A. Before final acceptance of the work, an authorized representative of the manufacturer of the installed materials and/or equipment shall personally inspect the installation and operation of his materials and/or equipment to determine that it is properly installed and in proper operating order. Testing and checking shall be accomplished during the course of the work where required by work being concealed, and at the completion of the work otherwise. In addition, the Contractor shall submit to the Owner's Representative a signed statement from each representative certifying as follows:

   “I certify that the materials and/or equipment listed below have been personally inspected by the undersigned authorized manufacturer's representative and is properly installed and operating in accordance with the manufacturer's recommendations and are asbestos free.”

B. Check inspections shall include plumbing, heating, air conditioning, ventilating, mechanical control and electrical equipment, and such other items hereinafter specified or specifically designated by the Owner’s Representative.

1.20 OPERATING AND MAINTENANCE INSTRUCTION

A. The Contractor shall prepare for the owner’s manual hereinafter specified complete sets of operating and maintenance instructions, system piping, valving, control and interlock diagrams, manuals, parts lists, etc. for each item of equipment. These are to be assembled as hereinafter specified for owner’s manual.

B. In addition, the Contractor shall provide the service of a competent engineer or a technician acceptable to the Owner’s Representative to instruct a representative of the Owner in the complete and detailed operation of all equipment and systems. These instructions shall be provided for a period of sufficient duration to fully accomplish the desired results. Upon completion of these instructions, a letter of release will be required, acknowledged by the Owner, stating the dates of instruction and personnel to whom instructions were given.

C. Additional diagrams, operating instructions, etc. shall be provided as specified hereinafter in the other sections of these specifications.

1.21 MATERIAL AND EQUIPMENT SCHEDULES

A. Contractor shall refer to both drawings and specification for schedules. Where reference is made to items “scheduled on drawings” or “scheduled in specifications,” same shall include schedules contained in both the drawings and the specifications. The Contractor’s attention is directed to the various specification sections and drawings for schedules.

1.22 APPLICABLE CODES AND STANDARDS

A. The installation shall meet the minimum standards prescribed in the latest editions of the following listed codes and standards, which are made a part of these specifications, except as may be hereinafter specifically modified in these specifications and associated drawings.

1. National Fire Protection Association Standards (NFPA):
   - NFPA 10 - Portable Fire Extinguishers
   - NFPA 54 - National Fuel and Gas Code
   - NFPA 70 - National Electrical Code
   - NFPA 90A - Air Conditioning Systems
   - NFPA 255 - Method of Test of Surface Burning Characteristics of Building Materials
Local and State Health Code (TDSH)

   15-78 - Safety Code for Mechanical Refrigeration
   A117.1 - Handicapped Code

3. American Society of Mechanical Engineers (ASME): Section IV, V, CSD-1

4. Air Conditioning and Refrigeration Institute Standards (ARI): All standards related to
   refrigeration and air conditioning equipment and piping furnished under these
   specifications.

5. American Water Works Association (AWWA): All applicable manuals and standards.

6. Sheet Metal and Air Conditioning Contractors National Associate, Inc, (SMACNA): All
   applicable manuals and standards.

7. Air Moving and Conditioning Association (AMCA): All applicable manuals and standards.


9. National Electrical Manufacturers’ Association (NEMA): All applicable manuals and
   standards.

10. Occupational Safety and Health ACT (OSHA):
    National Sanitation Foundation - Standard No. 2

11. American Society of Heating, Refrigeration, and Air conditioning Engineers (ASHRAE):
    90-80 Energy Conservation in New Building Design
    2001 ASHRAE Handbook of Fundamentals


13. American Gas Association (AGA)

14. Underwriters Laboratories, Inc. (UL)

15. Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS)

16. Applicable State Building Codes (International Building Codes, as amended):

17. Applicable State Mechanical Code (International Mechanical Code, as amended).


B. All materials and workmanship shall comply with all applicable city, state, and national codes,
   specifications, and industry standards. All materials shall be listed by the Underwriters
   Laboratories, Inc. as conforming to its standards and so labeled in every case where such a
   standard has been established for the particular type of material in question.

C. 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 Owner's Representative in writing of said discrepancies and apply for an
   interpretation. Should the discovery and notification occur after the execution of a contract, any
   additional work required for compliance with said regulations shall be paid for as covered by
   Division 1 of these contract documents, providing no work or fabrication of materials has been
   accomplished in a manner of noncompliance. Should the Contractor fabricate and/or install
   materials and/or workmanship in such a manner that does not comply with the applicable codes,
   rules, and regulations, the Contractor who performed such work shall bear all costs arising in
   correcting these deficiencies to comply with said rules and regulations.

1.23 DEFINITIONS

A. Refer to the condition of the contract for Division 1 for additional requirements regarding
   definitions.

B. Where “as required” or “as necessary” is used in these specifications or on the drawings, it shall
   mean “that situations exist that are not necessarily described in detail or indicated that may
   cause the Contractor certain complications in performing the work described or indicated. These
   complications entail the normal coordination activities expected of the Contractor where multiple
trades are involved and new or existing construction causes deviations to otherwise simplistic approaches to the work to be performed. The term shall not be interpreted to permit an option on the part of the Contractor to achieve the end result."

C. Where “and/or” is used in these specifications or on the drawings, it shall mean “that situations exist where either one or both conditions occur or are required and shall not be interpreted to permit an option on the part of the Contractor.

1.24 FINAL INSPECTION

A. Refer to Division 1 for additional requirements for final inspection.

B. It shall be the responsibility of the Contractor to personally conduct a careful inspection, assuring himself that the work on the project is ready for final acceptance and developing his own “punchlists,” before calling upon the Owner’s Representative to make a final inspection. Failure of the Contractor to conduct such inspections and provide the Owner’s Representative with a copy of his “punchlists” prior to the final inspection shall be adequate cause for the Owner’s Representative to cancel any Contractor-requested final inspection.

C. In order not to delay final acceptance of the work, the Contractor shall conduct his own “final inspections” prior to requesting the Owner’s Representative to “final” the project; will have all necessary bonds, guarantees, receipts, affidavits, etc. called for in the various articles of this specification prepared and signed in advance; and together with a letter of transmittal listing each paper included, shall deliver the same to the Owner’s Representative at or before the time of said final inspection. The Contractor is cautioned to check over each bond, receipt, etc. before preparing same for submission to see that the terms check with the requirements of the specifications.

D. The final inspection will be made jointly by the Owner’s Representative and the Owner.

1.25 REQUIREMENTS FOR FINAL ACCEPTANCE

A. Requirements for final acceptance shall include but not be limited to the Contractor accomplishing the following:

1. Construction: Complete all construction.
2. Deficiency Lists: Correct all deficiencies listed at time of Substantial Completion.
   a. Owner’s Manual: Submit at least 30 days prior to final acceptance on (1) copy of the owner's manual for the Owner’s Representative's review and comments. Following acceptance, prepare three (3) copies of bound and indexed owner’s manual, to be delivered System operating instructions.
   b. System control drawings.
   c. System interlock drawings.
   d. System maintenance instructions.
   e. Manufacturers’, suppliers’, and subcontractors’ names, addresses, and telephone numbers, both local representatives and manufacturers’ service headquarters.
   f. Equipment operating and maintenance instructions and parts lists.
   g. Manufacturer’s’ certifications (see Checking and Testing Materials and/or Equipment, this section).
   h. Contractor’s warranty.
   i. Acceptance certificates of authorities having jurisdiction.
   j. Log of all tests made during course of work.
   k. Owner’s acknowledgment of receipt of instruction, enumerating items in owner’s manual.
   l. List of manufacturers’ guarantees executed by the Contractor.
m. Certified performance curves.

n. Balance and performance test reports.

o. Owner’s acknowledgment of items of equipment or accessories indicated or specified to be turned over to Owner.

p. Verbal, as herein specified.

q. Posted, framed under glass or plastic laminated:

3. At the time of final acceptance, which shall include but not be limited to the following:

4. Instructions:
   a. System operating instructions.
   b. System control drawings.
   c. System interlock drawings.

5. Record Drawings: Deliver the specified record drawings to the Owner’s Representative.

1.26 RECORD DRAWINGS

A. The Contractor shall maintain a set of contract drawings (black-line prints) at the jobsite on which he shall indicate the installed (as-built) locations of the following:
   1. Equipment
   2. Main lines of piping and ductwork.
   3. Dimensional locations (including depth) of all underground piping, valves and conduits.

B. Drawings shall be used for construction reference and shall not leave the field office of the jobsite.

C. Drawings shall include all addenda, ASI’s, Change Orders, and existing conditions and equipment that are not reflected in the original contract drawings.

D. Upon completion of work, the Contractor shall obtain CAD files of the contract drawings from the Owner's Representative and transfer the above as-built information into these files. The as-built files shall be permanently marked “RECORD DRAWINGS” and printed on full-size Mylar sheets. Upon completion, the CAD files shall be transferred to CD in AutoCAD 2007 format. Both the CAD files CD and Mylar drawings shall be submitted to the Owner’s Representative as part of the Close-out Submittals.

E. Refer to Division 1 paragraph entitled “Record Documents” for additional requirements.

1.27 ALLOWANCES

A. Refer to Division 1 for allowances.

1.28 ALTERNATE PROPOSALS

A. Alternate proposals are summarized in Division 1 and on the bid proposal form. Refer to all sections of the specifications and the drawings to determine the exact extent and scope of the various alternate proposals as each pertains to the work of the various trades.

1.29 WARRANTY

A. General: All work performed (including equipment and materials furnished) under the various sections of these specifications shall be 100% warranted, for a period of one (1) year from the date of final acceptance thereof, against defective materials, design, and unauthorized substitution. Upon receipt of note of failure of any part of the guaranteed equipment and/or facilities during the guaranty period, the affected part(s) or facilities shall be replaced promptly with new parts, etc. by and at the expense of the Contractor. Further, the Contractor shall
properly obtain, execute, and forward any and all manufacturer’s warranties on equipment furnished under the Contract. Refer to Division 1 for additional requirements.

B. Extended Period: The Contractor shall provide all extended time warranties available from the manufacturer of the equipment provided as standard at no additional cost. This includes all extended warranties where specified with certain equipment as directed in other sections of this Specification.

PART 2 - PRODUCTS

2.1 MATERIALS AND WORKMANSHIP

A. All materials, unless otherwise specified, shall be 51% manufactured in the United States, new, free from all defects, and of the best quality. Foreign goods specifically approved for use by the Owner's Representative prior to bidding may be furnished.

B. Materials and equipment shall be installed in accordance with the manufacturer’s recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall present a neat, precise appearance.

C. The responsibility for the furnishing and installation of the proper plumbing equipment and/or material as intended rests entirely upon the Contractor. The Contractor shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

2.2 FLAME SPREAD AND SMOKE DEVELOPED PROPERTIES OF MATERIALS

A. Duct coverings, duct linings, vapor barrier facings, tapes, adhesives, core materials, insulation, jackets, piping (of any sort), and other materials in concealed locations, including any above-ceiling area, shall have a flame spread rating not over 25 without evidence of continued progressive combustion and a smoke developed rating no higher than 50. Flame spread and smoke developed ratings shall be in accordance with NFPA Standard No. 255.

2.3 BEARINGS

A. All ball bearings shall be of radial and/or thrust type, and enclosed in a dust and moisture-proof housing.

2.4 MOTORS

A. The Contractor shall provide all motors required for equipment supplied under each portion of the work. Motors shall be built in accordance with the latest ANSI, IEE, and NEMA standards, shall be fully coordinated with the equipment served, shall be of sizes and electrical characteristics scheduled.

2.5 STARTING EQUIPMENT

A. Each motor shall be provided with proper starting equipment. This equipment, unless hereinafter specified or scheduled to the contrary, shall be provided by the trade furnishing the motor. All motor starting equipment provided by any one trade shall be of the same manufacture unless such starting equipment is an integral part of the equipment on which the motor is mounted.
2.6 FIRE AND SMOKE PARTITION, WALL, AND/OR FLOOR PENETRATIONS
   A. Pipe, ductwork, conduit, etc. shall pass through fire- or smoke-rated floors, partitions, walls, or other barriers within a UL-listed assembly which shall maintain the rating of the applicable wall, floor, partition, or barrier.
   B. The Contractor shall review the architectural and structural drawings and determine the location of the fire-rated building elements. Where these elements are penetrated, UL-listed fire-rated penetration assemblies approved by the local authority shall be provided in accordance with the manufacturer’s instructions to obtain the required rating.

2.7 FOUNDATIONS / HOUSEKEEPING PADS
   A. General: All special foundations and supports required for the proper installation of equipment and pipe shall be provided as hereinafter specified and under the section of the specifications covering the equipment, unless otherwise indicated on the drawings.
   B. All equipment shall receive concrete housekeeping pads unless otherwise noted. Equipment to receive pads are to include (but not limited to): boilers, water heaters, water softeners, expansion / compression tanks, filter feeders, water treatment equipment, air compressors, pumps (in addition to inertia bases where required), surge tanks, deareators, etc.
   C. Concrete foundations for the support of equipment such as floor-mounted pumps, equipment, etc. shall be not less than 3 inches high and not less than 4 inches larger (in both directions) than supported unit, unless otherwise noted and shall be poured in forms built of new dressed lumber. All corners of the foundations shall be neatly chaffered by means of sheet metal or triangular wood strips nailed to the form. Pads shall not be laid out directly against walls or structures. 2 inches shall be left available for pad form work. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Allow 1 inch below the equipment bases for alignment and grouting (where applicable). Foundations for equipment located on the exterior of the building shall be provided as indicated. Foundations shall be constructed in accordance with approved shop drawings and shall be reinforced with #4 bars at 12 inches on center both ways (minimum).
   D. Pipe and Conduit Support: All pipes and conduits throughout the building, both horizontal and vertical, shall be adequately supported from the construction to line of grade, with proper provision for expansion, contraction, vibration elimination, and anchorage. Vertical pipes and conduits shall be supported from floor lines with riser clamps sized to fit the lines and to adequately support their weight. At the bases of lines, where required for proper support, provide anchor base fittings or other approved supports.

PART 3 - EXECUTION

3.1 SPACE AND EQUIPMENT ARRANGEMENT
   A. The size of equipment indicated on the drawings is based on the dimensions of a particular manufacturer. While other manufacturers will be acceptable, it is the responsibility of the Contractor to determine whether the equipment he proposes to furnish will fit in the space. Shop drawings shall be prepared when required by the Owner’s Representative to indicate a suitable arrangement.
   B. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.
3.2 LARGE APPARATUS
A. 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 and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly, completely protected from damage as hereinafter specified.

3.3 PROTECTION
A. The Contractor shall take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of work. This shall include the erection of all required temporary shelters and supports to adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the uncompleted building with tarpaulins or other protective covering. Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.
B. The Contractor shall protect existing facilities, the work of others, and the premises from any and all damages that may be made possible by the execution of work.
C. Equipment and materials shall be protected from rust both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these specifications.

3.4 COOPERATION BETWEEN TRADES AND WITH OTHER CONTRACTORS
A. Each trade, subcontractor, and/or Contractor must work in harmony with the various trades, subcontractors, and/or Contractors on the job as may be required to facilitate the progress to the best advantage of the job as a whole. Each trade, subcontractor, and/or Contractor must pursue its work promptly and carefully so as not to delay the general progress of the job. This Contractor shall work in harmony with Contractors working under other contracts on the premises.
B. It shall be the responsibility of each trade to cooperate fully with the other trades on the job to help keep the jobsite in a clean and safe condition. At the end of each day’s work, each trade shall properly store all of its tools, equipment, and materials and shall clean its debris from the job. Upon the completion of the job, each trade shall immediately remove all of its tools, equipment, any surplus materials, and all debris caused by its portion of the work.

3.5 PRECEDENCE OF MATERIALS AND COORDINATION OF WORK
A. These specifications and the accompanying drawings are intended to cover systems which will not interfere with the structural design of the building, which will fit into the several available spaces, and which will ensure complete and satisfactory systems. Each subcontractor and/or trade shall be responsible for the proper fitting of his material and apparatus into the building.
B. The work of the various trades shall be performed in the most direct and workmanlike manner without hindering or handicapping the work of other trades. Piping interferences shall be handled by giving precedence to pipe lines which require a stated grade for proper operation. Where space requirements conflict, the following order or precedence shall, in general, be observed:
   1. Building lines.
   2. Structural members.
3. Light fixtures.
4. Soil and drain piping.
5. Condensate drains.
6. Vent piping.
7. Supply, return, and outside air ductwork.
8. Exhaust ductwork.
9. HVAC water and steam piping.
10. Steam condensate piping.
11. Fire protection piping.
12. Natural gas piping.
13. Domestic water (cold and hot).
15. Electrical conduit.

C. Coordinate all major elements, components, and systems of plumbing equipment and materials in relationship with other systems, installations, and building components. Coordinate space requirements for installation and access. Verify the following:
1. Clearance for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
2. Equipment and accessory service connections and support details.
3. Fire-rated wall and floor penetrations.
4. Scheduling, sequencing, movement and positioning of large equipment into building during construction.
5. Access panel and door locations.
6. Clearances between building openings and VTR’s/Flues.

D. The light fixture grid layout as indicated on the drawings must be maintained. This Contractor shall refer to all light fixture plans and details indicated on the drawings and shall coordinate the location of dampers, supply grilles, return air grilles, sprinkler heads, etc. with the location of the light fixtures to assure proper access to all items in a manner acceptable to the Owner’s Representative.

E. The electrical trades shall locate all junction boxes, pull boxes, conduits, etc. to avoid interference with the diffusers, dampers, grilles, etc. hereinbefore mentioned. The mechanical trades shall furnish to all other trades copies of approved ductwork shop drawings to assist in the coordination of the rough-in and installation of all items of work.

3.6 CONNECTIONS FOR OTHERS

A. This Contractor shall rough-in for and make all water, sewer, electrical, etc. connections to all fixtures, equipment, machinery, etc. provided by others in accordance with detailed roughing-in drawings provided by the equipment suppliers, by actual measurements of the equipment connections, or as detailed.

B. After the equipment is set in place, this Contractor shall make all final connections and shall provide all required pipe, fittings, valves, traps, connectors, etc.

C. Provide all air gap fittings required, using materials hereinbefore specified. In each water line serving an item of equipment or piece of machinery, provide a shutoff valve. On each drain without integral trap provide a suitable trap.

D. All pipe fittings, valves, traps, etc. exposed in finished areas and connected to chrome-plated lines provided by others shall be chrome-plated to match.
E. Provide all transition pieces, etc. required for a complete installation of equipment provided by others.

3.7 INSTALLATION METHODS

A. Where to Conceal: All pipes and conduits shall be concealed in pipe chases, walls, furred spaces, below suspended floors, or above the ceilings of the building unless otherwise indicated.

B. Where to Expose: In mechanical rooms, janitor’s closets tight against pan soffits in exposed Tee structures, or storage spaces, but only where necessary, piping and conduit may be run exposed. All exposed piping and conduit shall be run in the neatest, most inconspicuous manner, and parallel or perpendicular to the building lines.

C. Support: All piping and conduit shall be adequately and properly supported from the building structure by means of hanger rods or clamps to walls as herein specified.

D. Maintaining Clearance: Where limited space is available above the ceilings and below concrete beams or other deep projections, pipe and conduit shall be sleeved through the projection where it crosses, rather than hung below them, in a manner to provide maximum above-floor clearance. Sleeves shall be as herein specified. Approval shall be obtained from the Owner’s Representative for each penetration.

E. All pipe, conduits, etc. shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All ducts, pipes, and conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that they shall be sloped to obtain the proper pitch. Piping and ducts run in furred ceilings, etc. shall be similarly installed, except as otherwise shown. Conduits in furred ceilings and in other concealed spaces may be run at angles to the construction but shall be neatly grouped and racked indicating good workmanship. All conduit and pipe openings shall be kept closed until the systems are closed with final connections.

F. Special Requirements:
   1. There shall be no pipe joints nearer than 12 inches to a wall, ceiling, or floor penetration unless pipe joint is a welded or mechanically-coupled-type joint.
   2. The Contractor shall study all construction documents and carefully lay out all work in advance of fabrication and erection in order to meet the requirements of the extremely limited spaces. Where conflicts occur the Contractor shall meet with all involved trades and the Owner’s Representative and resolve the conflict prior to erection of any work in the area involved.
   3. Prior to the installation of any ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the Owner’s Representative so that arrangements can be made for an inspection of the above-ceiling area about to be “sealed off.” The Contractor shall give as much advance notice as possible up to ten (10) working days, but in no case less than five (5) working days.
   4. The purpose of this inspection is to verify the completeness and quality of the installation of the air conditioning systems, the plumbing systems, and any other special above-ceiling systems such as pneumatic tube. The ceiling supports (tee bar or lath) should be in place so that access panel and light fixture locations are identifiable and so that clearances and access provisions may be evaluated.
   5. No ceiling material shall be installed until the deficiencies listed from this inspection have been corrected to the satisfaction of the Owner’s Representative.

3.8 CUTTING AND PATCHING
A. General: Cut and patch walls, floors, etc. resulting from work in existing construction or where made necessary by failure to provide proper openings or recesses in new construction.

B. Methods of Cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Owner’s Representative. Impact-type equipment will not be used except where specifically acceptable to the Owner’s Representative. Openings in concrete for pipes, conduits, outlet boxes, etc. shall be core drilled to exact size. **Determine location of embedded conduit and reinforcing bars prior to cutting.**

C. Restoration: All openings shall be restored to “as-new” condition under the appropriate specification section for the materials involved, and shall match remaining surrounding materials and/or finishes.

D. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc. shall be of the proper size and shape, and shall be installed in a manner acceptable to the Owner’s Representative.

E. Plaster: All plumbing work in area containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.

F. Weakening: No cutting, boring, or excavating which will weaken the structure shall be undertaken.

3.9 ROOF PENETRATIONS AND FLASHING

A. Pipe and conduit ducts, pitch pockets, curb bases, and flashing compatible with the roofing installation shall be provided for roof penetrations. Provide framing or other support around all openings through roof as required to preserve the structural integrity of the roof system and make the penetration weathertight.

3.10 EXCAVATING AND BACKFILLING

A. Perform trenching, excavating, backfilling for plumbing work as set forth below.

B. Depth of excavation varies with invert of pipe. Excavation to be carried to a depth of at least 6 inches below bottom of pipe elevation. Fill below pipe (6 inches), around pipe, and a minimum of 12 inches above pipe with sand of Class “B” crushed stone tamped firm and even. Separate topsoil during excavation. Final layer of dirt for exterior installations to be (6 inches minimum) to be topsoil. Backfilling shall be done to exclude use of rock or stone above sand or Class “B” crushed stone.

3.11 TESTS AND INSPECTIONS

A. General: The Contractor shall make all tests deemed necessary by the inspection departments of the engineer and the authority having jurisdiction, Board of Underwriters, etc. He shall provide all equipment, materials, and labor for making such tests. Fuel and electrical energy for system operational tests following beneficial occupancy by the Owner will be paid for by the Owner.

B. Other: Additional tests specified hereinafter under the various specifications sections shall be made.
C. Notification: The Owner’s Representative shall be notified at his office 36 hours prior to each test and other specifications requirements requiring action on the part of the Owner, Architect, Engineer, and/or Owner’s Representative.

D. Test Logs: All tests which the Contractor conducts shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel, description and extent of system tested, test conditions, test results, specified results, and any other pertinent data. Data shall be delivered to the Owner’s Representative as specified under “Requirements for Final Acceptance.”

E. Inspections: In general, an inspection by the Owner’s Representative shall be required prior to closing up any work and prior to beneficial occupancy or final project completion. The closing up of work includes, but is not limited to, pipe and conduit installations prior to backfilling; mechanical, plumbing electrical, and fire protection work prior to placement of concrete; or closing up walls and overhead mechanical, plumbing, electrical and fire protection work prior to installation of the ceiling.

3.12 CLEANING AND PAINTING

A. Thoroughly clean and touch up the finish on all parts of the materials and equipment. Exposed parts in equipment rooms, and all other spaces except sealed chases and attics shall be thoroughly cleaned of cement, plaster, and other materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out.

B. All other painting shall be accomplished under the Painting Section of Division 9 of the specifications.

3.13 DISCHARGE OF WASTES FROM CONSTRUCTION SITE

A. The Contractor shall comply with all applicable provisions of local, state, and federal laws regarding the discharge of wastes into sewer and waterways. Special caution shall be exercised to prevent the discharge of wastes which contain oil, tar, asphalt, roofing compound, kerosene, gasoline, paint, mud, cement, lime, or other materials which would degrade the water quality of the receiving water course. The Contractor shall construct and maintain oil interceptors, settling basins, acid neutralization tanks, and/or other effective pollution countermeasures, as required by the Texas Water Quality Board.

B. On LEED and CHPS projects, contractor is responsible for tracking waste leaving the jobsite. All waste on these projects to be sorted and processed during construction.

END OF SECTION
SECTION 22 0523

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. Bronze ball valves.
   2. Ductile iron Butterfly valves.
   4. Iron swing check valves.
   5. Bronze globe valves.
   6. Ductile iron globe valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. OS&Y: Outside screw and yoke.
F. RS: Rising stem.
G. SWP: Steam working pressure.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated and required accessories (chains, extensions, etc.).

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 globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

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

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to 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. Gear Actuator: For quarter-turn valves NPS 8 and larger.
   2. Handwheel: For valves other than quarter-turn types.
   3. Handlever: For quarter-turn valves NPS 6 and smaller.
   4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valve Action: Close rotation shall be clockwise.

F. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
   1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation. Extension to be provided by valve manufacturer to match specific product.

G. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves (with 316 stainless steel bolts).
   2. Threaded: With threads according to ASME B1.20.1.
2.2 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:
      b. Milwaukee Valve Company.
      c. Mueller Steam Specialty; a division of SPX Corporation.
      d. NIBCO INC.
      e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

   2. Description:
      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, blowout-proof.
      i. Ball: Stainless steel, vented.
      j. Port: Full.

2.3 BUTTERFLY VALVES

A. 200 CWP, Ductile Iron, Lug Style-Flanged Butterfly Valves, potable rated:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Milwaukee Valve Company.
      c. Mueller Steam Specialty; a division of SPX Corporation.
      d. NIBCO INC.
      e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

   2. Description:
      a. Standard: MSS SP-67, Type I.
      b. CWP Rating: 200 psig.
      c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      e. Seat: EPDM.
      f. Stem: One- or two-piece stainless steel.
      g. Disc: Aluminum Bronze
      h. Flange bolts to be 316 stainless steel.

2.4 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Milwaukee Valve Company.
      c. Mueller Steam Specialty; a division of SPX Corporation.
      d. NIBCO INC.
      e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

   2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
e. Ends: Threaded.
f. Disc: Bronze.

2.5 IRON SWING CHECK VALVES

A. Class 250, Iron Swing Check Valves with Metal Seats, potable rated:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Milwaukee Valve Company.
      c. Mueller Steam Specialty; a division of SPX Corporation.
      d. NIBCO INC.
      e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-71, Type I.
      b. CWP Rating: 500 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. Flange bolts to be 316 stainless steel.

2.6 BRONZE GLOBE VALVES

A. Class 150, Bronze Globe Valves with Nonmetallic Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Milwaukee Valve Company.
      c. Mueller Steam Specialty; a division of SPX Corporation.
      d. NIBCO INC.
      e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-80, Type 2.
      b. CWP Rating: 300 psig.
      d. Ends: Threaded.
      e. Stem: Bronze.
      f. Disc: PTFE or TFE.
      g. Packing: Asbestos free.
      h. Handwheel: Malleable iron, bronze, or aluminum.

2.7 DUCTILE IRON GLOBE VALVES

A. Class 150, Ductile Iron Globe Valves, potable rated:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Milwaukee Valve Company.
c. Mueller Steam Specialty; a division of SPX Corporation.
d. NIBCO INC.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-85, Type I.
b. CWP Rating: 200 psig.
d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: PTFE.
g. Flange bolts to be 316 stainless steel.

2.8 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Babbitt Steam Specialty Co.
   2. Roto Hammer Industries.
   3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
   1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
   2. Attachment: For connection to butterfly valve stems.
   3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.

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. Install valves with brass short nipples and brass unions at downstream side (outlet) of ball and globe valves (NPS 2 and smaller).

C. Locate valves for easy access and provide separate support where necessary.
D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem and handle movement. Valve handle to have ample clearance to be fully exercised without interference (full open and full closed) with no modifications to handle.

F. Install chainwheels on operators for butterfly valves NPS 4 and larger and more than 120 inches above finished floor. Extend chains to 96 inches above finished floor.

G. All valves NPS 3 and smaller shall be installed within 120 inches above finished floor.

H. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.

I. For all valves on insulated piping, provide insulated stem extension.

J. Install shutoff valves immediately upstream of each dielectric fitting.

K. Provide and 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.

L. Provide and install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
   1. Drain Valves (At low points in water mains, risers, and branches): Ball valves

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.

B. Perform the following adjustments before operation:
   1. Open shutoff valves to fully open position.
   2. Remove and clean strainer screens. Close drain valves and replace drain plugs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. Valve applications, use the following:
   1. Shutoff Service: Ball, butterfly valves.
   2. Butterfly Valve Dead-End Service: Flange (lug) type.
   4. Pump-Discharge Check Valves:
      a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.

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.
   2. For Copper Tubing, NPS 2-1/2 and larger: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
   4. For Steel Piping, NPS 2-1/2 and larger: Flanged ends.
3.5 VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Ball Valves: Two piece, full port, bronze with stainless-steel trim; with brass short nipple and brass union connection at downstream side (outlet).
   2. Bronze Swing Check Valves.

B. Pipe NPS 2-1/2 and Larger:
   2. Iron Swing Check Valves.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following hangers and supports for plumbing system piping and equipment.
   1. Steel pipe hangers, supports and riser clamps.
   2. Thermal-hanger shield inserts and saddles.
   3. Fastener systems.
   4. Pipe positioning systems.
   5. Equipment supports.

B. Related Sections include the following:
   1. All plumbing specification sections.

1.3 DEFINITIONS

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

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

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Weight loading for supports and hangers shall not exceed manufacturers recommended tolerances and limits.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts and saddles.
   3. Powder-actuated fastener systems.
   4. Pipe positioning systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, “Structural Welding Code-steel.”

B. Welding: Qualify procedures and personnel according to the following:
1. AWS D1.1. “Structural Welding Code-Steel”.

PART 2 – PRODUCTS

2.1 MATERIALS AND WORKMANSHIP

A. All materials, unless otherwise specified, shall be 51% manufactured in the United States, new, free from all defects, and of the best quality. Foreign goods specifically approved for use by the Owner's Representative prior to bidding may be furnished.

B. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall present a neat, precise appearance.

2.2 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.3 METAL COATING REQUIREMENTS:

A. All metal products shall have the following coatings:
1. Wet/damp areas: hot dipped galvanized.
2. Dry or conditioned areas: pre-galvanized.

2.4 STEEL PIPE HANGERS, SUPPORTS AND RISER CLAMPS

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

B. Manufacturers:
2. ERICO/Michigan Hanger Co.
3. Grinnell Corp.

C. Galvanized, Metallic Coatings: Pre-galvanized (minimum thickness of 0.5 mils) or hot dipped (1.4 to 3.9 thickness).
D. Nonmetallic Coatings: Plastic coating, jacket or liner.

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

F. Channel, rod and securement hardware:
   1. Channel: 12-ga.
   2. Rod: Sized as scheduled.
   3. Hardware (clamps, bolts, washers, etc): coating per area indication.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig minimum, compressive-strength insulation insert with a sheet metal shield.

B. Manufactures:
   1. B-line
   2. ERICO / Michigan Hanger CO
   3. Grinnell Corp
   4. Buckaroos

C. Insulation –Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with vapor barrier. Wood inserts are not acceptable.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type 1 calcium silicate or ASTM C 552, Type II cellular glass.

E. Insulation-Insert Material for Cold and Hot Piping, up to 3” diameter: Molded fiberglass block, 20 lbs/ft³ density, thermal conductivity of 0.30.

2.6 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened Portland cement concrete with pull-out, tension and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      b. Hilti, Inc.
      c. Powers Fasteners.

B. Concrete Insert: electroplated steel finish, for embedding in concrete. Steel insert nut for rod attachment.
   1. Manufacturers:
      b. Hilti, Inc.
      c. Powers Fasteners.

2.7 PIPE POSITIONING SYSTEMS

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

B. Manufacturers:
   2. HOLDRITE Corp.; Hubbard Enterprises.
2.8 EQUIPMENT SUPPORTS

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

2.9 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes and bars. Galvanized only. Painted steel not acceptable.

PART 3 - EXECUTION

3.1 HANGERS AND SUPPORTS APPLICATIONS AND INSTALLATION

A. Specific hanger and support requirements are specified in Hanger Application Schedule below.

B. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps and attachments as required to properly support piping form building structure; attaching to metal roof decks is not permissible.

C. Use hangers and supports with galvanized, metallic coatings for piping. Field applied finish is not acceptable.

D. Use nonmetallic plastic coating, jacket or liner coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

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

F. Rod to be installed plumb. Bending rod is not acceptable. Provide and install required attachments.

G. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Heavy Duty Steel Clevis Hangers: For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
   2. Strut System Clamps: For attachment of piping to channel. NPS ½ to NPS 2.
      a. Noninsulated copper piping to have dielectric insert. (dielectric tape not acceptable).
   3. 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.
      a. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
      b. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
   4. Install hangers for piping with the following maximum horizontal spacing and minimum rod diameters (hangers shall be spaced to prevent sagging):
      a. NPS 2 and Smaller: 60 inches with 3/8-inch rod.
      b. NPS 2-1/2 to 5: 60 inches with 1/2-inch rod.
      c. NPS 6 to 8: 60 inches with 3/4-inch rod.
H. Vertical-Piping Riser Clamps: Unless otherwise indicated and except as specified in piping system Section, install the following types:
1. Required at all risers from under-floor or through floors from floor below. Risers clamps to be installed every 10 ft max. Coordinate installation with sleeves.

I. Building and Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Wide Jaw C-Clamps: For structural shapes, with retaining clip.
2. NPS 2 and smaller: mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer’s written instructions.
3. NPS 2 ½ and larger: Concrete spot insert. Install building attachments within concrete slabs. Install additional attachments at concentrate 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.

J. Insulation Piping Installation:
1. Provide manufacture galvanized metal shield with locking tabs or securement band.
2. For Trapeze or Clamped Systems: Thermal insert and shield shall cover entire circumference of pipe.
3. For Clevis or Band Hangers: Thermal insert and shield shall cover lower 180 degrees of pipe.
4. Thermal Insert Length: Extend 4 inches beyond sheet metal shield for piping operating below ambient air temperature.

K. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures; minimum three (3) for vertical pipe sections.

L. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer Specification Section “Plumbing Fixtures” for plumbing fixtures.

M. Install hangers and supports complete with necessary inserts, bolts, rods, nuts washers and other accessories.

N. Load Distribution: Install hangers and supports so piping live and dead loads and stressed from movement will not be transmitted to connected equipment.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

3.2 EQUIPMENT SUPPORTS
A. Manufacturer’s structural-steel system to suspend equipment from structure overhead or to support equipment above floor.

3.3 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 inch.

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

END OF SECTION
SECTION 22 0553

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. Valve tags.
   5. Warning tags.

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.

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. 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.
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.

B. 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.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2 by 11 inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), 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.


C. Background Color: Red.

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 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 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 label to indicate flow direction.
   2. Lettering Size:  At least 1-1/2 inches high.

2.4 VALVE TAGS
A. Valve Tags:  Stamped or engrave with ¼ inch letters piping system abbreviation and ½ inch numbers.
B. Valve Schedules:  For each piping system, on 8-1/2 by 11-inch (A4) bond paper.  Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of a 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 date.

2.5 WARNING TAGS
A. Warning Tags:  Preprinted or partially preprinted, accident-prevention tags, or plasticized card stock with matte finish suitable for writing.
   1. Size:  Approximately 4 by 7 inches.
   2. Fasteners:  Brass grommet and wire.
   3. Nomenclature:  Large-size primary caption such as “DANGER”, “CAUTION”, OR “DO NOT OPERATE”.

PART 3 - EXECUTION

3.1 PREPARATION
A. Clean piping and equipment surfaces or substances that could impair band 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 Specification Section “Interior Painting”.
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.

C. Pipe Label Color Schedule:
   1. Domestic Water Piping:
      a. Background Color: Blue.
   2. Domestic Hot Water Piping:
      a. Background Color: Red.
   3. Sanitary Waste and Vent and Storm Drainage Piping:
      a. Background Color: Green.
      b. Letter Color: White

3.4 VALVE-TAG INSTALLATION
A. Install tags on valves and controls 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:
   2. Valve-Tag Color:
      b. Hot Water: Orange.
   3. Letter Color:
      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 22 0716
PLUMBING INSULATION

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 plumbing insulation for equipment and pipe, including the following:
   1. Insulation Materials:
      a. Cellular glass.
      b. Flexible Elastomeric.
      c. Mineral fiber.
      d. Phenolic
   2. Adhesives.
   3. Mastics.
   4. Sealants.
   5. Factory-applied jackets.
   6. Field-applied tape.
   7. Field-applied jackets.
   8. Securements.

B. Related Sections include the following:
   1. Specification Section “Hangers and Supports” for high-density inserts at hangers; wood inserts at hangers are not acceptable.
   2. Specification Section “Special Conditions for All Plumbing Work”.
   3. Specification Section “Basic Plumbing Materials and Methods”.

C. Not all items listed within this specification are used. Use only items applicable per application schedule.

1.3 DEFINITIONS

A. ASJ: All-service jacket.

B. CONCEALED: Covered or concealed by a ceiling (gypsum or lay-in acoustical tile) or wall.

C. EXPOSED: Open to view; not concealed by a ceiling or wall of any sort.

D. FSK: Foil, scrim, kraft paper.

E. UNDERFLOOR: Accessible crawl space beneath lowest floor level (considered “outdoors”).

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any). Provide submittal data on all products to be used.
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. 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, 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.

1.6 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.

B. All products to be stored in a dry location, protected from the elements. All damaged insulation to be replaced.

1.7 COORDINATION

A. Coordinate size and location of supports, hangers, and high-density insulation inserts and shields specified in Specification Section “Hangers and Supports.” Coordinate with drawing details where applicable; wood inserts at hangers are not acceptable.

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

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

C. Insulation not to be installed until building is dried in.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2.2 INSULATION MATERIALS

A. Refer to Part 3 schedule articles for requirements about 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. Phenolic:
   1. Products
      a. Insul-phen
   2. 100% CFC-free, HCFC-free, and halogen-free, closed cell rigid phenolic foam insulation.
   3. Minimal thermal conductivity @ 75˚ F.
      a. Green, 2.5 lb/ft³. 0.15 (Btu.in/hr.ft².F)
      b. Pink, 5.0 lb/ft³. 0.21 (Btu.in/hr.ft². F)

G. Cellular Glass:
   1. Products:
      a. Pittsburgh Corning Corporation; Foamglas Super K.
   2. Block Insulation: ASTM C 552, Type I.
   3. Special-Shaped Insulation: ASTM C 552, Type III.
   4. Board Insulation: ASTM C 552, Type IV.
   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.
   7. Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Minimal thermal conductivity at 75˚ F of 0.29 (Btu.in/hr.ft². F) (R-value of 10.34@ 3 inches thickness). Factory-applied jacket requirements are specified in Part 2 “Factory- Applied Jackets” Article.

H. Flexible Elastomeric:
   1. Products:
      a. Aeroflex USA Inc.; Aerocel.
      b. Armacel LLC; AP Armaflex.
   2. Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   3. Minimal thermal conductivity at 75˚ F of 0.25 (Btu.in/hr.ft². F.)

I. Mineral-Fiber Blanket Insulation:
   1. Products:
      a. Johns Manville; Microlite.
      b. Knauf Insulation; Duct Wrap
      c. Owens-Corning; All-Service Duct Wrap.
J. Mineral-Fiber, Preformed Pipe Insulation:
1. Products:
   a. Johns Manville; Micro-Lok.
   b. Knauf Insulation; 1000° 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 Part 2 "Factory-Applied Jackets" Article.

K. Fire Rated Wrap
1. Manufacturers:
   a. 3M
   b. Specialty Products and Insulation Co.
2. Insulation Materials: Fire rated fiber wrap insulation: 1-1/2 inch thick low bio-persistent Alka-line Earth Silicate fiber with melting point at 2200 degrees F. jacket shall be foil faced (one side) Kraft fiber paper with a concealed reinforcing scrim. (FSK) One hour rating with 1-layer of wrap, 3 inches to combustibles. Two hour rating with 2 layers of wrap, 0 inch to combustibles.
3. Accessories and Attachments:
   a. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq.yd.
      1) Tape Width: 4 inches.
   b. Bands: 3/4 inch wide, in one of the following materials compatible with jacket.
      1) Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
   c. Insulation Anchor Pins and Speed Washers: Galvanized steel plate, pin and washer manufactured for attachment to duct by weld. Pin length sufficient for insulation thickness indicated.
   d. Vapor Retarders: Mastics: Materials recommended by insulation material manufacturers that are compatible with insulation materials, jackets, and substrates.
4. Secured per manufacturer’s requirements and AHJ.

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. All products are to contain low V.O.C. as defined/governed by LEED IEQ 4.1 and 4.2 (Regardless of project type).
B. Cellular-Glass, Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
   1. Products:
      a. Foamglas: Pittseal 444N or equal
C. Flexible Elastomeric: Comply with MIL-A-24179A, Type II, Class I.
   1. Products:
      a. K-Flex: 720 LVOC or equal
D. Phenolic: Water based adhesive with a service temp of minus 20°F to 700°F.
   1. Products:
      a. Foster 97-15
E. Metal Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products:
a. Design Polymerics, DP2502 (or approved equal).

### 2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II. All products are to contain low V.O.C. as defined/governed by LEED IEQ 4.1 and 4.2 (Regardless of project type).

B. Vapor-Barrier Mastic: Water based; suitable for outdoor use on below ambient services, or indoor vapor barrier use.
   1. Products:
      a. Childers Products, Division of ITW; CP-35.
      2. Water-Vapor Permeance: ASTM F 1249, 0.09 perm at 55-mils film thickness.
      3. Service Temperature Range: Minus 20 to plus 190 deg F.
      4. Solids Content: ASTM D 1644, 60 percent by volume and 73 percent by weight.
      6. VOC: 36 g/l.

### 2.5 SEALANTS

A. Joint Sealants:
   1. Joint Sealants for Cellular-Glass Products:
      a. Pittsburgh Corning Corporation; Pittseal 444N.
   2. Joint Sealant for Phenolic Products
      a. Foster 95-50

B. Metal Jacket:
   1. Products:
      a. Foster 95-44 or equal.
      b. Childers Products, Division of ITW; CP-76.

C. Mineral Fiber:
   1. Design Polymerics DP 2502.
   2. Childers Products, Division of ITW; CP-35.

D. PVC Jacket:
   1. Childers Products, Division of ITW; CP-35.

### 2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   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.

### 2.7 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, 25/50 ASTM-F 84, 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:
      a. Johns Manville; Zeston.
      b. Proto PVC Corporation; LoSmoke.
   2. Adhesive: As recommended by jacket material manufacturer.
   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.
   5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:
   1. Products:
      a. Childers Products, Division of ITW; Metal Jacketing Systems.
      b. PABCO Metals Corporation; Surefit.
      c. RPR Products, Inc.; Insul-Mate.
      a. Factory cut and rolled to size.
      b. Finish and thickness are indicated in field-applied jacket schedules.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136 and UL listed.
   1. Width: 3 inches.
   2. Thickness: 14.0 mils.
   4. Elongation: 2 percent.
   5. Tensile Strength: 55 lbf/inch in width.
   6. Color: White

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136 and UL listed.
   1. Width: 3 inches.
   2. Thickness: 13 mils.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. Color: Silver

2.9 SECUREMENTS

A. Bands:
   1. Products:
      a. Childers Products; Bands.
      b. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 316; 0.015 inch thick, 3/4 inch wide with wing or closed seal.
      c. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch with wing or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel.

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. For Stainless Steel; apply a corrosion coating to insulated surfaces with an epoxy primer and an epoxy finish 5 mils thick.

B. Verify and coordinate insulation installation with the systems and trades installing heat tracing. Comply with requirements for heat tracing that applies to insulation.

3.3 COMMON INSTALLATION REQUIREMENTS

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. 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

C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, and pipe system as specified in insulation system schedules.

D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

E. Install high-density inserts at hanger locations prior to insulating; wood or block inserts are not acceptable

F. Do not weld brackets, clips, pins or other attachment devices to piping, fittings, tanks, coils, equipment, vessel, and specialties.

G. Keep insulation materials clean and dry before, during application, and finishing.

H. Install insulation with tight longitudinal seams and end joints, with least number of joints practical.

I. Install insulation so that material is not over compressed.
J. Seal all joints, and seams, including penetrations in insulation, at supports, and other projections with insulation of same material overlapped by 2”. Secure strips with outward clinching staples along both edges of strip, (spaced 1 inch on center) and seal entire joint or seam with mastic.

K. Do not insulate, conceal, or enclose pipe hangers, channel and steel supports, etc. not directly fasten to duct.

L. 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.

M. Apply adhesives, mastics, and sealants at manufacturer’s recommended coverage rate and wet and dry film thicknesses. Do not water down products unless directed by manufacture. Use clean potable demineralized water when required.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair all damage insulation prior to concealment as noted above.

P. Do not insulation or conceal vibration-control devices, labels, stamps, nameplates, data plates, manholes, cleanouts, etc. require for maintenances.

Q. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarded integrity, unless otherwise indicated.

R. Insulate pipe elbows, tees, valves, strainers, flanges, etc., using preformed fitting insulation, mitered fittings or oversized preformed pipe insulation made from same material thickness and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. 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, voids, and irregular surfaces with insulating mastic finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation. Provide a removable reusable insulation cover; design that maintains vapor barrier. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts.

S. Cover segmented insulated surfaces with a layer of finishing mastic prior to jacket installation.

T. 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. Secure PVC covers to adjoining insulation facing using staples and ASJ tape. Seal PVC fitting covers with mastic.

U. 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 adhesive and finish with finishing mastic. All connections are to be accessible.

V. Install removable insulation segment and covers at flanges, valves, controls, unions, equipment access doors, manholes, hand holes, and other elements that require frequent removal for service and inspection. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.4 PENETRATIONS
A. Install insulation continuously through all walls, floors, and partitions penetrations and sleeves.

B. Extend jacket of outdoor installation into wall and roof jacks by 2 inches. Seal jacket to roof flashing with approved flashing sealant.

C. Insulation Installation at Below-Grade Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with approved flashing sealant.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Preformed Pipe Insulation Installation on Pipe, Fittings, Valves, Flanges, Tanks, Elbows, and Appurtenances for Cellular-Glass, Mineral-Fiber, Flexible Elastomeric, and Phenolic insulations:
   1. Install insulation in a manner that secures material to system being insulated with staples, tape and mastic.
   2. When insulation with preformed pipe insulation, seal all longitudinal seams, end joints, and protrusions with manufacturers recommended tape matching jacket, vapor-barrier mastic, joint sealant, and adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
   3. Secure fittings, jacket, cover, etc. with tape matching jacket and secure with outward clinched staples 1 inch on center. Apply vapor-barrier mastic over staples.
   4. Arrange insulation to permit access to valves packing, flanges, unions, etc. and valve operation for maintenance without disturbing insulation. Install insulation so that it can be removed without damage to surrounding insulation or access enclosure.
   5. Pipe hangers are not to be concealed in insulation.
   6. Seal all exposed insulation ends with mastic.
   7. Seal all mitered joints prior to installing covers with vapor-barrier mastic.
   8. Install preformed pipe insulation to outer diameter of pipe flange.
   9. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   10. Fill voids between inner circumference of valves, flange, elbows, and bolts insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   11. Install preformed sections of same material insulation when available. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Install PVC cover over fitting or mitered section.
   12. Arrange insulation to permit access to valves packing, flanges, unions, etc. and valve operation for maintenance without disturbing insulation. Install insulation so that it can be removed without damage to surrounding insulation or access enclosure.

3.6 GENERAL BLANKET INSULATION INSTALLATION (IN ADDITION TO COMMON REQUIREMENTS)

A. Blanket Insulation Installation on Pipes, Drains, Tanks, Vessels, Elbows, and Appurtenances:
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for a minimum of 50 percent coverage of insulated surface and 100 percent coverage of equipment, tanks, etc.; to secure insulation to surfaces. Apply adhesive to entire circumference of all surfaces; including fittings and transitions.
   2. 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 3/4-inch outward-clinching staples, 1 inch on center. Coat all seams/joints with mastic.
3. Repair punctures, tears, penetrations and protrusions with 6-inch-wide strips of same material used to insulate duct. Seal all seams with staples, cover with mastic and cover with embedded fiberglass reinforced mesh, cover mesh with finish coat of mastic.
4. Do not conceal hangers beneath/under insulation.
5. Insulation termination: Butt insulation up to termination point. Apply mastic no less than 3" overlap on insulation, and 3" on metal surface.

3.7 FIELD-APPLIED JACKET INSTALLATION
A. Install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Apply two continuous beads of sealant to seams and joints, one bead under lap and the finish bead along seam and joint edge. Secure metal jacket with stainless-steel bands 12 inches on center and at end joints.

3.8 FINISHES
A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in painting Sections (if applicable).
   1. Flat Acrylic Finish: Two (2) finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
C. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL
A. Perform the following field tests and inspections and prepare test reports:
   1. Inspect insulated pipe, and equipment, randomly selected by Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to two (3) location(s) for each system.
   2. All insulation applications will be considered defective work if sample inspection reveals noncompliance with requirements.
   3. Remove all defective work and install new insulation and jackets to replace insulation and jackets removed for inspection. Repeat inspection procedures as needed.

3.10 PIPING INSULATION SCHEDULE, GENERAL
A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Fire-suppression piping.
   2. Drainage piping located in crawl spaces.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
3.11 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Hot and Recirculated Hot Water:
   1. Concealed Locations:
      a. All Pipe Sizes: Insulation shall be any of the following:
         1) Mineral Fiber Preformed: Type 1: 1-inch thick.
         2) Phenolic (2.5 lb/ft³), 1-inch thick.
         3) Cellular Glass: 1-1/2 inches thick.
   2. Exposed Locations: (including inside mechanical rooms):
      a. All Pipe Sizes: Insulation shall be any of the following:
         1) Phenolic (3.5 lb/ft³), 1-inch thick.
         2) Cellular Glass: 1-1/2 inches thick.

B. Condensate, Equipment Drain, Floor Drains, Traps and Waste Water below 60 Deg F:
   1. All PVC Piping exposed to and in a Return Air Plenum: Insulation shall be any of the following:
      a. Fire rated wrap.
   2. All Other Pipe: Insulation shall be any of the following:
      b. Phenolic (2.5 lb/ft³): 1-1/2 inches thick.

C. Horizontal Storm Water Piping (continuous from roof drain body to first vertical drop):
   1. All PVC Piping exposed to and in a Return Air Plenum: Insulation shall be any of the following:
      a. Fire rated wrap.
   2. All Other Pipe: Insulation shall be any of the following:
      b. Phenolic (2.5 lb/ft³): 1-1/2 inches thick.
      c. Mineral Fiber, Preformed, Type 1: 1-inch thick.

D. Roof Drain Body:
   1. PVC Roof Drain Body exposed to and in a Return Air Plenum: Insulation shall be any of the following:
      a. Fire rated wrap.
   2. All Other Roof Drain Bodies: Insulation shall be any of the following:

E. Sanitary Waste & Vent; Domestic Waterpiping:
   1. All PVC Piping exposed to and in a Return Air Plenum: Insulation shall be any of the following:
      a. Fire rated wrap.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE (ATTIC AND CRAWL SPACE INCLUDED)

A. Domestic Cold, Hot and Recirculated Hot Water:
   1. All Pipe Sizes: Insulation shall be any of the following:
      a. Preinsulated Pipe: 1-1/2" thick (underfloor, outdoors and buried)
      b. Cellular Glass: 2 inches thick (outdoors, not acceptable indoors)
      c. Phenolic (5 lb/ft³): 2 inches thick (outdoors, not acceptable indoors)
      d. Mineral Fiber Preformed, Type 1: 1-1/2 inch thick ( uninsulated Attic space)

B. Condensate, Equipment Drain, Floor Drains, Traps and Waste Water below 60 Deg. F:
   1. All Pipe Sizes: Insulation shall be any of the following:
a. Cellular Glass: 1-1/2 inches thick
b. Phenolic (5 lb/ft³): 1-1/2 inches thick

C. Fire Protection:
   1. All Pipe Sizes: Insulation shall be any of the following:
      a. Cellular Glass: 1-1/2 inches thick
      b. Phenolic (5 lb/ft³): 1-1/2 inches thick

3.13 INSIDE EXTERIOR WALL PIPING INSULATION SCHEDULE

A. Domestic Cold, Hot and Recirculated Hot Water:
   1. All Pipe Sizes: Insulation shall be any of the following:
      a. Cellular Glass: 1-1/2 inches thick
      b. Phenolic (2.5 lb/ft³): 1 inch thick
c. Mineral Fiber Preformed, Type 1: 1 inch thick, coat entire ASJ jacket with vapor mastic

B. Condensate, Equipment Drain, Floor Drains, Traps and Waste Water below 60 Deg. F:
   1. All Pipe Sizes: Insulation shall be any of the following:
      a. Cellular Glass: 1-1/2 inches thick
      b. Phenolic (2.5 lb/ft³): 1-1/2 inches thick

C. Fire Protection:
   1. All Pipe Sizes: Insulation shall be any of the following:
      a. Cellular Glass: 1-1/2 inches thick
      b. Phenolic (2.5 lb/ft³): 1-1/2 inches thick

3.14 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. Piping exposed in finish interior areas, outdoors, in underfloor, mechanical rooms:
   1. Aluminum, Stucco Embossed: 0.016 inch thick.

C. Indoor piping fitting or elbows:
   1. PVC: (0.015 inch thick).

END OF SECTION
SECTION 22 1116
DOMESTIC WATER PIPING

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and
         specialties inside the building.
      2. Encasement for piping.

1.3 SUBMITTALS
   A. Product Data: For the following products:
      1. Piping and fittings.
   B. Field quality-control reports.

1.4 QUALITY ASSURANCE
   A. Piping materials shall bear label, stamp, or other markings of specified testing agency. Origin
      of product to be domestic. No imported product will be acceptable.
   B. Comply with NSF 14 for plastic, potable domestic water piping and components. Include
      marking "NSF-pw" on piping.
   C. Comply with NSF 61 for potable domestic water piping and components.

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

PART 2 - PRODUCTS

2.1 PIPING MATERIALS
   A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting
      materials, and joining methods for specific services, service locations, and pipe sizes.
2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L or K water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type L or K water tube, annealed temper.

C. Copper Pipe, Pre-insulated:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Insul-Pipe Systems, Inc.
      b. Insul-tek
      c. Thermal Pipe Systems, Inc.
      d. Thermacor Process L.P.
   2. Description: Factory pre-insulated double-wall pipe system.
   3. Carrier Pipe: Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B).
   5. Pipe Insulation: Foamed-in-place polyurethane, 90% closed cell, poured in place, "K" = 0.14 per inch @ 75 degrees F, with a density of not less than 2.5 lbs. per cubic foot. Insulation shall be completely encased within a seamless jacket.
      a. Insulation at each end of each length of pipe shall be protected with an end seal bonded both to the carrier pipe and the outer jacket. Piping cuts made in the field must be provided with end-seals equal to factory type.
      b. Insulation thickness, minimum: 1.12-inches for NPS 2 and smaller; 1.67-inches for NPS 2-1/2; 1.42-inches for NPS 3; 1.93-inches for NPS 4; and 1.93-inches for NPS 6.
   6. Jacket: PVC; ASTM D-1784, Class 12454-B, of not less than .060 inches thick and able to withstand H-20 highway loading.
   7. Fitting insulation: Coupling joints on straight runs shall be field wrapped with a mold/jacket of roll PVC, sealed with self seal tape and filled with field mixed pour polyurethane foam. Fittings shall be field insulated using a field mixed polyurethane poured between the fitting and a PVC fitting cover supplied by the manufacturer that is sealed with self seal tape. Vapor barrier jacketing material for fittings and joints shall be of the same material as the pipe jacketing. Installation shall be as per manufacturer's instructions.

2.3 NIPPLES

A. Brass Nipple: ASTM B687-88
   1. Threads: NPT (Federal Services Handbook H-28)
   2. Potable use.

2.4 UNIONS

A. Factory-fabricated, brass or bronze union assembly, for 150-psig minimum working pressure at 180 deg F, ASTM B687-88
B. End Connections: Solder-joint copper alloy and / or threaded ferrous.
C. Potable use.
2.5 FLANGES
   A. Factory-fabricated, bronze union assembly, for 150-psig minimum working pressure at 180
deg F, ASME B16.24, Class 150.
   B. End Connections: Solder-joint copper alloy and / or threaded ferrous.
   C. Potable use.
   D. All bolts to be 316 stainless steel (Class 150).

2.6 PIPING JOINING MATERIALS
   A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or
   ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring
type unless otherwise indicated.
   B. Solder Filler Metals: ASTM B 32, 95/5 lead-free alloys. Include water-flushable and soluble
   flux according to ASTM B 813.
   C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-
duty brazing unless otherwise indicated.

2.7 ENCASEMENT FOR PIPING
   A. Standard: ASTM A 674 or AWWA C105.
   B. Form: Tube.
   C. Material: LLDPE film of 0.008-inch minimum thickness or high-density, cross-laminated PE
   film of 0.004-inch minimum thickness.
   D. Color: Black or blue.

2.8 TRANSITION FITTINGS
   A. General Requirements:
      1. Same size as pipes to be joined.
      2. Pressure rating at least equal to pipes to be joined.
      3. End connections compatible with pipes to be joined.
   B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system
   fitting.
   C. Sleeve-Type Transition Coupling: AWWA C219.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of
      the following:
         a. Cascade Waterworks Manufacturing.
         b. Dresser, Inc.; Dresser Piping Specialties.
         c. Ford Meter Box Company, Inc. (The).
         d. JCM Industries.
         e. Romac Industries, Inc.
         f. Smith-Blair, Inc; a Sensus company.
         g. Viking Johnson; c/o Mueller Co.
D. Plastic-to-Metal Transition Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of
      the following:
      b. Harvel Plastics, Inc.
      c. Spears Manufacturing Company.
   2. Description: CPVC one-piece fitting with manufacturer's Schedule 80 equivalent
      dimensions; one end with threaded brass insert and one solvent-cement-socket end.

E. Plastic-to-Metal Transition Unions:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of
      the following:
      a. Colonial Engineering, Inc.
      b. NIBCO INC.
      c. Spears Manufacturing Company.
   2. Description: CPVC four-part union. Include brass threaded end, solvent-cement-joint
      plastic end, rubber O-ring, and union nut.

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 underground copper tube in PE encasement according to ASTM A 674 or
   AWWA C105.

D. Provide and install shutoff valve, strainer, pressure reducing valve, hose-end drain valve,
   pressure gage, and test tee with valve, inside the building at each domestic water service
   entrance. Comply with requirements in Section "Meters and Gages" for pressure gages and
   Section "Domestic Water Piping Specialties" for drain valves and strainers.

E. Install domestic water piping level and plumb.

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

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

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

I. Install piping adjacent to equipment and specialties to allow service and maintenance.

J. Install piping to permit valve servicing.
K. 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.

L. Install piping free of sags and bends.

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

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

O. All pipe nipples to be brass.

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. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

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

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

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

G. All piping is to be cleaned prior to concealment.

3.3 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
   1. NPS 2 and Smaller: Fitting-type coupling.
   2. NPS 2-1/2 and Larger: mechanical joint-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition unions.

3.4 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 exterior water-service piping. Use transition fitting to join dissimilar piping materials.
D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to all equipment.

3.5 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 engineer and authorities having jurisdiction.
   2. During installation, notify engineer and authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of engineer and authority 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 engineer and authority having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   3. Reinspection: If the engineer or authority having jurisdiction finds that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   4. Reports: Prepare inspection reports and have them signed by engineer and authority 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.

3.6 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system according to either of the following:
1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

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.

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.

3.7 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 to be provided and installed at all equipment connections and appurtenances.

C. Under-building-slab, domestic water, building service and distribution piping, NPS 2 and smaller, shall be the following:
   1. Soft copper tube, ASTM B 88, Type K; (continuous, no joints under slab.)

D. Under-building-slab, domestic water, building-service piping, NPS 2-1/2 and larger, shall be the following (see detail for additional requirements):
   1. Hard copper tube, ASTM B 88, Type K; wrought- copper brazed-joint fittings and joints.
   2. Mechanical-joint, ductile iron pipe; standard-pattern mechanical-joint fittings; and mechanical joints.

E. Aboveground domestic water piping, all sizes, shall be the following:
   1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.

F. Underfloor domestic water piping shall be the following:
   1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.
   2. Pre-insulated copper pipe. (Hot and Recirculated water only)

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following domestic water piping specialties:
   1. Vacuum breakers.
   2. Backflow preventers.
   5. Temperature-actuated water mixing valves.
   7. Hose bibbs.
   8. Wall hydrants.
  10. Trap-seal primer valves.
  11. Flexible connectors.
  12. Drain Valves.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: Diagram power, signal, and control wiring.
C. Field quality-control test reports.
D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. NSF Compliance:
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ames Co.
      b. Conbraco Industries, Inc.
      c. FEBCO; SPX Valves & Controls.
      e. Woodford Manufacturing Company.
      f. Zurn Plumbing Products Group; Wilkins Div.
   3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
   5. Inlet and Outlet Connections: Threaded.
   6. Finish: Mechanical areas: Rough bronze. Finished areas: Chrome

B. Hose-Connection Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.
      b. MIFAB, Inc.
      d. Woodford Manufacturing Company.
      e. Zurn Plumbing Products Group.
   5. Finish: Rough bronze.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ames Co.
      b. Conbraco Industries, Inc.
      c. FEBCO; SPX Valves & Controls.
      e. Zurn Plumbing Products Group; Wilkins Div.
   3. Operation: Continuous-pressure applications.
   4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
   5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
   6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
   7. Accessories:
a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

b. Strainer: Y-pattern with threaded ends on inlet of NPS 2 and smaller.


B. Double-Check Backflow-Prevention Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   e. Zurn Plumbing Products Group; Wilkins Div.

3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Accessories:
   a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

C. Pressure Type Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   e. Zurn Plumbing Products Group; Wilkins Div.

3. Operation: Up to 10-foot head of water back pressure.
4. Inlet Size: NPS 1/2 or NPS 3/4.
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   e. Zurn Plumbing Products Group; Wilkins Div.

4. Size: Service line size.
5. Design Outlet Pressure Setting: 70 psig.
6. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.
2.4 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. ITT Industries; Bell & Gossett Div.
      c. NIBCO INC.
      d. Taco, Inc.
      e. Watts Industries, Inc.; Water Products Div.
   2. Type: Y-pattern globe valve with two readout ports and memory setting indicator.
   4. Size: Same as connected piping, but not larger than NPS 2.
   5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Memory-Stop Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.
      b. Milwaukee Valve Company.
      c. NIBCO INC.
   2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
   3. Pressure Rating: 400-psig minimum CWP.
   4. Size: NPS 2 or smaller.
   5. Body: Copper alloy.
   6. Port: Standard or full port.
   7. Ball: Chrome-plated brass.
   8. Seats and Seals: Replaceable.
   9. End Connections: Solder joint or threaded.

2.5 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      b. Lawler Manufacturing Company, Inc.
      c. Leonard Valve Company.
      d. Powers; a Watts Industries Co.
      e. Symmons Industries, Inc.
   4. Type: Thermostatically controlled water mixing valve.
   5. Material: Bronze body with corrosion-resistant interior components.
   7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
   8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.

B. Manifold, Thermostatic, Water-Mixing-Valve Assemblies:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
b. Leonard Valve Company.
c. Powers; a Watts Industries Co.
d. Symmons Industries, Inc.

2. Description: Factory-fabricated, thermostatically controlled, water-mixing-valve assembly in two or three-valve parallel arrangement.

3. Large-Flow Parallel: Thermostatic water mixing valve and downstream pressure regulator with pressure gages on inlet and outlet.


6. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.

7. Water Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.

8. Component Pressure Ratings: 125 psig minimum, unless otherwise indicated.

9. Cabinet (where indicated): Factory-fabricated, stainless steel, for recessed or surface mounting (per drawing indication) and with hinged, stainless-steel door.

10. Performance characteristics and other requirements: Refer to drawings.

C. Individual-Fixture, Water Tempering Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Lawler Manufacturing Company, Inc.
      c. Leonard Valve Company.
      d. Powers; a Watts Industries Co.
      e. Watts Industries, Inc.; Water Products Div.
      f. Zurn Plumbing Products Group; Wilkins Div.
   3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
   5. Temperature Control: Adjustable.
   6. Inlets and Outlet: Threaded.
   7. Finish: Rough or chrome-plated bronze.

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:
   1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
   2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
   3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
   4. Screen: Stainless steel with round perforations, unless otherwise indicated.
   5. Perforation Size:
      a. Strainers NPS 2 and Smaller: 0.033 inch.
      b. Strainers NPS 2-1/2 to NPS 4: 0.062 inch.

2.7 HOSE BIBBS

A. Hose Bibbs:
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
8. Finish for Equipment Rooms: Rough bronze, or chrome plated.
10. Finish for Finished Rooms: Chrome plated.
11. Operation for Equipment Rooms: Metal wheel handle or operating key.
12. Operation for Service Areas: Metal wheel handle.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome plated hose bibb.
16. Other requirements: Refer drawing schedules and provide equivalency to model and manufacturer listed.

2.8 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   d. Watts Drainage Products Inc.
   e. Woodford Manufacturing Company.
   f. Zurn Plumbing Products Group.

4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. Inlet: NPS 3/4 or NPS 1.
6. Other requirements: Refer drawing schedules and provide equivalency to model and manufacturer listed.

B. Nonfreeze, Hot- and Cold-Water Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   c. Watts Drainage Products Inc.
   d. Woodford Manufacturing Company.
   e. Zurn Plumbing Products Group; Specification Drainage Operation.

4. Casings and Operating Rods: Of length required to match wall thickness. Include wall clamps.
5. Inlets: NPS 3/4 or NPS 1.
7. Other requirements: Refer drawing schedules and provide equivalency to model and manufacturer listed.
2.9 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
   2. Pressure Rating: 600-psig minimum CWP.
   5. Ball: Stainless steel.
   8. Inlet: Threaded.

2.10 WATER HAMMER ARRESTERS (SHOCK ARRESTORS)

A. Water Hammer Arresters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. MIFAB, Inc.
      c. PPP Inc.
      e. Watts Drainage Products Inc.
      f. Zurn Plumbing Products Group; Specification Drainage Operation.
   3. Type: Copper tube with piston.
   4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.11 TRAP-SEAL PRIMER VALVES (TRAP PRIMERS)

A. Supply-Type, Trap-Seal Primer Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. MIFAB, Inc.
      b. PPP Inc.
   5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
   6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
   7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Flushometer, Trap-Seal Primer Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Sloan Valve Company.
      b. Zurn Plumbing Products Group; Commercial Brass Operation.
   2. Standard: Vacuum breaker trap primer fitting that diverts a small amount of water with each flush; NPS 3/8 minimum, trap makeup connection.
5. Accessories: Chrome-plated wall flange, fittings and elbow.

C. Drainage-Type, Lavatory, Trap-Seal Primer Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2.12 TRAP-SEAL PRIMER SYSTEMS
A. Trap-Seal Primer Systems:
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on drawings "Plumbing Fixture Schedule" or a comparable product by one of the following:
   a. PPP Inc.
2. Standard: ASSE 1044,
3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
4. Cabinet: Recessed or Surface-mounting (per drawing indication) steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
7. Number Outlets: Refer to drawings.

2.13 FLEXIBLE CONNECTORS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flex-Hose Co., Inc.
   2. Metraflex, Inc.

B. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   2. End Connections: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
   1. Locate backflow preventers in same room as connected equipment or system.
   2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Install backflow preventers at 42-in above finished floor in an accessible location, preferably on a wall with galvanized steel channel and pipe strap support.
4. Do not install bypass piping around backflow preventers.
5. Provide and install threaded brass plugs for all test ports.

B. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

C. Install water-pressure-reducing valves downstream from shutoff valves.

D. Install balancing valves in locations where they can easily be adjusted.

E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
1. Install water mixing valves at 42-in above finished floor in an accessible location, preferably on a wall with galvanized steel channel and pipe strap support.
2. Install thermometers and water regulators if specified.
3. Install cabinet-type units recessed in or surface mounted on wall as specified.

F. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve, solenoid valve, and pump.

G. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."

H. Install water hammer arresters in water piping according to PDI-WH 201 and applicable drawing details.

I. Install trap-seal primer valves without dedicated isolation valves; supply from nearest branch serving an occupant-use plumbing fixture. System style trap primer to have isolation valve.

J. Install supply- and drainage-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

K. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow. Install unit at a minimum of 36” AFF.

L. Provide and install a calibrated balancing valve in each hot-water circulation return loop. Verify that system flowrate is set and matches drawing requirements.

3.2 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible connectors in suction and discharge manifold connections to each domestic water booster pump.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:
1. Test and certify each backflow assembly according to authorities having jurisdiction and the device’s reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.
3.4 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

D. Open throttling valves to proper setting.

E. Verify (by instrument flow testing) that auto-flow balancing valves in hot-water-circulation return piping are flowing specified gpm.

F. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

G. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.

H. Check plumbing specialties and verify proper settings, adjustments, and operation.

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 the following for soil, waste, and vent piping inside the building:
   1. Pipe, tube, and fittings.
   2. Special pipe fittings.

1.3 DEFINITION

A. Condensate Piping: Drainage piping that indirectly conveys clear-water condensate from air conditioning and refrigeration equipment to the sanitary drainage system.

B. Indirect Drainage Piping: Piping that conveys wastewater from mechanical equipment, including cooling towers, evaporative coolers, evaporative condensers, chilled-water systems, etc., to the sanitary drainage system.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. LLDPE: Linear, low-density polyethylene plastic.

E. NBR: Acrylonitrile-butadiene rubber.

F. PE: Polyethylene plastic.

G. PVC: Polyvinyl chloride plastic.

H. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Field quality-control inspection and test reports.
1.6 QUALITY ASSURANCE

   A. Piping materials shall bear label, stamp, or other markings of specified testing agency. Origin of product to be domestic. No imported product will be acceptable.

   B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 PIPING MATERIALS

   A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PVC PIPE AND FITTINGS

   A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

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

2.4 PEX PIPING AND FITTINGS

   A. PEX Tubing: ASTM F876 & F877 Grade A.

      1. Redbrass Male Threaded Adapter

         a. Manufacturers:

            1) Uponor Aqua Pex

2.5 SPECIAL PIPE FITTINGS

   A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

      1. Manufacturers:

         b. Fernco, Inc.
         c. Logan Clay Products Company (The).
         d. Mission Rubber Co.
         e. NDS, Inc.
         f. Plastic Oddities, Inc.

      2. Sleeve Materials:

         b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
   1. Manufacturers:
      b. Mission Rubber Co.

C. Flexible Ball Joints: Ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include gasketed ball-joint section and ductile-iron gland, rubber gasket, and steel bolts.
   1. Manufacturers:
      a. EBAA Iron Sales, Inc.

D. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
   1. Manufacturers:
      a. EBAA Iron Sales, Inc.
      b. Romac Industries, Inc.
      c. Star Pipe Products; Star Fittings Div.

E. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
   1. Manufacturers:
      a. SIGMA Corp.

PART 3 - EXECUTION

3.1 EXCAVATION
   A. Refer to Specification Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS
   A. Flanges and unions shall be provided and installed at equipment connections and appurtenances.
   B. Indirect drainage piping for equipment connections shall be any of the following:
      1. Copper DWV tube, copper drainage fittings, and soldered joints
   C. Below-floor (crawl space), condensate drain and vent piping shall be any of the following:
      1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
      2. Solid-wall, Schedule 40, PVC pipe; PVC socket fittings; and solvent-cemented joints.
      3. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
D. Above-floor, condensate drain and vent piping shall be any of the following:
   1. Solid-wall, Schedule 40, PVC pipe; PVC socket fittings; and solvent-cemented joints.
   2. Copper DWV tube, copper drainage fittings, and soldered joints.
   3. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

E. Underground, condensate drain and vent piping shall be any of the following:
   1. Solid-wall, Schedule 40, PVC pipe; PVC socket fittings; and solvent-cemented joints.
   2. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

F. Below-floor (crawl space), soil, waste and vent piping shall be any of the following:
   1. Solid-wall, Schedule 40, PVC pipe; PVC socket fittings; and solvent-cemented joints.
   2. Copper DWV tube, copper drainage fittings, and soldered joints.
   3. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

G. Above-floor, soil, waste and vent piping shall be any of the following:
   1. Galvanized steel nipples.
   2. Solid-wall, Schedule 40, PVC pipe; PVC socket fittings; and solvent-cemented joints.
   3. Copper DWV tube, copper drainage fittings, and soldered joints.
   4. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

H. Underground, soil, waste, vent piping shall be any of the following:
   1. Solid-wall, Schedule 40, PVC pipe; PVC socket fittings; and solvent-cemented joints.
   2. Copper DWV tube, copper drainage fittings, and soldered joints.
   3. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

I. Above and below floor (crawl space), trap primer drainage piping shall be any of the following:
   1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.
   2. PEX Tubing: ASTM F877 and F876, NSF Standard 14 and 61; brass fittings; No joints in slab (other than fixture connections).
   3. All underslab piping to be wrapped in 6 mil poly-sleeve.

J. Under-building-slab, trap primer drainage piping shall be any of the following:
   1. Soft copper tube, ASTM B 88, Type L; cast- or wrought- copper brazed-joint fittings; and brazed joints.


3.3 PIPING INSTALLATION

A. Condensate shall be indirectly discharged into the sanitary drainage system through a 2-inch air gap (into a floor drain or hub drain) and shall not be directly connected (hard piped).

B. Indirect drainage piping shall be discharged into the sanitary drainage system through a 2-inch air gap (into a floor or hub drain) and shall not be directly connected (hard piped).

C. Provide clean outs as indicated on drawings and per local codes.
D. Lead fittings are not acceptable.

E. Sanitary sewer piping outside the building is specified in Specification Section "Sanitary Sewerage."

F. Basic piping installation requirements are specified in Plumbing Specification Section "Basic Plumbing Materials and Methods."

G. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Plumbing Specification Section "Basic Plumbing Materials and Methods."

H. Install sleeves for all pipes passing through walls and concrete floors. Refer to Plumbing Specification Section “Basic Plumbing Materials and Methods” for requirements.

I. 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 fixture fittings if 2 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 135 degrees without the installation of a cleanout. 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.

J. 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.

K. 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 all piping.
   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.

L. Install engineered soil and waste drainage and vent piping systems as follows:

M. Do not enclose, cover, or put piping into operation until it is inspected and approved by engineer and authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Plumbing Specification Section "Basic Plumbing Materials and Methods."

B. Solder Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 VALVE INSTALLATION

A. Provide and install backwater valves in sanitary main entering the building where the top of the manhole is at a higher elevation than the finished floor of the first floor.
B. Backwater Valves:
   1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
   2. Install backwater valves in accessible locations.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Contractor is responsible for coordination with all other trades.

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. 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.
   5. Stainless steel flanges required at water fixture drain connection.

3.7 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 engineer and 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 inspections by engineer and authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Re-inspection: If engineer or authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by engineer and authorities having jurisdiction.

D. Test sanitary drainage and vent piping 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.

3.8 CLEANING

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.

END OF SECTION
SECTION 22 1319
DRAIN PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:
   1. Cleanouts.
   2. Floor drains.
   3. Roof Drains.
   5. Miscellaneous storm drainage piping specialties.

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories.

B. Field quality-control test reports.

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

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.


1.6 COORDINATION

A. Coordinate size and location of concrete bases for outdoor cleanouts.

B. Coordinate size and location of roof penetrations and flashing requirements with architectural.
PART 2 - PRODUCTS

2.1 MATERIALS AND WORKMANSHIP

A. All materials, unless otherwise specified, shall be 51% manufactured in the United States, new, free from all defects, and of the best quality. Foreign goods specifically approved for use by the Owner's Representative prior to bidding may be furnished.

B. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall present a neat, precise appearance.

2.2 CLEANOUTS

A. Exposed Metal Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. MIFAB, Inc.
      d. Tyler Pipe; Wade Div.
      e. Watts Drainage Products Inc.
      f. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M for cast iron cleanout test tee.
   3. Size: Same as connected drainage piping
   4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
   5. Closure: Countersunk or raised-head, brass plug.
   6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Metal Floor Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      c. Tyler Pipe; Wade Div.
      d. Watts Drainage Products Inc.
      e. Zurn Plumbing Products Group; Light Commercial Operation.
      f. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
   3. Size: Same as connected branch.
   4. Type: Threaded, adjustable housing.
   5. Body or Ferrule: Cast iron.
   6. Clamping Device: Not required.
   7. Outlet Connection: Spigot.
   8. Closure: Brass plug with straight threads and gasket.
   9. Adjustable Housing Material: Cast iron with threads.
   11. Frame and Cover Shape: Round.
   12. Top Loading Classification: Heavy Duty.
   13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
   15. Size: Same as connected branch.
C. Cast-Iron Wall Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains:
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on the drawing “Floor Drain Schedule” or a comparable product by one of the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Light Commercial Operation.
   g. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3.
3. Seepage Flange: Required.
4. Anchor Flange: Required.
5. Outlet: Bottom.
7. Trap Pattern: Standard P-trap, unless otherwise indicated.
8. Other Requirements: Refer to drawing schedule and provide full model equivalency.

2.4 ROOF DRAINS

A. Metal Roof Drains:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group.
2. Standard: ASME A112.21.2M.
3. Pattern: Roof drain.
5. Dimensions of Body: Reference Roof Drain Schedule on Drawings.
6. Combination Flashing Ring and Gravel Stop: Required.
8. Outlet: Bottom.
10. 2” Extension Collars: Required for overflow drains only.
11. Underdeck Clamp: Required.

B. Metal Combination Roof Drains (Primary and Overflow):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group.
2. Standard: ASME A112.21.2M.
3. Pattern: Roof drain.
5. Dimensions of Body: Reference Roof Drain Schedule on Drawings.
6. Combination Flashing Ring and Gravel Stop: Required.
8. Outlet: Bottom.
10. 2” Extension Collars: Required for overflow drain only, internal.
11. Underdeck Clamp: Required.
13. Separate outlets for each drain (two total).

2.5 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies: Refer to architectural drawings and specifications for requirements.

2.6 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Hub Drains:
1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Floor-Drain, Trap-Seal Primer Fittings:
1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

C. Air-Gap Fittings:
1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
2.7 MISCELLANEOUS STORM DRAIN PIPING SPECIALTIES

A. Downspout Boots:
1. Description: Manufactured, Dura-coated cast iron body, with strap or ears (with last bolt holes) for attaching to building.
2. Size: Inlet size to match downspout; outlet size NPS 4.

B. Downspout Nozzles:
1. Description:
   a. Plain, bronze body with threaded inlet and bronze wall flange with mounting holes. (Cast iron conductor)
   b. Cast nickel-bronze construction, push on PVC connection, nickel-bronze bolt-on escutcheon and security ring (PVC conductor).
2. Size: Same as connected conductor.

2.8 SOLIDS INTERCEPTORS

A. Solids Interceptors:
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on drawings “Plumbing Fixture Schedule” or a comparable product by one of the following:
   b. MiFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Type: Factory-fabricated interceptor made for removing and retaining sediment from wastewater.
3. Body Material: Cast iron or steel.
4. Interior Lining: Corrosion-resistant enamel.
5. Exterior Coating: Corrosion-resistant enamel.
7. Other Requirements: Refer to drawing schedule and provide full model equivalency.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Plumbing Specification Section "Basic Plumbing Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Provide and install cleanouts (in addition to those indicated on the drawings) in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 135 degrees.
3. Locate at maximum intervals of 50 feet for piping.
4. Locate at base of each vertical soil and waste stack.
5. Locate one cleanout for each restroom.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame anchored to reinforcement or studs and cover flush with finished wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to architectural requirements.
   3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
   4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install roof flashing assemblies on roof drains, sanitary stack vents and vent stacks that extend through roof.

G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

H. Assemble open drain fittings and install with top of hub 2 inches above floor.

I. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
   1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
   2. Size: Same as floor drain inlet.
   3. Connection to floor drain body is not acceptable.

J. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

K. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

L. Install reinforcement for wall-mounting-type specialties.

M. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

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

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Refer to architectural roofing drawings and specifications for requirements.

B. Install flashing for piping passing through roofs with counter-flashing or commercially made flashing fittings, according to Specification Section “Sheet Metal Flashing and Trim.”

C. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

D. Fabricate and install flashing and pans, sumps, and other drainage shapes.
3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION
SECTION 22 3300

ELECTRIC WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following electric water heaters:
   1. Commercial, storage electric water heaters.
   2. Compression expansion tanks.
   3. Water heater accessories.

1.3 SUBMITTALS

A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories. Submitted product to match specified/scheduled equipment including all options and appurtenances, in addition to specifications.

B. Specification Compliance Review:
   1. Manufacturers and bidders must provide the consulting engineer with a Compliance Review of the Specifications and Addenda’s. The Compliance Review shall be a paragraph-by-paragraph review of the Specifications and schedule with the following information “C”, “D”, or “E” marked in the margin of the original Specifications and any subsequent Addenda’s. If the manufacturer or bidder does not provide the Compliance Review to the engineer for review, with the submittal, the submittal will be subject to rejection as non-compliant.
      a. “C” Comply with no exceptions.
      b. “D” Comply with deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.
      c. “E” Exception do not comply. For each and every exception, provide a numbered footnote with reasons and possible alternatives. Non-compliance with the specifications is grounds for rejection as unacceptable. A bid from any alternative or listed equipment manufacturer with any number of exceptions will be reason for rejection for non-compliance without further review.
      d. Unless a deviation or exception is specifically noted in the Compliance Review, the manufacturer shall provide full compliance with entire specification. Deviations or exceptions taken in letters or cover letters in a bid document, subsidiary documents, by omission or by contradiction do not release the manufacturer or bidder from being in complete compliance, unless the exception or deviation has been specifically noted in the Compliance Review and approved by the consulting engineer.
      e. Equipment manufacturers or bidders that do not meet the specifications thru the above process will be subject to rejection without further review.
C. Shop Drawings: Diagram power, signal, and control wiring.

D. Product Certificates: For each type of commercial electric water heater, signed by product manufacturer.
   1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For electric water heaters to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of electric water heaters through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

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

D. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

F. Origin of product to be domestic, no imported products will be acceptable.

1.5 COORDINATION

A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric 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 Period(s): From date of Substantial Completion:
a. Commercial Electric Water Heaters:
   1) Storage Tank: Six (6) years.
   2) Controls and Other Components: Three (3) years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 COMMERCIAL ELECTRIC WATER HEATERS (2.5 THROUGH 30 GALLON)

A. Commercial Storage Electric Water Heaters: Comply with UL 174 requirements for storage-tank-type water heaters.
   1. Manufacturers:
      b. Smith, A.O. Water Products Company.
      a. Tappings: ½" NPT (2.5 Gallon tank) or ¾" NPT (6 through 30 Gallon) factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
      b. Pressure Rating: 150 psig.
      c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings; high temperature porcelain enamel.
      d. ASME rated tank per ASME Boiler and Pressure Vessel Code, Section IV Part HLW if specified on schedule.
   3. Factory-Installed Storage-Tank Appurtenances:
      a. Anode Rod: Replaceable magnesium.
      b. Drain Valve: ¾", ¼ turn bronze ball valve, stainless steel ball and trim. ¾" hose thread adaptor and cap.
      c. Insulation: Comply with ASHRAE/IESNA 90.1; 2-⅝" rigid polyurethane foam insulation, non-CFC.
      d. Jacket: Steel with enameled finish.
      e. Heating Elements: Electric, screw-in immersion type arranged in multiples of three; stainless steel.
         1) Staging: Input not exceeding 18 kW per step.
      f. Temperature control: Adjustable thermostat, surface mounted.
      g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
      h. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating on top of tank. Select one relief valve with sensing element that extends into storage tank.
   4. Special Requirements: NSF 5 construction.
   5. Capacity and Characteristics: Refer to drawing schedule.
2.3 COMMERCIAL ELECTRIC WATER HEATERS (50 THROUGH 120 GALLON)

A. Commercial, Storage Electric Water Heaters: Comply with UL 1453 requirements for storage-tank-type water heaters.
   1. Manufacturers:
      b. Smith, A. O. Water Products Company.
      a. Tappings: 1-1/2" NPT factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
      b. Pressure Rating: 150 psig.
      c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings; high temperature porcelain enamel.
      d. ASME rated tank per ASME Boiler and Pressure Vessel Code, Section IV Part HLW if specified on schedule.
   3. Factory-Installed Storage-Tank Appurtenances:
      a. Anode Rod: Replaceable magnesium; two (2) anodes per tank.
      b. Drain Valve: ¾", ¼ turn bronze ball valve, stainless steel ball and trim. ¾" hose thread adaptor and cap.
      c. Insulation: Comply with ASHRAE/IESNA 90.1; 3" rigid polyurethane foam insulation, non-CFC.
      d. Jacket: Steel with enameled finish.
         1) Staging: Input not exceeding 18 kW per step.
      f. Temperature Control: Adjustable thermostat. (Non-ASME: Surface mounted, ASME: Immersion type)
      g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
      h. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
   4. Special Requirements: NSF 5 construction.
   5. Capacity and Characteristics: Refer to drawing schedule.

2.4 COMPRESSION EXPANSION TANKS

A. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air pre-charge to minimum system-operating pressure at tank.
   1. Manufacturers:
      a. Smith, A. O.; Aqua-Air Div.
      b. Rheem Water Heater Div.
   2. Construction:
      a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
      b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
      c. Air-Charging Valve: Factory installed.
   3. Capacity and Characteristics:
      b. Capacity Acceptable: Refer to drawings.
c. Air Precharge Pressure: Refer to drawings.

2.5 WATER HEATER ACCESSORIES

A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

B. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than water heater working-pressure rating.

C. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 3/4.

D. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

E. Water Regulators: ASSE 1003, water-pressure reducing valve. Set at 25-psig maximum outlet pressure, unless otherwise indicated.

2.6 SOURCE QUALITY CONTROL

A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial water heater storage tanks before shipment to minimum of one and one-half times pressure rating.

C. Prepare test reports.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

A. Install commercial water heaters on concrete bases.
   1. Concrete base construction requirements are specified in Specification Section "Basic Plumbing Materials and Methods."

B. Install 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.

C. Extend commercial-water-heater relief-valve outlet, with drain piping of same material as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains with drain piping of same material as domestic water piping.
E. Install thermometer on outlet piping of water heaters. Refer to Specification Section "Meters and Gauges" for thermometers.

F. Install pressure gage(s) on outlet of commercial electric water-heater piping. Refer to Specification Section "Meters and Gauges" for pressure gages.

G. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.

H. Fill water heaters with water.

3.2 CONNECTIONS

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

B. Install water heater and piping adjacent to heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

C. Ground equipment according to Specification Section "Grounding and Bonding."

D. Connect wiring according to Specification Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial electric water heaters. Refer to Division 1 Section "Closeout Procedures" or "Demonstration and Training."

END OF SECTION
SECTION 22 4100

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:
   1. Faucets for lavatories.
   2. Flushometers.
   3. Toilet seats.
   4. Protective shielding guards.
   5. Fixture supports.
   6. Dishwasher air-gap fittings.
   7. Disposers.
   8. Water closets.
   9. Urinals.
   10. Lavatories.
   11. Commercial sinks.
   13. Service basins.
   14. Utility Boxes

B. Related Sections include the following:
   1. Specification Section "Water Distribution" for exterior plumbing fixtures and hydrants.
   2. Specification Section "Toilet and Bath Accessories."
   5. Specification Section "Drinking Fountains and Water Coolers."
   6. Specification Section "Plumbing Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.

1.3 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities; and is compliant with the Texas Accessibility Standards (TAS), Article 9102, Texas Civil Statutes.

B. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
1.4 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. Shop Drawings: Diagram power, signal, and control wiring.

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

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

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


D. Regulatory Requirements: Comply with requirements in the Texas Accessibility Standards (TAS), Architectural Barriers Act, Article 9102, Texas Civil Statutes.


F. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

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

H. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
   1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
   2. Water-Closet, Flushometer Tank Trim: ASSE 1037.

I. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
   1. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
   3. Hose-Connection Vacuum Breakers: ASSE 1011.
J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
2. Brass and Copper Supplies: ASME A112.18.1.

K. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Disposers: ASSE 1008 and UL 430.
5. Off-Floor Fixture Supports: ASME A112.6.1M.

1.6 WARRANTY
A. Warranty Period: Two (2) years from dated of Substantial Completion.

1.7 EXTRA MATERIALS
A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Faucet Cartridge, Assembly and Associated O-Rings: Equal to 2 or 5 percent of amount of each type and size installed (whichever is greater).
2. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 12 of each type.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS
A. Product descriptions hereinafter represent minimum requirements for each fixture; refer to Basis-of-Design manufacturer and model number listed on the drawing "Plumbing Fixture Schedule" for additional features, construction details, accessories and/or options.

2.2 MATERIALS AND WORKMANSHIP
A. All materials, unless otherwise specified, shall be 51% manufactured in the United States, new, free from all defects, and of the best quality. Foreign goods specifically approved for use by the Owner's Representative prior to bidding may be furnished.

B. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall present a neat, precise appearance.
2.3 STOPS

A. Angle Stops:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: (unless noted otherwise on drawings or on schedule).
      a. Chicago Faucets.
      b. McGuire Manufacturing Co., Inc.
      c. T & S Brass and Bronze Works, Inc.
   2. Description: Heavy duty cast brass with compression cartridge.
      a. Finish: Chrome plated.
      b. Stem: Brass, full turn.
      c. Operation: Loose Key, unless otherwise indicated.
      d. Outlet: NPS 3/8, compression
      e. Inlet Size: NPS 1/2, female thread.

2.4 LAVATORY FAUCETS

A. Lavatory Faucets, Manual:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product listed on the drawing “Plumbing Fixture Schedule” or a comparable product by one of the following: (unless noted otherwise on drawings or within Schedule)
      a. Chicago Faucets.
      b. T & S Brass and Bronze Works, Inc.
   2. Description: Two-handle mixing valve. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
      b. Finish: Polished chrome plate.
      c. Maximum Flow Rate: 0.5 gpm. (unless noted otherwise on drawings or within Schedule)
      d. Valve Handle(s): Wrist blade, 4 inches.
      e. Spout Outlet: Aerator.

B. Lavatory Faucets, Automatic, Metering:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product listed on the drawing “Plumbing Fixture Schedule” or a comparable product by one of the following: (unless noted otherwise on drawings or within Schedule)
      a. Chicago Faucets.
      b. T & S Brass and Bronze Works, Inc.
   2. Description: Push button operated, metering; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
      b. Finish: Polished chrome plate.
      c. Maximum Flow Rate: 0.5 gpm, (unless noted otherwise on drawings or within Schedule)
      d. Mixing Valve: None, cold water only.
      e. Spout Outlet: Aerator, vandal resistant.

2.5 SINK FAUCETS

A. Sink Faucets, Manual, Single Hole:
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product listed on the drawing “Plumbing Fixture Schedule” or a comparable product by one of the following: (unless noted otherwise on drawings or within Schedule)
   a. Chicago Faucets.
   b. T & S Brass and Bronze Works, Inc.

2. Description: One or two-handle valve. Include cold and hot-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
   b. Finish: Polished chrome plate.
   c. Maximum Flow Rate: 2.2 gpm, (unless noted otherwise on drawings or within Schedule)
   d. Mixing Valve: None.
   e. Handle: Wrist blade, 4 inches; coordinate single handle (CW only) units with floor plans such that lever is always located on front side of counter/sink.
   f. Spout Outlet: Aerator.
   g. Operation: Compression, manual.

B. Sink Faucets, Manual:
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product listed on the drawing “Plumbing Fixture Schedule” or a comparable product by one of the following: (unless noted otherwise on drawings or within Schedule).
   a. Chicago Faucets.
   b. T & S Brass and Bronze Works, Inc.

2. Description: Two-handle mixing. Include cold and hot-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
   b. Finish: Polished chrome plate.
   c. Maximum Flow Rate: 2.2 gpm, (unless noted otherwise on drawings or within Schedule)
   d. Mixing Valve: None.
   e. Handles: Wrist blade, 4 inches.
   f. Spout Outlet: Aerator.
   g. Operation: Compression, manual.

C. Sink Faucets, Kitchen:
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product listed on the drawing “Plumbing Fixture Schedule” or a comparable product by one of the following: (unless noted otherwise on drawings or within Schedule)
   a. Chicago Faucets.
   b. T & S Brass and Bronze Works, Inc.

2. Description: Kitchen faucet without spray, single-handle mixing. Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
   b. Finish: Polished chrome plate.
   c. Maximum Flow Rate: 2.2 gpm, (unless noted otherwise on drawings or within Schedule).
   d. Mixing Valve: Integral to cartridge.
   e. Handle: Lever, minimum 4 inches.
   f. Spout Outlet: Aerator.
2.6 FLUSHOMETERS

A. Flushometers, Automatic:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product listed on the drawing “Plumbing Fixture Schedule” or a comparable product by one of the following: (unless noted otherwise on drawings or within Schedule)
      a. Sloan Valve Company.
   2. Description: Flushometer for water-closet or urinal-type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
      a. Internal Design: Diaphragm operation.
      b. Style: Exposed.
      c. Trip Mechanism: Oscillating, lever-handle actuator.

2.7 TOILET SEATS

A. Toilet Seats:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Inc.
      b. Bemis Manufacturing Company.
      c. Church Seats.
      d. Kohler Co.
   2. Description: Toilet seat for water-closet-type fixture.
      a. Material: Molded, solid plastic.
      b. Configuration: Open front without cover.
      c. Size: Elongated.
      d. Hinge Type: SC, self-sustaining, check.
      e. Class: Heavy-duty commercial.

2.8 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: (unless noted otherwise on drawings or within Schedule)
      a. McGuire Manufacturing Co., Inc.
      b. TRUEBRO, Inc.
   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.

2.9 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Josam Company.
   2. MIFAB Manufacturing Inc.
   4. Tyler Pipe; Wade Div.
   5. Zurn Plumbing Products Group; Specification Drainage Operation.

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

C. **Urinal Supports:**
   1. **Description:** Type I, manufactured urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet. Factory painted.
   2. **Accessible-Fixture Support:** Include rectangular steel uprights.

D. **Lavatory Supports:**
   1. **Description:** Type II, manufactured lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet. Factory painted.
   2. **Accessible-Fixture Support:** Include rectangular steel uprights.

E. **Securements**
   1. Stainless Steel drop in anchors with heavy-duty class stainless steel bolts. All-threaded is not acceptable.

2.10 **DISHWASHER AIR-GAP FITTINGS**

A. **Dishwasher Air-Gap Fittings:**
   1. **Manufacturers:** Subject to compliance with requirements, provide product (or provide Dishwasher loop where local jurisdiction allows):
      a. Watts Brass & Tubular; a division of Watts Regulator Co.
   2. **Description:** Fitting suitable for use with domestic dishwashers and for deck mounting; with plastic body chrome-plated brass cover; and capacity of at least 5 gpm; and inlet pressure of at least 5 psig at a temperature of at least 140 deg F. Include 5/8-inch ID inlet and 7/8-inch ID outlet hose connections.
   3. **Hoses:** Rubber and suitable for temperature of at least 140 deg F.
      a. **Inlet Hose:** 5/8-inch ID and 48 inches long.
      b. **Outlet Hose:** 7/8-inch ID and 48 inches long.

2.11 **DISPOSERS**

A. **Disposers:**
   1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following: (unless noted otherwise on drawings or within Schedule).
      a. **In-Sink-Erator;** a div. of Emerson Electric Co.
      b. **KitchenAid.**
   2. **Description:** Batch-feed household, food-waste disposer. Include reset button; switch; corrosion-resistant chamber with jam-resistant, cutlery- or stainless-steel grinder or shredder; NPS 1-1/2 outlet; quick-mounting, stainless-steel sink flange; antisplash guard; and combination cover/stopper.
      a. **Type:** Batch-feed household.
      b. **Model:** Sound-insulated chamber.
      c. **Motor:** 115-V ac.
      d. **Minimum 1/2 HP motor**
2.12 WATER CLOSETS

A. Water Closets, Floor Mounted, ADA-Compliant:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product listed on the drawing “Plumbing Fixture Schedule” or a comparable product by one of the following: (unless noted otherwise on drawings or within Schedule)
      a. American Standard Companies, Inc.
      b. Kohler Co.
   2. Description: Accessible, wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
      a. Style: One piece.
         1) Bowl Type: Elongated with siphon-jet design; include bolt caps matching fixture.
         2) Design Consumption: 1.28 gal./flush (unless noted otherwise on drawings or within Schedule).
         4) Toilet Seat: Required; see other paragraph.
         5) Flushometer: Required; see other paragraph.
   3. Description: Accessible, floor-mounting, floor-outlet, vitreous-china fixture designed for flushometer valve operation.
      a. Style: Flushometer valve.
         1) Bowl Type: Elongated with siphon-jet design; include bolt caps matching fixture.
         2) Height: Accessible, 16-3/4”.
         3) Design Consumption: 1.28 gal./flush (unless noted otherwise or within Schedule).
         4) Color: White.
         5) Toilet Seat: Required; see other paragraph.
         6) Flushometer: Required; see other paragraph.

2.13 URINALS

A. Urinals:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product listed on the drawing “Plumbing Fixture Schedule” or a comparable product by one of the following: (unless noted otherwise on drawings or within Schedule).
      a. American Standard Companies, Inc.
      b. Kohler Co.
   2. Description: Accessible, wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
      a. Type: Siphon jet.
      b. Design Consumption: 0.5 gal./flush (unless noted otherwise on drawings or within Schedule).
      e. Outlet Size: NPS 2.

2.14 LAVATORIES

A. Lavatories:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product listed on the drawing “Plumbing Fixture Schedule” or a comparable product by one of the following: (unless noted otherwise on drawings or within Schedule).
      a. American Standard Companies, Inc.
2.15 COMMERCIAL SINKS

A. Commercial Sinks:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product listed on the drawing “Plumbing Fixture Schedule” or a comparable product by one of the following: (unless noted otherwise on drawings or within Schedule).
   a. Elkay Manufacturing Co.
   b. Just Manufacturing Company.

2. Description: Counter-mounting, seamless commercial sink, self-rimming, fully undercoated for sound attenuation, with 1-3/4" radius coved corners.
   a. Metal: 304 stainless steel, 18 gauge.
   b. Finish: Satin.
   c. Drain: 3" Grid, chrome-plated brass, with vandal resistant strainer and NPS 1-1/2 tailpiece; unless otherwise indicated.
   d. Supplies: NPS 1/2 chrome-plated copper with stops.
   e. Drain Piping: NPS 1-1/2 chrome-plated, cast-brass P-trap; 0.045-inch thick tubular brass waste to wall (trap arm); and wall escutcheon(s).

2.16 KITCHEN SINKS

A. Kitchen Sinks, Barrier Free:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product listed on the drawing “Plumbing Fixture Schedule” or a comparable product by one of the following: (unless noted otherwise on drawings or within Schedule).
   a. Kohler Co.
   b. American Standard Companies, Inc.

2. Description: Two-compartment (high/low), accessible, built into counter, enameled, cast-iron kitchen sink.
   a. Overall Dimensions:
   b. Metal Thickness: 0.038 inch 0.050 inch.
   c. Left Compartment:
      1) Dimensions: 7 x 9-inches.
      2) Drain: 3-1/2-inch outlet for disposer.
         a) Location: Near back of compartment.
   d. Right Compartment:
      1) Dimensions: 21 x 16-inches.
      2) Drain: 3-1/2-inch crumb cup.
         a) Location: Near back of compartment on left side.
   e. Supplies: NPS 1/2 chrome-plated copper with stops.
   f. Drain Piping: Drain Piping: NPS 1-1/2 chrome-plated, cast-brass P-trap; 0.045-inch thick tubular brass waste to wall (trap arm); and wall escutcheon(s).
   g. Color: White.
   h. Barrier-free Shroud: Required.
   i. Disposer: Required for left compartment.
j. Dishwasher Air-Gap Fitting: Required.

2.17 SERVICE BASINS

A. Service Basins:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product listed on the drawing “Plumbing Fixture Schedule” or a comparable product by one of the following: (unless noted otherwise on drawings or within Schedule).
      b. Stern-Williams Co., Inc.
   2. Description: Flush-to-wall, floor-mounting, pre-cast terrazzo fixture with rim guard.
      b. Faucet: As indicated on drawing “Plumbing Fixture Schedule.”
      c. Color: Not applicable.
      d. Drain: Cast-brass with nickel-bronze grid and NPS 3 (DN 80) outlet; extra heavy-duty, cast iron, deep seal trap.

2.18 UTILITY BOXES

A. Utility Boxes, Clothes Washer:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product listed on the drawing “Plumbing Fixture Schedule.”
   2. Description: Flush mounted in wall cavity with shutoff valves.
      a. Material: Galvanized Steel.
      b. Finish: Unpainted.
      c. Valves: Bronze, brass stem, compression.
      d. Outlets: 3/4" Hose Thread.
      e. Inlet Size: NPS 1/2, female thread.
      f. Supplies: 60-inch Heavy-duty CW and HW clothes washer hoses, manufactured by Floodcheck (no exceptions). Provide with shock arrestors equal to Precision Plumbing Products #WHA-500L.

B. Utility Boxes, Ice Maker:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product listed on the drawing “Plumbing Fixture Schedule.”
   2. Description: Flush mounted in wall cavity with angle stop.
      a. Material: Galvanized Steel.
      b. Finish: Unpainted.
      c. Supply: Annealed copper tube, minimum 48-inch length (coiled) to permit pulling out appliance for rear service.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
   1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. All wall mounted fixtures and equipment shall be installed with floor mounted carriers (Manufacturer provided).

D. Install wall-mounted fixtures AT ELEVATIONS INDICATED ON ARCHITECTURAL DRAWINGS.

E. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

F. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

G. Install wall-mounting fixtures with tubular waste piping attached to supports.

H. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

I. Install counter-mounting fixtures in and attached to casework.

J. Install fixtures level and plumb according to roughing-in drawings.

K. 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, if supply stops are not specified with fixture. Valves are specified in Specification Section “Valves.”

L. All appurtenances supporting fixtures to be chrome plated in exposed areas (including but not limited to under cabinet areas).

M. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

N. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

O. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

P. Install toilet seats on water closets.

Q. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

R. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
S. 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.

T. Install shower flow-control fittings with specified maximum flow rates in shower arms.

U. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

V. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

W. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Install on countertop at sink. Connect inlet hose to dishwasher and outlet hose to disposer.

X. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Specification Section "Basic Mechanical Materials and Methods."

Y. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Specification Section "Joint Sealants."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other plumbing specifications. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures and appliances with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Specification Section "Grounding and Bonding."

D. Connect wiring according to Specification Section "Conductors and Cables."

E. Arrange for electric-power connections to fixtures, transformers and devices that require power. Electric power is specified in Electrical Specification Sections.

3.4 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
3.5 ADJUSTING

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

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

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

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

E. Install fresh batteries in sensor-operated mechanisms.

F. Run hot water (full flow) at each faucet until temperature is stable (-2 degree deviation from water heater set point); balance manual (y-type, etcetera) mixing valve at each faucet to 110 F spout-discharge temperature.

G. After compression cartridges are well-seated (50-60 cycles), adjust faucet wrist-blade handles to position parallel to back-splash (or wall that lavatory is mounted to) when fully closed (tight).

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers’ recommended cleaning methods and materials. Do the following:
   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   2. Remove sediment and debris from drains.

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

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

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

END OF SECTION
SECTION 22 4716
WATER COOLERS

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following water coolers and related components:
1. Water coolers.
2. Fixture supports.

1.3 DEFINITIONS
A. Accessible Water Cooler: Fixture that can be approached and used by people with disabilities.
B. Cast Polymer: Dense, cast-filled-polymer plastic.
C. Fitting: Device that controls flow of water into or out of fixture.
D. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.4 SUBMITTALS
A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.
B. Shop Drawings: Diagram power, signal, and control wiring.
C. Field quality-control test reports.
D. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Regulatory Requirements: Comply with requirements in the Texas Accessibility Standards (TAS), Architectural Barriers Act, Article 9102, Texas Civil Statutes.
D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

E. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.


G. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 Water Coolers

A. Basis-of-Design Product
   1. Subject to compliance with requirements, provide the product listed on the drawing "Plumbing Fixture Schedule" or a comparable product by one of the following:
      a. Elkay Manufacturing Co.
      b. Halsey Taylor.
   2. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-mounting water cooler.
      a. Cabinet: Bilevel with two attached cabinets and with bilevel skirt kit, all stainless steel.
      b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
      c. Control: Push bar.
      d. Drain(s): NPS 3/8 with ball, gate, or globe valve.
      e. Cooling System: Electric, with hermetically sealed compressor, refrigerant, hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
         1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.
      g. Support: Type II, water cooler carrier. Refer to "Fixture Supports" Article.

2.2 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Josam Co.
   2. MIFAB Manufacturing, Inc.
   4. Tyler Pipe; Wade Div.
   5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.
   1. Type I: Hanger-type carrier with two vertical uprights.
   2. Type II: Bilevel, hanger-type carrier with three vertical uprights.

Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.

B. Examine walls and floors for suitable conditions where fixtures are to be installed.

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

3.2 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.

C. Install fixtures level and plumb. For fixtures indicated for children, install at height indicated in architectural drawings.

D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Specification Section "Valves."

E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Specification Section "Basic Mechanical Materials and Methods."

G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Specification Section "Joint Sealants."
3.4 CONNECTIONS

A. Piping installation requirements are specified in other plumbing specification sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Specification Section "Grounding and Bonding."

D. Connect wiring according to Specification Section "Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
   1. Remove and replace malfunctioning units and retest as specified above.
   2. Report test results in writing.

3.6 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

3.7 CLEANING

A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION
SECTION 23 0100
SPECIAL CONDITIONS FOR ALL MECHANICAL WORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK
A. This section covers the general provisions of the mechanical specifications applicable to the following systems:
   1. Heating, air conditioning, and ventilation.
B. The use of the word mechanical in the body of the various specifications sections shall be interpreted to include all the aspects of all of the systems referenced in Mechanical Specifications.

1.2 DRAWINGS
A. These specifications are accompanied by drawings of the building and details of the installations showing the locations of equipment, piping, ductwork, etc. The drawings and these specifications are complementary to each other; requirements described in one or the other shall be considered binding as if described in both.
B. If any departures from the drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted to the Owner’s Representative for approval. No departures shall be made without prior written approval by the Owner’s Representative.
C. There are intricacies of construction which are impractical to specify or indicate in detail; means and methods for performing such work shall adhere to commonly accepted industry standards.
D. It is the Contractor’s responsibility to properly use all information found on the Architectural, Structural, Mechanical, and Electrical drawings and applicable shop drawings where such information affects his work.
E. For new buildings, all final dimensions shall be scaled from the Architectural drawings, unless otherwise noted. For work associated with existing buildings (renovations and additions), all final dimensions shall be field verified.

1.3 CONSTRUCTION REQUIREMENTS
A. The architectural, civil, structural, electrical, plumbing, fire protection and mechanical drawings, and specifications are all part of the Contract Documents. In many instances there are details described on another trade’s drawings that are not necessarily included or referenced in the mechanical drawings. It is the Contractor’s responsibility to review in detail all parts of the Contract Documents prior to submitting a bid. Failure to comply with this requirement shall not relieve the Contractor of responsibility or be used as cause for additional compensation because architectural, structural, or electrical details were not included in the mechanical drawings.
B. It is the intent of the Contract Documents to provide complete and fully functional installation in every respect. Material and/or construction details not specifically described in the Contract Documents, but commonly considered incidental to the industry, are required by the Contractor.
C. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to comply with Codes, to facilitate the work of other trades, to conform to the details of the installation supplied by the manufacturer of the equipment to be installed, and thereby to provide an integrated satisfactory operating installation.

D. The mechanical, electrical and plumbing drawings are schematic in nature and do not show every connection in detail or every pipe or conduit in its exact location. These details are subject to the requirements of ordnances and structural and architectural conditions.

E. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases and above suspended ceilings, etc. in finished portions of the building, unless specifically noted to be exposed. Work shall be installed to avoid compromising 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. All work shall be installed parallel or perpendicular to building lines unless otherwise noted.

F. When the mechanical drawings do not give exact details as to the elevation of pipe or ducts, physically arrange the systems to fit in the space available at the elevations intended with the proper grades for the functioning of the system involved. Piping, exposed conduit, and duct systems are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner. The plans do not show all required offsets, control lines, pilot lines, and other location details. Work shall be concealed in all finished areas. Piping specified to be insulated shall be supported in a manner that will allow the insulation to be installed without gaps. Insulated piping in concealed areas shall be offset with fittings as necessary to permit installation of insulation. Bending of pipes or installing pipes in a strain to insulate will not be permitted.

G. Final placement of serviceable equipment shall be carefully coordinated with all other trades to ensure sufficient clearance for maintenance according to manufacturer’s recommendations. Lubricating orifices and adjustable components shall be easily accessible. Piping, conduit, valve stems, cabling and other building systems shall not interfere with service space.

H. Location of Exposed Devices
   1. All exposed devices (grills, registers, diffusers, sprinkler heads, medical gas outlets, plumbing rough-ins, lights, outlets, communication devices, etcetera) shall be referenced to fixed data points that are coordinated with all trades; shall be located to present symmetrical arrangements with respect to the fixed data point; and shall facilitate the proper arrangements of acoustical ceiling tiles. Fixed data points shall include such features as wall and ceiling lines, soffits, balanced border widths, masonry joints, etc. Devices located in acoustical ceiling tiles shall occur symmetrically in tile joints or in the centers of whole tiles. The final determination of the exact location of each outlet and the arrangements to be followed shall be acceptable to the Owner’s Representative.
   2. The drawings schematically indicate locations of the exposed devices. Final locations shall be determined by carefully coordinating the drawings pertaining to each trade. Where conflicts are identified, Owner’s Representative shall determine final location. The Owner reserves the right to make any reasonable change in location of any device before installation, without additional cost.

1.4 QUALIFICATIONS
A. Contractor must have minimum of five years experience installing commercial heating, ventilation and air conditioning systems, plumbing and piping systems similar to those described in these Contract Documents.

B. Contractor must be licensed and hold a current contracting license that has been valid for a minimum of five years in the State of Texas.

C. Contractor must be able to bond work for payment and performance of work being bid. Contractor's bonding agency shall have a Best's insurance rating of A or A+.

1.5 MATERIAL AND EQUIPMENT REQUIREMENTS

A. Manufacturer's Instructions: The manufacturer's published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufacturer materials or equipment, unless otherwise indicated. The Contractor shall promptly notify the Owner's Representative in writing of any conflict between the requirements of the Contract Documents and the manufacturer's direction and shall obtain the clarification of the Owner's Representative before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer's directions or such clarification by the Owner's Representative, he shall bear all costs arising in connection with the correction of the deficiencies.

B. Storage at Site: The Contractor shall not receive material or equipment at the jobsite until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage and from surrounding work.

C. Capacities shall be not less than those indicated and shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

D. Conformance to Agency Requirements: Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriters Laboratories, Inc., ETL listed or constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers or the Air Moving and Conditioning Association, the Contractor shall submit proof that the items furnished under this section of the specifications conform to such requirements. The label of the Underwriters Laboratories, Inc. or ETL applied to the item will be acceptable as sufficient evidence that the items conform to such requirements. The ASME stamp or the AMCA label will be acceptable as sufficient evidence that the items conform to the respective requirements.

E. Nameplates: Each major component of equipment shall have the manufacturer's name, address, and model-identification 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. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number otherwise surfaces of ferrous metal shall be given a rust-inhibiting coating. The treatment shall withstand 200 hours in salt-spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen shall show no signs of wrinkling or cracking and no signs of rust creepage beyond 1/8 inch on either side of the scratch mark. Where rust inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified, except that coal tar or asphalt-type coatings will not be acceptable unless so stated for a specific item. Where steel is specified to be hot-dip galvanized, mill-galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-26915.

G. Protection from Moving Parts: Belts, pulleys, chains, gears, couplings, projecting set screws, keys, and other rotating parts located so that any person can come in close proximity thereto, shall be fully enclosed or properly guarded.
H. Drive Guards: For machinery and equipment, provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears, and other moving parts regardless of height above the floor. Drive guards may be excluded where motors and drives are inside factory-fabricated air handling units casings. Guards shall be constructed of sheet steel, cast iron, expanded metal, or wire mesh rigidly secured so as to be removable without disassembling pipe duct or electrical connection to equipment. Provide a 1-inch diameter hole in each drive guard at each shaft center to allow access for speed measurement.

I. Verifications of Dimensions: The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. The Contractor shall visit the premises and thoroughly familiarize himself with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Owner’s Representative of any discrepancy before performing any work. Adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner, Architect, or Engineer.

J. Standard Products: Materials and equipment to be provided 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.

K. Spare Parts Data: As soon as practicable after approval of materials and equipment and, if possible, not later than four months prior to the date of beneficial occupancy, the Contractor shall furnish spare parts data for each different item of equipment listed. The data shall include a complete list of parts and supplies with current unit prices and sources of supply, a list of parts and supplies that are either normally furnished at no extra cost with the purchase of the equipment or specified hereinafter to be furnished as part of the Contract, and a list of additional items recommended by the manufacturer to assure efficient operation for a period of 120 days at the particular installation. The foregoing shall not relieve the Contractor of any responsibilities under the warranty specified.

1.6 INSPECTION OF THE SITE

A. The Contractor shall visit the site, verifying all existing items indicated on drawings and/or specified, and familiarize himself with the existing work conditions, hazards, grades, actual formations, soil conditions, structures, utilities, equipment, systems, facilities, and local requirements. The submission of bids shall be deemed evidence of such visits. All proposals shall take these existing conditions into consideration, and the lack of specific information shall not relieve the Contractor of any responsibility.

1.7 UTILITY LOCATIONS AND ELEVATIONS

A. Locations and elevations of the various utilities included within the scope of this work have been obtained from substantially reliable sources and are offered separately from the Contract Documents, as a general guide only, without guarantee as to accuracy. Examine the site, the locations, and availability of all utilities and services required for their relation to the work. Verify the location of all existing site utilities with each responsible utility company or applicable party. The Contractor shall repair all damage to existing utilities, whether indicated on the drawings or not, at his sole expense.

1.8 PERMITS, UTILITY CONNECTIONS, AND INSPECTIONS

A. Permitting Fees: Contractor shall pay for all fees associated with permits required by municipal authorities having jurisdiction.
B. Tapping and Impact Fees: Contractor shall pay for all fees associated with tapping into municipal utility mains, including sanitary sewer, natural gas and domestic water. Impact fees will be paid for by the Owner.

C. Compliance: The Contractor shall comply in every respect with all requirements of local authorities having jurisdiction, including building inspections, fire marshal, local ordinances and codes, and utility company requirements. In no case does this relieve the Contractor of the responsibility of complying with these specifications and drawings where specified conditions are of a higher quality than the requirements of the above-specified authorities. Where requirements of the specifications and drawings are below the requirements of the above offices having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above authorities.

D. Utilities: The Contractor shall coordinate with the various utility companies involved in this project and shall provide required utility relocations, extensions, modifications, and/or changes (complete in all respects) as described in the Contract Documents. Contractor shall verify the location of all existing utilities with the applicable Utility Company. The Contractor shall be responsible for all damages to existing utilities, whether indicated on drawings or not, and repair all damage to existing utilities as acceptable to the affected Utility Company.

E. Certification: Prior to final acceptance, the Contractor shall furnish a certificate of acceptance from the inspection departments having jurisdiction over the work for any and all work installed under this Contract. Any additional labor costs incurred as a result of a substitution shall be the Contractor's responsibility.

1.9 EXISTING FACILITIES

A. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection, and in-service maintenance of all plumbing, heating, air conditioning, and ventilating services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

B. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being performed under this project.

C. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, light fixtures, air conditioning ductwork and equipment, etc. to provide this access and shall reinstall same upon completion of work in the areas affected.

D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed, all Contractors shall remove and reinstall in locations approved by the Architect/Engineer all devices required for the operation of the various systems installed in the existing construction. This is to include but is not limited to temperature controls system devices, electrical switches, relays, fixtures, piping, conduit, etc.

E. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner two weeks in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, shall be included in the contract amount.
1.10 DEMOLITION AND RELOCATION

A. The Contractor shall modify, remove, and/or relocate all materials and items so indicated on the drawings or required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination or otherwise disposed of as directed by the Owner. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition. The Contractor may, at his discretion, and upon the approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.

B. All items which are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved.

C. When 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.

D. Service lines and wiring to items to be removed, salvaged, or relocated shall be removed to points indicated on the drawings, specified, or acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied off or disconnected in a safe manner acceptable to the Owner. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities which must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner as hereinbefore specified.

1.11 SUBSTITUTION OF MATERIALS AND EQUIPMENT

A. No substitution of materials or equipment herein specified or called for on the drawings will be permitted, except by written permission of the Owner’s Representative. Where several makes of equipment or material are mentioned, any item named may be bid upon provided it meets space, capacity specifications, and other requirements.

1.12 SUBMITTALS

A. Submittals for Review:
   1. As soon as practical or within 30 days after the date of contract award or notice to proceed, and before purchasing or starting installation of any materials or equipment, the Contractor shall submit for review sufficient material and equipment data to indicate that all requirements of the specifications have been met and samples shall be furnished when requested. All manufacturer’s data used as part of the submittal shall have all non-applicable features crossed out or deleted in a manner that will clearly indicate exactly what is to be furnished.
   2. Four (4) copies of the submittal list and detailed submittals (for the Owner’s and A/E’s use) shall be submitted to the Owner’s Representative. The Contractor is requested to include a minimum of three (3) additional copies for insertion in the project’s Owner’s Manuals at the completion of the project, and the number of additional copies the Contractor requires...
for his and his subcontractor's use during the project's construction. The detailed submittals shall be accompanied by the same number of sets of pictorial and descriptive data derived from the manufacturer's catalogs and sales literature, or incorporated in the shop drawings. The Contractor may provide a detailed submittal on any item even though not required by the Owner's Representative.

B. Format
1. Submittals shall be bound in a BLACK hardback three-ring binder with clear-view sleeves on the spine and front. Binders larger than 3-inches shall be divided into two volumes. The front sleeve shall have a cover sheet inserted with the title “MECHANICAL SUBMITTALS” centered in large print. Below the title shall be printed the name of the project, the date, the project location, the name and address of the contractor, the name and address of the subcontractor and the name and address of the engineer(s) in smaller print.
2. Provide a Table of Contents at the beginning of the binder that summarizes the information being submitted according to specification section.
3. Submittals shall be tab divided by specification section; all sections identified in the project specifications shall have a tab. When no information is being provided concerning a particular specification section, insert a single dated sheet that explains the circumstances.
4. Loose-leaf or piecemeal submittals are not acceptable and subject to rejection unless prior approval has been granted by the Engineer.
5. Email/Digital Submittals are not acceptable and subject to rejection unless prior approval has been granted by the Engineer.

C. Content:
1. The Contractor shall prepare or cause to be prepared shop drawings, product data, materials and equipment lists, diagrams, data, samples, and other submittals as required by the contract documents, hereinafter referred to as "Submittal Data." The Contractor shall review and approve all submittal data for compliance with the contract documents, manufacturer's recommendations, adequacy, clearances, code compliance, safety, and coordination with associated work.
2. The Contractor shall submit approved submittal data to the Owner's Representative for review and comment as to general conformance with the design concept and general compliance with information given in the contract documents. Owner's Representative's review shall not include review of quantities, dimensions, weights or gauges, fabrication processes, construction methods, coordination with other trades or work, or construction safety and precautions, all of which are the sole responsibility of the Contractor.
3. The Contractor shall clearly and specifically identify and call to the attention of the Owner's Representative any deviation from the contract documents for which Owner acceptance is desired. The responsibility for such a deviation accepted by the Owner shall remain with the Contractor.
4. Timeliness: The burden of timeliness in the complete cycle of submittal data is on the Contractor. The Contractor shall allow a minimum of four (4) weeks' time frame for review of each submission by the Owner's Representative. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all re-submission cycles on nonconforming materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not justify any request for scheduled construction time extensions or extra compensation.
5. Work performed in accordance with approved submittal data that is not in accordance with the Contract Documents and did not have the specific acceptance of the Owner's Representative shall be replaced at Contractor's cost.

D. Re-submittals
1. Re-submit entire submittal in accordance with afore mentioned format and content requirements. **Loose-leaf or piecemeal re-submittals are not acceptable.** New and/or revised data for each section shall be prefaced with a colored (yellow, pink, orange, etc) cover sheet that identifies (in a word or two) the materials and/or equipment being re-submitted. Typeset the words “REVISED SUBMITTAL NO. 1 (or 2, 3 as applicable)” centered at the bottom of the cover sheet.

2. Subsequent re-submittals (second and third, if necessary) shall have different colored cover sheets to distinguish between the various re-submittals.

3. Include a cover letter at front of binder that specifically responds to each “REVISE AND RE-SUBMIT COMMENT” or “REJECTED” comment by number. Example responses would include the following:
   a. RESPONSE: “Please see attached re-submittal.”
   b. RESPONSE: “Will be re-submitted at a latter date.”
   c. RESPONSE: “Requirement for (xxxxxx) was deleted in Addendum No. 2.”
   d. RESPONSE: “Exception requested based on Section xx, Paragraph x.x.x.

E. These paragraphs related to Mechanical submittal data supersede any conflicting requirements contained in Division 01 sections.

1.13 CONTRACTOR CERTIFICATION OF SUBMITTAL DATA

A. The Contractor shall provide the following certification with all submittal data furnished to the Owner’s Representative for review and comment.

   Project Title:

   Description of Submittal Data:

   This is to certify that the above-described submittal data has been reviewed and is approved for compliance with the Contract Documents, manufacturer's recommendation, adequacy, clearances, code compliance, safety, and coordination with other trades and/or work except as follows: (list “none” or itemize and explain). In addition, the Contractor shall submit to the Owner's Representative a signed statement from each representative certifying as follows:

   “I certify that the materials and/or equipment listed below have been personally inspected by the undersigned authorized manufacturer's representative and is properly installed and operating in accordance with the manufacturer's recommendations and are asbestos free.”

   Name and Company

1.14 ACCEPTANCE OF MATERIALS AND EQUIPMENT

A. All equipment installed on this project shall have **local (within 125 miles)** representation, local factory-authorized service, and a local stock of repair parts. This requirement is essential and will be strictly reviewed by the Owner's Representative prior to concurrence with the Contractor's approval for all submittals covered by Mechanical sections of this Specification.

B. NOTICE: The Contractor is responsible for providing materials and equipment that conform to the requirements of the project manual in every respect unless a deviation has been “accepted” in writing. Removal of any nonconforming materials and equipment and the replacement with conforming materials and equipment shall be at the Contractor's sole expense, regardless of when nonconformance was discovered.
C. Approval of materials and equipment shall be based on manufacturer’s published data and shall be tentatively subject to the submission of complete shop drawings which comply with the contract documents. Approval is also dependent upon the existence of adequate and acceptable clearances for entry, servicing, and maintenance.

D. Approval of materials and equipment under this provision shall not be construed as authorizing any deviations from the specifications, unless the attention of the Owner’s Representative has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.

E. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of approved manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.

1.15 SHOP DRAWINGS

A. As soon as practicable after the award of contract and approval of materials and equipment, but prior to installation, complete and detailed shop drawings of the following shall be submitted for review and comment:
   1. Equipment arrangements.
   2. Duct layouts.
   3. Piping layouts.
   4. Layouts of equipment spaces indicating ductwork and piping larger than 2 inches.
   5. Typical fittings and connections.
   7. Factory-fabricated equipment and materials.
   8. Anchors.
   9. Control.
   10. Interlock.
   11. Sprinkler locations.
   12. Other details as directed by the Owner’s Representative. Composite drawings of areas requiring coordination between trades shall be provided and expedited to eliminate conflicts and to ensure maximum cooperation and work progress.

B. Work performed without benefit of reviewed and approved shop drawings will not be recommended for payment by the Engineer until such time as the shop drawings are submitted, reviewed, and approved. Any work performed without the benefit of reviewed and approved shop drawings may require removal, relocation, and/or replacement at the Contractor’s sole expense in order to resolve conflicts between the various systems and provide the performance specified.

C. All installation of equipment, fixtures, terminal devices, etc. shall be made in accordance with approved composite shop drawings. The Contractor shall modify installation and relocate installed work to provide code clearances, service access, and eliminate conflict with other systems.

D. Submit one print of shop drawings for each area, floor, system, etc. The print will be marked with the A/E’s comments and returned to the Contractor. Contractor shall revise shop drawings, incorporate revisions in field and submit revised shop drawings at project close out.

1.16 SITE OBSERVATION

A. Site observation by the Architect, Engineer, and/or Owner’s Representative is for the express purpose of verifying compliance by the Contractor with the contract documents, and shall not be
1.17 SUPERVISION
A. In addition to the Superintendent required under the conditions of the contract, each subcontractor shall keep a competent superintendent or foreman on the job at all times.
B. It shall be the responsibility of each superintendent to study all plans and familiarize himself with the work to be done by other trades. He shall coordinate his work with other trades and, before material is fabricated or installed, make sure that his work will not cause an interference with another trade. Where interferences are encountered, they shall be resolved at the jobsite by the superintendents involved. Where interferences cannot be resolved without major changes to the plans, the matter shall be referred to the Owner’s Representative for comments.

1.18 OPERATION PRIOR TO COMPLETION
A. When any piece of mechanical equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation and has the written permission of the Owner’s Representative to do so. The warranty period shall not commence, however, until such time as the equipment is operated for the beneficial use of the Owner or date of substantial completion, whichever occurs first.
B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, properly adjust, and complete all deficiency list items before final acceptance by the Owner. The date of acceptance and the start of the warranty may not be the same date.

1.19 MANUFACTURER’S RECOMMENDATIONS
A. The manufacturer’s published directions shall be followed in the delivery, storage, protection, installation, piping, and wiring of all equipment and material. The Contractor shall promptly notify the Owner’s Representative, in writing, of any conflict between the requirements of the contract documents and the manufacturer’s directions, and shall obtain the Owner’s Representative’s comments before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer’s directions or applicable comments from the Owner’s Representative, he shall bear all costs arising in connection with the correction of such deficiencies.

1.20 CHECKING AND TESTING MATERIALS AND/OR EQUIPMENT
A. Before final acceptance of the work, an authorized representative of the manufacturer of the installed materials and/or equipment shall personally inspect the installation and operation of his materials and/or equipment to determine that it is properly installed and in proper operating order. Testing and checking shall be accomplished during the course of the work where required by work being concealed, and at the completion of the work otherwise. In addition, the Contractor shall submit to the Owner’s Representative a signed statement from each representative certifying as follows:

“I certify that the materials and/or equipment listed below have been personally inspected by the undersigned authorized manufacturer’s representative and is properly installed and operating in accordance with the manufacturer’s recommendations and are asbestos free.”
B. Check inspections shall include plumbing, heating, air conditioning, ventilating, mechanical control and electrical equipment, and such other items hereinafter specified or specifically designated by the Owner's Representative.

1.21 OPERATING AND MAINTENANCE INSTRUCTION

A. The Contractor shall prepare for the owner's manual hereinafter specified complete sets of operating and maintenance instructions, system piping, valving, control and interlock diagrams, manuals, parts lists, etc. for each item of equipment. These are to be assembled as hereinafter specified for owner's manual.

B. In addition, the Contractor shall provide the service of a competent engineer or a technician acceptable to the Owner's Representative to instruct a representative of the Owner in the complete and detailed operation of all equipment and systems. These instructions shall be provided for a period of sufficient duration to fully accomplish the desired results. Upon completion of these instructions, a letter of release will be required, acknowledged by the Owner, stating the dates of instruction and personnel to whom instructions were given.

C. Additional diagrams, operating instructions, etc. shall be provided as specified hereinafter in the other sections of these specifications.

1.22 MATERIAL AND EQUIPMENT SCHEDULES

A. Contractor shall refer to both drawings and specification for schedules. Where reference is made to items "scheduled on drawings" or "scheduled in specifications," same shall include schedules contained in both the drawings and the specifications. The Contractor's attention is directed to the various specification sections and drawings for schedules.

1.23 APPLICABLE CODES AND STANDARDS

A. The installation shall meet the minimum standards prescribed in the latest editions of the following listed codes and standards, which are made a part of these specifications, except as may be hereinafter specifically modified in these specifications and associated drawings.

1. National Fire Protection Association Standards (NFPA):
   NFPA 10 - Portable Fire Extinguishers
   NFPA 54 - National Fuel and Gas Code
   NFPA 70 - National Electrical Code
   NFPA 90A - Air Conditioning Systems
   NFPA 255 - Method of Test of Surface Burning Characteristics of Building Materials

   15-78 - Safety Code for Mechanical Refrigeration
   A117.1 - Handicapped Code

3. American Society of Mechanical Engineers (ASME): Section IV, V, CSD

4. Air Conditioning and Refrigeration Institute Standards (ARI): All standards related to refrigeration and air conditioning equipment and piping furnished under these specifications.

5. American Water Works Association (AWWA): All applicable manuals and standards.


7. Air Moving and Conditioning Association (AMCA): All applicable manuals and standards.

10. Occupational Safety and Health ACT (OSHA): National Sanitation Foundation - Standard No. 2
11. American Society of Heating, Refrigeration, and Air conditioning Engineers (ASHRAE): ASHRAE 90.1
13. American Gas Association (AGA)
14. Underwriters Laboratories, Inc. (UL)
15. Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS)
16. Applicable Local and State Building Codes (International Building Codes, as amended):
17. Applicable Local and State Mechanical Code (International Mechanical Code, as amended).

B. All materials and workmanship shall comply with all applicable city, state, and national codes, specifications, and industry standards. All materials shall be listed by the Underwriters Laboratories, Inc. as conforming to its standards and so labeled in every case where such a standard has been established for the particular type of material in question.

C. 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 Owner's Representative in writing of said discrepancies and apply for an interpretation. Should the discovery and notification occur after the execution of a contract, any additional work required for compliance with said regulations shall be paid for as covered by Division 1 of these contract documents, providing no work or fabrication of materials has been accomplished in a manner of noncompliance. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules, and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations.

1.24 DEFINITIONS
A. Refer to the condition of the contract for Division 1 for additional requirements regarding definitions.

B. Where “as required” or “as necessary” is used in these specifications or on the drawings, it shall mean “that situations exist that are not necessarily described in detail or indicated that may cause the Contractor certain coordination requirements in performing the work described or indicated. These coordination requirements entail the normal coordination activities expected of the Contractor where multiple trades are involved and new or existing construction causes deviations to otherwise simplistic approaches to the work to be performed. The term shall not be interpreted to permit an option on the part of the Contractor to achieve the end result.”

C. Where “and/or” is used in these specifications or on the drawings, it shall mean “that situations exist where either one or both conditions occur or are required and shall not be interpreted to permit an option on the part of the Contractor.

1.25 FINAL INSPECTION
A. Refer to Division 1 for additional requirements for final inspection.
B. It shall be the responsibility of the Contractor to personally conduct a careful inspection, assuring himself that the work on the project is ready for final acceptance and developing his own “punchlists,” before calling upon the Owner's Representative to make a final inspection. Failure of the Contractor to conduct such inspections and provide the Owner's Representative with a copy of his “punchlists” prior to the final inspection shall be adequate cause for the Owner's Representative to cancel any Contractor-requested final inspection.

C. In order not to delay final acceptance of the work, the Contractor shall conduct his own “final inspections” prior to requesting the Owner's Representative to “final” the project; will have all necessary bonds, guarantees, receipts, affidavits, etc. called for in the various articles of this specification prepared and signed in advance; and together with a letter of transmittal listing each paper included, shall deliver the same to the Owner’s Representative at or before the time of said final inspection. The Contractor is cautioned to check over each bond, receipt, etc. before preparing same for submission to see that the terms check with the requirements of the specifications.

D. The final inspection will be made jointly by the Owner's Representative and the Owner.

1.26 REQUIREMENTS FOR FINAL ACCEPTANCE

A. Requirements for final acceptance shall include but not be limited to the Contractor accomplishing the following:

1. Construction: Complete all construction.
2. Deficiency Lists: Correct all deficiencies listed at time of Substantial Completion.
3. Owner's Manual: Submit at least 30 days prior to final acceptance on (1) copy of the owner's manual for the Owner's Representative's review and comments. Following acceptance, prepare three (3) copies of bound and indexed owner's manual, to be delivered at the time of final acceptance, which shall include but not be limited to the following:
   a. System operating instructions.
   b. System control drawings.
   c. System interlock drawings.
   d. System maintenance instructions.
   e. Manufacturers’, suppliers’, and subcontractors' names, addresses, and telephone numbers, both local representatives and manufacturers’ service headquarters.
   f. Equipment operating and maintenance instructions and parts lists.
   g. Manufacturer’s certifications (see Checking and Testing Materials and/or Equipment, this section).
   h. Contractor's warranty.
   i. Acceptance certificates of authorities having jurisdiction.
   j. Log of all tests made during course of work.
   k. Owner's acknowledgment of receipt of instruction, enumerating items in owner's manual.
   l. List of manufacturers’ guarantees executed by the Contractor.
   m. Certified performance curves.
   n. Balance and performance test reports.
   o. Owner's acknowledgment of items of equipment or accessories indicated or specified to be turned over to Owner.

4. Instructions:
   a. Verbal, as herein specified.
   b. Posted, framed under glass or plastic laminated:
      1) System operating instructions.
      2) System control drawings.
      3) System interlock drawings.

5. Record Drawings: Deliver the specified record drawings to the Owner's Representative.
1.27 RECORD DRAWINGS

A. The Contractor shall maintain a set of contract drawings (black-line prints) at the jobsite on which he shall indicate the installed (as-built) locations of the following:
   1. Equipment
   2. Main lines of piping and ductwork.
   3. Dimensional locations (including depth) of all underground piping, valves and conduits.

B. Drawings shall be used for construction reference and shall not leave the field office of the jobsite.

C. Drawings shall include all addenda, ASI’s, Change Orders, and existing conditions and equipment that are not reflected in the original contract drawings.

D. Upon completion of work, the Contractor shall obtain CAD files of the contract drawings from the Owner’s Representative and transfer the above as-built information into these files. The as-built files shall be permanently marked “RECORD DRAWINGS” and printed on full-size Mylar sheets. Upon completion, the CAD files shall be transferred to CD in AutoCAD 2007 format. Both the CAD files CD and Mylar drawings shall be submitted to the Owner's Representative as part of the Close-out Submittals.

E. Refer to Division 1 paragraph entitled “Record Documents” for additional requirements.

1.28 ALLOWANCES

A. Refer to Division 1 for allowances.

1.29 ALTERNATE PROPOSALS

A. Alternate proposals are summarized in Division 1 and on the bid proposal form. Refer to all sections of the specifications and the drawings to determine the exact extent and scope of the various alternate proposals as each pertains to the work of the various trades.

1.30 WARRANTY

A. General: All work performed (including equipment and materials furnished) under the various sections of these specifications shall be 100% warranted, for a period of one (1) year from the date of final acceptance thereof, against defective materials, design, and unauthorized substitution. Upon receipt of note of failure of any part of the guaranteed equipment and/or facilities during the guaranty period, the affected part(s) or facilities shall be replaced promptly with new parts, etc. by and at the expense of the Contractor. Further, the Contractor shall properly obtain, execute, and forward any and all manufacturer’s warranties on equipment furnished under the Contract. Refer to Division 1 for additional requirements.

B. Extended Period: The Contractor shall provide all extended time warranties available from the manufacturer of the equipment provided as standard at no additional cost. This includes all extended warranties where specified with certain equipment as directed in other sections of this Specification.

PART 2 - PRODUCTS

2.1 MATERIALS AND WORKMANSHIP
A. All materials, unless otherwise specified, shall be current United States manufacture, new, free from all defects, and of the best quality. Foreign goods specifically approved for use by the Owner's Representative prior to bidding may be furnished.

B. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall present a neat, precise appearance.

C. The responsibility for the furnishing and installation of the proper mechanical equipment and/or material as intended rests entirely upon the Contractor. The Contractor shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

2.2 FLAME SPREAD AND SMOKE DEVELOPED PROPERTIES OF MATERIALS

A. Duct coverings, duct linings, vapor barrier facings, tapes, adhesives, core materials, insulation, jackets, piping (of any sort), and other materials in concealed locations, including any above-ceiling area, shall have a flame spread rating not over 25 without evidence of continued progressive combustion and a smoke developed rating no higher than 50. Flame spread and smoke developed ratings shall be in accordance with NFPA Standard No. 255.

2.3 BEARINGS

A. All ball bearings shall be of radial and/or thrust type, and enclosed in a dust and moisture-proof housing.

2.4 MOTORS

A. The Contractor shall provide all motors required for equipment supplied under each portion of the work. Motors shall be premium efficiency and be built in accordance with the latest ANSI, IEE, and NEMA standards, shall be fully coordinated with the equipment served, shall be of sizes and electrical characteristics scheduled.

2.5 STARTING EQUIPMENT

A. Each motor shall be provided with proper starting equipment. This equipment, unless hereinafter specified or scheduled to the contrary, shall be provided by the trade furnishing the motor. All motor starting equipment provided by any one trade shall be of the same manufacture unless such starting equipment is an integral part of the equipment on which the motor is mounted.

2.6 LOW VOLTAGE (CONTROLS/THERMOSTAT) WIRING

A. All low voltage wiring installed by the Mechanical Contractor, Electrical Contractor or Controls Vendor shall be run in a neat and workmen like manner, parallel and perpendicular to building lines on J-Hooks (above ceiling grid only). Plenum rated cable shall be installed above ceilings. All other locations (exposed, Mechanical Rooms, outdoors or above hard lid ceiling) should be installed in conduit.

2.7 SLEEVES, INSERTS, AND FASTENINGS

A. General: Proper openings through floors, walls, roofs, etc. for the passage of piping, ductwork, conduits, etc. shall be provided. All piping and conduit through floors and piping through walls must pass through sleeves except soil pipe installed under concrete slabs-on-fill, and pipe and
conduit that is cast-in-place. Sleeves shall be set in new construction before concrete is poured, as cutting holes through any part of the concrete will not be permitted unless acceptable to the Owner's Representative.

B. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve 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 in diameter and larger.
   3. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.

   1. Assemble and install mechanical sleeve seals according to manufacturer’s written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.

D. Sleeves: The minimum clearance between horizontal pipe, including insulation where applicable, and sleeve shall be 1/4 inch, except that the minimum clearance shall be 2 inches where piping contacts the ground. Sleeves through floors shall extend 3/4 inch above the floor; sleeves through walls and partitions shall be installed flush with exposed surfaces.

E. Materials: Install sleeves large enough to provide 1/4” annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   1. Steel Pipe Sleeves: For pipes smaller than 6-inch NPS.
   2. Steel, Sheet-Metal Sleeves: For pipes 6-inch NPS and larger, penetrating gypsum-board partitions.
   3. 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.
      a) Seal space outside of sleeve fittings with non-shrink, nonmetallic grout.

F. Inserts: Suitable concrete inserts for pipe, conduit, and equipment hangers shall be set and properly located for all piping, conduit, and equipment to be suspended from concrete construction.

G. Fasteners: Fastening of pipes, conduits, etc. in the building shall be as follows:
   1. To wood members: by wood screws.
   2. To masonry and concrete: by threaded metal inserts, metal expansion screws, or toggle bolts, whichever is appropriate for the particular type of masonry or concrete.
   3. To steel: machine screws or welding (when specifically permitted or directed), or bolts. **NOTE: Under no circumstances will the use of plastic anchors or plastic expansion shields be permitted for any purpose whatsoever.**

H. Ratproofing: The open space around all piping, ductwork, etc. passing through the ground floor and/or exterior walls shall be ratproofed in a manner acceptable to the Owner's Representative.

I. Weatherproofing: The annular space between a pipe and its sleeve in exterior walls or through floor to below grade shall be filled with polyurethane foam rods 50% greater in diameter than the space as backing and fill material and made watertight with a permanent elastic polysulfide compound. Seal both surfaces of wall or floor with a fire-resistant sealant.
J. Air Plenums: The space around piping, ductwork, etc. passing through an air plenum shall be made airtight in a manner acceptable to the Owner's Representative. The sealant used must be fire resistant.

2.8 FIRE AND SMOKE PARTITION, WALL, AND/OR FLOOR PENETRATIONS

A. Pipe, ductwork, conduit, etc. shall pass through fire- or smoke-rated floors, partitions, walls, or other barriers within a UL-listed assembly which shall maintain the rating of the applicable wall, floor, partition, or barrier.

B. The Contractor shall review the architectural and structural drawings and determine the location of the fire-rated building elements. Where these elements are penetrated, UL-listed fire-rated penetration assemblies approved by the local authority shall be provided in accordance with the manufacturer's instructions to obtain the required rating.

2.9 METAL BUILDING SYSTEMS/MECHANICAL-ELECTRICAL SUPPORTS

A. Metal building systems are required to be designed by the manufacturer to accommodate and support the mechanical systems indicated on the mechanical drawings and specified in Mechanical specifications.

B. The metal building systems manufacturer is required to provide the following:
   1. Framed openings through the roofs with supports, roof curbs, and flashings for roof-mounted equipment, fans, vents, and air intakes.
   2. Structural support for piping, conduits, and suspended equipment consisting of beam, joists, purlins, and/or blocking above and perpendicular to pipe routes and equipment hangers at intervals not to exceed 8 feet.
   3. Structural support for suspended ceilings, diffusers, grilles, light fixtures including associated raceways and ductwork.

C. The mechanical trade shall:
   1. Provide all routes, weights, installation heights, opening locations, etc. for all equipment, piping, vents, etc. to the metal building system manufacturer and coordinate requirements for structural supports, hangers, attachments, etc. with the metal building systems manufacturer.
   2. Provide all supporting devices (hangers, attachments, brackets, cross beams, etc.) to attach to the metal building structural system.

2.10 FOUNDATIONS / HOUSEKEEPING PADS

A. General: All special foundations and supports required for the proper installation of equipment and pipe shall be provided as hereinafter specified and under the section of the specifications covering the equipment, unless otherwise indicated on the drawings.

B. All mechanical equipment shall receive concrete housekeeping pads unless otherwise noted. Equipment to receive pads are to include (but not limited to): air handlers, fan-coils, condensing units, boilers, water heaters, water softeners, expansion / compression tanks, filter feeders, water treatment equipment, air compressors, fans, pumps (in addition to inertia bases where required), chillers, surge tanks, deareators, etc.

C. Concrete foundations for the support of equipment such as floor-mounted pumps, fans, etc. shall be not less than 5½ inches high and not less than 4 inches larger (in both directions) than supported unit, unless otherwise noted and shall be poured in forms built of new dressed lumber. All corners of the foundations shall be neatly chamfered by means of sheet metal or triangular
wood strips nailed to the form. Pads shall not be laid out directly against walls or structures. 2 inches shall be left available for pad form work. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Allow 1 inch below the equipment bases for alignment and grouting (where applicable). Foundations for equipment located on the exterior of the building shall be provided as indicated. Foundations shall be constructed in accordance with approved shop drawings and shall be reinforced with #4 bars at 12 inches on center both ways (minimum).

D. Pipe and Conduit Support: All pipes and conduits throughout the building, both horizontal and vertical, shall be adequately supported from the construction to line of grade, with proper provision for expansion, contraction, vibration elimination, and anchorage. Vertical pipes and conduits shall be supported from floor lines with riser clamps sized to fit the lines and to adequately support their weight. At the bases of lines, where required for proper support, provide anchor base fittings or other approved supports.

2.11 ACCESS DOORS

A. General: Provide access doors for all serviceable mechanical appurtenances (valves, trap primers, shock arresters, volume dampers, fire/smoke dampers, actuators, sensors, etc.) in inaccessible locations. Such locations include gypsum, brick and CMU ceilings and walls.

B. Location of panels shall be carefully coordinated with other Exposed Devices as described in earlier paragraphs.

C. Manufacturers shall be Inland-Milcor, Bilco, Miami Carey, or approved equal. Unless indicated otherwise, use panels equal to Milcor Style M for masonry and drywall construction, equal to Milcor Style K for plastered masonry walls and ceilings. Stainless steel panels shall be used in ceramic tile or glazed structural tile.

D. Minimum construction features include 14-gage frame and door, continuous hinges, cam-style latch and 10x10" unobstructed opening size.

E. UL labeled when in fire-rated construction, one and one-half hour rating.

F. Access doors located outside, in restrooms or in a moisture-laden environment (dressing area, shower area, lockers, etc.) shall be stainless steel construction.

G. Equipment access doors shall be of sufficient size to remove/replace equipment and provide routine maintenance as necessary, unless otherwise noted. Doors shall be set flush with adjacent finish surfaces. Exterior doors shall be provided with cylinder locks.

H. Access doors into ductwork shall be 14-gage insulated galvanized steel with 16-gage galvanized gasketed steel frame and cam-type locks. Ductwork access door shall be a minimum of 18" × 18" in size.

2.12 FLOOR AND CEILING PLATES

A. Except as otherwise noted, provide one-piece chrome-plated brass floor and ceiling plates (or escutcheons) around all pipes, conduits, etc. passing through walls, floors, or ceilings in any spaces, except underfloor and attic spaces. Plates shall be sized to fit snugly against the outside of the pipe or against the outside of insulation on lines which are insulated, and positively secured to such pipe or insulation. Plates will not be required for piping where pipe sleeves extend % of an inch above finish floor and are concealed. Plates shall be one piece.
PART 3 - EXECUTION

3.1 SPACE AND EQUIPMENT ARRANGEMENT

A. The size of mechanical equipment indicated on the drawings is based on the dimensions of a particular manufacturer. While other manufacturers will be acceptable, it is the responsibility of the Contractor to determine whether the equipment he proposes to furnish will fit in the space. Shop drawings shall be prepared when required by the Owner’s Representative to indicate a suitable arrangement.

B. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

3.2 LARGE APPARATUS

A. 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 and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly, completely protected from damage as hereinafter specified.

3.3 PROTECTION

A. The Contractor shall take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of work. This shall include the erection of all required temporary shelters and supports to adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the uncompleted building with tarpaulins or other protective covering. Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.

B. The Contractor shall protect existing facilities, the work of others, and the premises from any and all damages that may be made possible by the execution of work.

C. Equipment and materials shall be protected from rust both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these specifications.

3.4 COOPERATION BETWEEN TRADES AND WITH OTHER CONTRACTORS

A. Each trade, subcontractor, and/or Contractor must work in harmony with the various trades, subcontractors, and/or Contractors on the job as may be required to facilitate the progress to the best advantage of the job as a whole. Each trade, subcontractor, and/or Contractor must pursue its work promptly and carefully so as not to delay the general progress of the job. This Contractor shall work in harmony with Contractors working under other contracts on the premises.

B. It shall be the responsibility of each trade to cooperate fully with the other trades on the job to help keep the jobsite in a clean and safe condition. At the end of each day’s work, each trade shall properly store all of its tools, equipment, and materials and shall clean its debris from the job. Upon the completion of the job, each trade shall immediately remove all of its tools, equipment, any surplus materials, and all debris caused by its portion of the work.
3.5 PRECEDENCE OF MATERIALS AND COORDINATION OF WORK

A. These specifications and the accompanying drawings are intended to cover systems which will not interfere with the structural design of the building, which will fit into the several available spaces, and which will ensure complete and satisfactory systems. Each subcontractor and/or trade shall be responsible for the proper fitting of his material and apparatus into the building.

B. The work of the various trades shall be performed in the most direct and workmanlike manner without hindering or handicapping the work of other trades. Piping interferences shall be handled by giving precedence to pipe lines which require a stated grade for proper operation. Where space requirements conflict, the following order or precedence shall, in general, be observed:

   1. Building lines.
   2. Structural members.
   3. Light fixtures.
   4. Soil and drain piping.
   5. Condensate drains.
   6. Vent piping.
   7. Supply, return, and outside air ductwork.
   8. Exhaust ductwork.
   9. HVAC water and steam piping.
  10. Steam condensate piping.
  11. Fire protection piping.
  12. Natural gas piping.
  13. Domestic water (cold and hot).
  15. Electrical conduit.

C. The light fixture grid layout as indicated on the drawings must be maintained. This Contractor shall refer to all light fixture plans and details indicated on the drawings and shall coordinate the location of dampers, supply grilles, return air grilles, sprinkler heads, etc. with the location of the light fixtures to assure proper access to all items in a manner acceptable to the Owner's Representative.

D. The electrical trades shall locate all junction boxes, pull boxes, conduits, etc. to avoid interference with the diffusers, dampers, grilles, etc. hereinbefore mentioned. The mechanical trades shall furnish to all other trades copies of approved ductwork shop drawings to assist in the coordination of the rough-in and installation of all items of work.

3.6 CONNECTIONS FOR OTHERS

A. This Contractor shall rough-in for and make all water, sewer, electrical, etc. connections to all fixtures, equipment, machinery, etc. provided by others in accordance with detailed roughing-in drawings provided by the equipment suppliers, by actual measurements of the equipment connections, or as detailed.

B. After the equipment is set in place, this Contractor shall make all final connections and shall provide all required pipe, fittings, valves, traps, connectors, etc.

C. Provide all air gap fittings required, using materials hereinbefore specified. In each water line serving an item of equipment or piece of machinery, provide a shutoff valve. On each drain without integral trap provide a suitable trap.

D. All pipe fittings, valves, traps, etc. exposed in finished areas and connected to chrome-plated lines provided by others shall be chrome-plated to match.

E. Provide all sheet metal ducts, transition pieces, etc. required for a complete installation of equipment provided by others.
3.7 INSTALLATION METHODS

A. Where to Conceal: All pipes and conduits shall be concealed in pipe chases, walls, furred spaces, below suspended floors, or above the ceilings of the building unless otherwise indicated.

B. Where to Expose: In mechanical rooms, janitor’s closets tight against pan soffits in exposed Tee structures, or storage spaces, but only where necessary, piping and conduit may be run exposed. All exposed piping and conduit shall be run in the neatest, most inconspicuous manner, and parallel or perpendicular to the building lines.

C. Support: All piping and conduit shall be adequately and properly supported from the building structure by means of hanger rods or clamps to walls as herein specified.

D. Maintaining Clearance: Where limited space is available above the ceilings and below concrete beams or other deep projections, pipe and conduit shall be sleeved through the projection where it crosses, rather than hung below them, in a manner to provide maximum above-floor clearance. Sleeves shall be as herein specified. Approval shall be obtained from the Owner’s Representative for each penetration.

E. All pipe, conduits, etc. shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All ducts, pipes, and conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that they shall be sloped to obtain the proper pitch. Piping and ducts run in furred ceilings, etc. shall be similarly installed, except as otherwise shown. Conduits in furred ceilings and in other concealed spaces may be run at angles to the construction but shall be neatly grouped and racked indicating good workmanship. All conduit and pipe openings shall be kept closed until the systems are closed with final connections.

F. Special Requirements:
   1. There shall be no pipe joints nearer than 12 inches to a wall, ceiling, or floor penetration unless pipe joint is a welded or mechanically-coupled-type joint.
   2. The Contractor shall study all construction documents and carefully lay out all work in advance of fabrication and erection in order to meet the requirements of the extremely limited spaces. Where conflicts occur the Contractor shall meet with all involved trades and the Owner’s Representative and resolve the conflict prior to erection of any work in the area involved.
   3. All piping not directly buried in the ground shall be considered as “interior piping.”
   4. Prior to the installation of any ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the Owner’s Representative so that arrangements can be made for an inspection of the above-ceiling area about to be “sealed off.” The Contractor shall give as much advance notice as possible up to ten (10) working days, but in no case less than five (5) working days.
   5. The purpose of this inspection is to verify the completeness and quality of the installation of the air conditioning systems, the plumbing systems, and any other special above-ceiling systems such as pneumatic tube. The ceiling supports (tee bar or lath) should be in place so that access panel and light fixture locations are identifiable and so that clearances and access provisions may be evaluated.
   6. No ceiling material shall be installed until the deficiencies listed from this inspection have been corrected to the satisfaction of the Owner’s Representative.

3.8 CUTTING AND PATCHING

A. General: Cut and patch walls, floors, etc. resulting from work in existing construction or where made necessary by failure to provide proper openings or recesses in new construction.
B. Methods of Cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Owner’s Representative. Impact-type equipment will not be used except where specifically acceptable to the Owner’s Representative. Openings in concrete for pipes, conduits, outlet boxes, etc. shall be core drilled to exact size. **Determine location of embedded conduit and reinforcing bars prior to cutting.**

C. Restoration: All openings shall be restored to “as-new” condition under the appropriate specification section for the materials involved, and shall match remaining surrounding materials and/or finishes.

D. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc. shall be of the proper size and shape, and shall be installed in a manner acceptable to the Owner’s Representative.

E. Plaster: All mechanical work in area containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.

F. Weakening: No cutting, boring, or excavating which will weaken the structure shall be undertaken.

3.9 ROOF PENETRATIONS AND FLASHING

A. Pipe and conduit ducts, pitch pockets, curb bases, and flashing compatible with the roofing installation shall be provided for roof penetrations. Provide framing or other support around all openings through roof as required to preserve the structural integrity of the roof system and make the penetration weathertight.

B. Provide 30-inch round or square flashing acceptable to the roofing trades at all roof and deck drain and sleeve flashing locations.

C. Roof curbs for all roofs except standing seam metal roofs shall be provided by the equipment supplier supplying the roof-mounted equipment, etc., and such curbs shall be installed by the roofing trades. Contractor shall coordinate all roof curb requirements with all trades and the roofing trades at the earliest possible stage of the project.

D. Roof curbs for standing seam metal roofs shall be provided by the roofing trades. Curb base size, height, and type shall be coordinated with the roofing trades at the earliest possible stage of the project.

E. Flashing for pipe and conduit penetrations of standing seam metal roofs shall be provided and installed by the roofing trades.

3.10 EXCAVATING AND BACKFILLING

A. Perform trenching, excavating, backfilling for mechanical work as set forth below.

B. Depth of excavation to provide a minimum of 3 feet above top of pipe. Excavation to be carried to a depth of at least 6 inches below bottom of pipe elevation. Fill below pipe (6 inches), around pipe, and a minimum of 12 inches above pipe with sand of Class "B" crushed stone tamped firm and even. Separate topsoil during excavation. Final layer of dirt (12 inches minimum) to be topsoil. Trenches to be at least 18 inches wider than pipe with batter boards placed every 25
feet. Backfilling shall be done to exclude use of rock or stone above sand or Class "B" crushed stone.

3.11 TESTS AND INSPECTIONS

A. General: The Contractor shall make all tests deemed necessary by the inspection departments of the authority having jurisdiction, Board of Underwriters, etc. He shall provide all equipment, materials, and labor for making such tests. Fuel and electrical energy for system operational tests following beneficial occupancy by the Owner will be paid for by the Owner.

B. Other: Additional tests specified hereinafter under the various specifications sections shall be made.

C. Notification: The Owner's Representative shall be notified at his office 36 hours prior to each test and other specifications requirements requiring action on the part of the Owner, Architect, Engineer, and/or Owner's Representative.

D. Test Logs: All tests which the Contractor conducts shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel, description and extent of system tested, test conditions, test results, specified results, and any other pertinent data. Data shall be delivered to the Owner's Representative as specified under “Requirements for Final Acceptance.”

E. Inspections: In general, an inspection by the Owner's Representative shall be required prior to closing up any work and prior to beneficial occupancy or final project completion. The closing up of work includes, but is not limited to, pipe and conduit installations prior to backfilling; mechanical, electrical, and fire protection work prior to placement of concrete; or closing up walls and overhead mechanical, electrical, and fire protection work prior to installation of the ceiling.

3.12 CLEANING AND PAINTING

A. Thoroughly clean and touch up the finish on all parts of the materials and equipment. Exposed parts in equipment rooms, and all other spaces except sealed chases and attics shall be thoroughly cleaned of cement, plaster, and other materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out.

B. Exposed metal work which is not galvanized shall be carefully brushed down with steel brushes to remove rust and other spots and left smooth and clean and then painted with a suitable rust resistant primer. Exposed metal work includes work exterior to the building; exposed in mechanical or electrical equipment rooms and storage rooms; and other areas where occupants could see the work, whether normally occupied or not.

C. All other painting shall be accomplished under the Painting Section of Division 9 of the specifications.

3.13 DISCHARGE OF WASTES FROM CONSTRUCTION SITE

A. The Contractor shall comply with all applicable provisions of local, state, and federal laws regarding the discharge of wastes into sewer and waterways. Special caution shall be exercised to prevent the discharge of wastes which contain oil, tar, asphalt, roofing compound, kerosene, gasoline, paint, mud, cement, lime, or other materials which would degrade the water quality of the receiving water course. The Contractor shall construct and maintain oil interceptors, settling basins, acid neutralization tanks, and/or other effective pollution countermeasures, as required by the Texas Water Quality Board.
END OF SECTION
SECTION 23 0513

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following basic mechanical materials and methods to complement other Mechanical Sections.
   1. Piping materials and installation instructions common to most piping systems.
   2. Concrete base construction requirements.
   3. Escutcheons.
   4. Dielectric fittings.
   5. Dielectric isolation tape
   6. Flexible connectors.
   7. Mechanical sleeve seals.
   8. Nonshrink grout for equipment installations.
   10. Installation requirements common to equipment specification sections.
   11. Mechanical demolition.
   12. Cutting and patching.
   13. Touchup painting and finishing.
   14. Access Doors

B. Pipe and pipe fitting materials are specified in mechanical piping system Sections, if applicable.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, 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 duct shafts.

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:
   2. CPVC: Chlorinated polyvinyl chloride plastic.
   3. NP: Nylon plastic.
   4. PE: Polyethylene plastic.
   5. PVC: Polyvinyl chloride plastic.
G. The following are industry abbreviations for rubber materials:
   1. CR: Chlorosulfonated polyethylene synthetic rubber.
   2. EPDM: Ethylene propylene diene terpolymer rubber.

1.3 SUBMITTALS

A. Product Data: For dielectric fittings, flexible connectors, access doors, solder/brazing material and mechanical sleeve seals.

B. Shop Drawings: Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.

C. Coordination Drawings: Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
   1. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
   2. Equipment and accessory service connections and support details.
   3. Fire-rated wall and floor penetrations.
   4. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
   5. Access panel and door locations

1.4 QUALITY ASSURANCE

A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

B. Equipment Selection: Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be approved in advance by appropriate Contract Modification for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

1.5 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 prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

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

1.6 SEQUENCING AND SCHEDULING

A. Coordinate Mechanical equipment installation with other building components.
B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

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

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces.

G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Dielectric Tape:
      a. Holdrite (#272-4).
   2. Metal, Flexible Connectors:
      a. Flexicraft Industries.
      b. Flex-Hose, Co., Inc.
      c. Grinnell Corp.; Grinnell Supply Sales Co.
      d. Mercer Rubber Co.
      e. Metraflex Co.
      f. Uniflex, Inc.
   3. Rubber, Flexible Connectors:
      a. General Rubber Corp.
      b. Mercer Rubber Co.
      c. Metraflex Co.
      d. Red Valve Co., Inc.
      e. Uniflex, Inc.
   4. Mechanical Sleeve Seals:
      a. Calpico, Inc.
      b. Metraflex Co.
      c. Thunderline/Link-Seal.

2.2 PIPE AND PIPE FITTINGS

A. Refer to individual Specification piping Sections for pipe and fitting materials and joining methods, if applicable.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
2.3 JOINING MATERIALS

A. Refer to individual Specification piping Sections for special joining materials not listed below, if applicable.

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 B32.
   1. ASTM B 32, 95/5 lead-free alloys. Include water–flushable and soluble flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8.
   1. BCuP Series: Copper-phosphorus alloys.
   2. BAg1: Silver alloy.

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: Manufacturer’s standard solvent cements for the following:
   1. CPVC Piping: ASTM F 493.
   2. PVC Piping: ASTM D 2564, medium bodied (bond). Include purple primer according to ASTM F 656.


J. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon-steel bolts and nuts.

K. Couplings: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.
   2. Followers: ASTM A 47 malleable iron or ASTM A 536 ductile iron.
   5. Finish: Enamel paint.

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, to prevent galvanic action and stop corrosion. Unions in first paragraph below are available in at least NPS 1/2 to NPS 2.

B. Dielectric Unions:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   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 Mechanical Products Group; Wilkins Water Control Products.

2. Description:
   a. Pressure Rating: 250 psig at 180 deg F.
   b. End Connections: Solder-joint copper alloy and threaded ferrous.
   c. Flanges in first paragraph below are available in at least NPS 1-1/2 to NPS 4.

C. Dielectric Flanges:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   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: 175 psig minimum.
   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, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Description:
   a. Nonconducting materials for field assembly of companion flanges.
   b. Pressure Rating: 150 psig.
   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, provide products by one of 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 noncorrosive, thermoplastic.

F. Dielectric Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Perfection Corporation; a subsidiary of American Meter Company.
   b. Precision Mechanical 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 noncorrosive, propylene.

2.5 DIELECTRIC ISOLATION TAPE

A. Tape to eliminate dissimilar metal contact: (equal to Holdrite #272-4)
   1. White Polyester Felt. Pressure sensitive adhesive rubber base (one side only).
   2. 4" width.

2.6 FLEXIBLE CONNECTORS

A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 125-psig minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:
   1. 2-Inch NPS and Smaller: Threaded.
   2. 2-1/2-Inch NPS and Larger: Flanged.
   3. Option for 2-1/2-Inch NPS and Larger: Grooved for use with keyed couplings.

B. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.

C. Rubber, Flexible Connectors: CR or EPDM elastomer rubber construction, with multiple plies of NP fabric, molded and cured in hydraulic presses. Include 125-psig minimum working-pressure rating at 220 deg F. Units may be straight or elbow type, unless otherwise indicated.

2.7 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe materials and size of pipe.
   2. Pressure Plates: Stainless steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.8 PIPING SPECIALTIES

A. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:
   1. Steel Sheet Metal: 0.0239-inch minimum thickness, galvanized, round tube closed with welded longitudinal joint.
   2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
   3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
   4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
      a. Underdeck Clamp: Clamping ring with set screws.
   5. Sleeve Fasteners: Manufactured, steel clips for securement during pour. Equal to B-line, BD40, BE-5-8 or BE-9-12.
B. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.
   1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
   2. OD: Completely cover opening.
   3. Cast Brass: One piece, with set screw. (split face acceptable for existing piping)

2.9 GROUT

A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.
   2. Design Mix: 5000-psig, 28-day compressive strength.

2.10 ACCESS DOORS

A. General: Provide access doors for all serviceable mechanical appurtenances (valves, trap primers, shock arresters, actuators, sensors, etcetera) in inaccessible locations. Such locations include gypsum, brick and CMU ceilings and walls.

B. Location of panels shall be carefully coordinated with other Exposed Devices as described in earlier paragraphs.

C. Manufacturers shall be Milcor, Mifab, or approved equal. Unless indicated otherwise, use panels equal to Milcor Style M for masonry and drywall construction, equal to Milcor Style K for plastered masonry walls and ceilings. Stainless steel panels shall be used in ceramic tile or glazed structural tile.

D. Minimum construction features include 16-gage frame and door, continuous hinges, cam-style latch and 10x10" unobstructed opening size.

E. UL labeled when in fire-rated construction, one and one-half hour rating.

F. Access doors located outside, in restrooms or in a moisture-laden environment (dressing area, shower area, lockers, etcetera) shall be stainless steel construction.

G. Equipment access doors shall be of sufficient size to remove/replace equipment and provide routine maintenance as necessary, unless otherwise noted. Doors shall be set flush with adjacent finish surfaces. All access doors shall be provided with cylinder locks. All access doors (MEP) shall have one (1) common key.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS AND APPLICATIONS

A. General: Install piping as described below, unless piping Sections specify otherwise. Individual piping Sections specify unique piping installation requirements.

B. General Locations and Arrangements: 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. All piping to be installed in compliance with current NEC required clearances.

D. Install manufactured isolation clamps at all dissimilar metal pipe supports. Install dielectric isolation tape (engineer approved) only when a manufactured isolation clamp is not available.

E. Install piping at indicated slope.

F. Install components with pressure rating equal to or greater than system operating pressure.

G. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.

H. Install piping free of sags and bends.

I. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.

J. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.

K. Install piping to allow application of insulation plus 1-inch clearance around insulation.

L. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

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

N. Install couplings according to manufacturer's written instructions.

O. 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 in Section "Penetration Firestopping" for firestop materials and installations.
   1. Fire-stop all sleeves at floor penetrations of multistory buildings including underfloor penetrations.

P. Verify final equipment locations for roughing-in.

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

R. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:
   1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
   2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
   5. 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:
      a. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
b. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
c. Align threads at point of assembly.
d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
e. 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.


7. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

8. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following:
   a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. CPVC Piping: ASTM D 2846 and ASTM F 493.
   c. PVC Pressure Piping: ASTM D 2672.
   d. PVC Nonpressure Piping: ASTM D 2855.

   a. Plain-End Pipe and Fittings: Use butt fusion.
   b. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.2 ESCUTCHEON REQUIREMENTS

A. Install escutcheons at pipe penetrations of walls, ceilings, and floors in finished areas.
   1. Escutcheons for New Piping:
      a. Piping exposed through floors and walls in finished areas: One piece, cast brass with polished chrome-plated finish with set screw. Deep escutcheons to be provided where standard depth will not fit.
      b. Escutcheons shall cover entire hole penetration.
      c. Escutcheon to be appropriately sized for pipe.
   2. Escutcheons for Existing piping:
      a. Piping exposed through floors and walls in finished areas: Split plate, cast brass with polished chrome-plated finish with set screw. Deep escutcheons to be provided where standard depth will not fit.
      b. Escutcheons shall cover entire hole penetration.
      c. Escutcheon to be appropriately sized for pipe.
   3. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.3 PIPE SLEEVE INSTALLATION REQUIREMENTS

A. Pipe sleeves are required at all through wall and floor penetrations.
   1. Sleeves are to be of the following material:
      a. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.
2. Sleeves are required for all through floor and wall penetrations. Sleeves to be set and poured in place (in slab applications), secure all sleeves with fasteners.

3. Sleeves to extend 2 inches past face of floor or wall. Pipe sleeve in finished areas to be flush with wall or floor for installation of escutcheon.

4. Install sleeves in new partitions, slabs, and walls as they are built.

5. 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 Section "Joint Sealants" for joint sealants.

6. 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 Section "Joint Sealants" for joint sealants.

7. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals specified in this Section.

8. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated. Seal annular space with water tight sealant. (equal to NP-1). All sleeves and penetrations to maintain rating of wall / floor. Seal pipe penetrations with fire-stopping materials.

9. Install sleeve materials according to the following applications:
   a. Sleeves for Piping Passing through Concrete Floor Slabs: galvanized steel pipe.
   b. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe sleeves.
      1) Extend sleeves 2 inches above finished floor level.
      2) 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 inches (50 mm) above finished floor level. Comply with requirements in Section "Sheet Metal Flashing and Trim" for flashing.

10. Sleeves for Piping Passing through Gypsum-Board Partitions:
    a. Galvanized-steel pipe sleeves.
    b. Exception: Sleeves are not required for water supply tubes and waste pipes for individual mechanical fixtures if escutcheons will cover openings.

11. Sleeves for Piping Passing through Concrete Roof Slabs: Reference details.

12. Sleeves for Piping Passing through Exterior Concrete Walls:
    a. Galvanized-steel pipe sleeves.
    b. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.

13. Sleeves for Piping Passing through Interior Concrete Walls:
    a. Galvanized-steel pipe sleeves.

14. Mechanical sleeve seals
    a. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building. Sleeves must be poured in place. Installation of sleeves after wall is constructed is not acceptable.
    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.

B. Piping Connections: Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping 2-inch NPS and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS or smaller threaded pipe connection.
   2. Install flanges, in piping 2-1/2-inch NPS and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

3.4 DIELECTRIC FITTING INSTALLATION

A. Install unions, in piping 2-inch NPS and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS or smaller threaded pipe connection.
B. Install flanges, in piping 2-1/2-inch NPS and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.

3.5 EQUIPMENT INSTALLATION – COMMON REQUIREMENTS

A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.
C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
E. Install equipment giving right of way to piping installed at required slope.

3.6 PAINTING AND FINISHING

A. Apply paint to exposed piping according to the following, unless otherwise indicated:
   1. Interior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
   2. Interior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
   5. Exterior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
B. Do not paint piping specialties with factory-applied finish.
C. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGE
A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

### 3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment (not to be used at pipe supports).

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.

### 3.9 DEMOLITION

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair cut surfaces to match adjacent surfaces.

### 3.10 CUTTING AND PATCHING

A. Disconnect, demolish, and remove Work specified in Mechanical Sections.

B. If pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.

C. Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.

D. Work Abandoned in Place: Cut and remove underground pipe a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.

E. Removal: Remove indicated equipment from Project site.

F. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

### 3.11 GROUTING

A. Install nonmetallic, nonshrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placing of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases to provide smooth bearing surface for equipment.
G. Place grout around anchors.

H. Cure placed grout according to manufacturer's written instructions.

END OF SECTION
SECTION 23 0529

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. This Section includes the following hangers and supports for plumbing system piping and
   equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe positioning systems.
   7. Equipment supports.

B. Related Sections include the following:
   1. Specification Section "Metal Fabrications" for structural-steel shapes and plates for
      trapeze hangers for pipe and equipment supports.
   2. Specification Section “Metal Ducts” for duct hangers and supports.

1.3 DEFINITIONS

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

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

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes capable of supporting combined weight of supported
   systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported
   equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts.
   3. Powder-actuated fastener systems.
   4. Pipe positioning systems.
B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
   2. Metal framing systems. Include Product Data for components.
   3. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

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

B. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 METAL COATING REQUIREMENTS:

A. All metal products shall have the following coatings:
   1. Wet/damp areas: hot dipped galvanized.
   2. Dry or conditioned areas: pre-galvanized.

2.3 STEEL PIPE HANGERS AND SUPPORTS

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

B. Manufacturers:
   1. AAA Technology & Specialties Co., Inc.
   2. Bergen-Power Pipe Supports.
   4. Carpenter & Paterson, Inc.
   5. Empire Industries, Inc.
   6. ERICO/Michigan Hanger Co.
   7. Globe Pipe Hanger Products, Inc.
   8. Grinnell Corp.
   9. GS Metals Corp.
   11. PHD Manufacturing, Inc.
   12. PHS Industries, Inc.
   13. Piping Technology & Products, Inc.
   14. Tolco Inc.
C. Galvanized, Metallic Coatings: Pre-galvanized (minimum thickness of 0.5 mils) or hot dipped (1.4 to 3.9 mil thickness).

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

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

2.4 TRAPEZE PIPE HANGERS

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

2.5 METAL FRAMING SYSTEMS

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

B. Manufacturers:
   2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
   3. GS Metals Corp.
   5. Thomas & Betts Corporation.
   6. Tolco Inc.
   7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

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

2.6 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig minimum, compressive-strength insulation insert with a sheet metal shield.

B. Manufacturers:
   1. Carpenter & Paterson, Inc.
   2. ERICO/Michigan Hanger Co.
   3. PHS Industries, Inc.
   4. Pipe Shields, Inc.
   5. Rilco Manufacturing Company, Inc.
   6. Buckaroos

C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with vapor barrier. **Wood inserts are not acceptable.**

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

E. Insulation-Insert Material for Hot Piping only, up to 3” diameter: Molded fiberglass block, 20 lbs/ft³ density, thermal conductivity of 0.30.

F. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
G. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

H. Insert Length: Extend 4 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.7 FASTENER SYSTEMS

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

1. Manufacturers:
   b. Empire Industries, Inc.
   c. Hilti, Inc.
   d. ITW Ramset/Red Head.
   e. MKT Fastening, LLC.
   f. Powers Fasteners.

2.8 PIPE POSITIONING SYSTEMS

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

B. Manufacturers:
   2. HOLDRITE Corp.; Hubbard Enterprises.
   3. Samco Stamping, Inc.

2.9 EQUIPMENT SUPPORTS

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

2.10 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars.
   2. Interior: Black steel.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
B. Comply with MSS SP-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 padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, 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 24, requiring clamp flexibility and up to 4 inches of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of 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 2.
  10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
  11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
  12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
  13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
  14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
  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 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 2 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 20, from single rod if horizontal movement caused by expansion and contraction might occur.
  19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side- 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.
J. 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. Thermal-Hanger Shield Inserts: For supporting insulated cold pipe. Wood inserts are not acceptable.

K. 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 absorb 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 absorb 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 absorb expansion and contraction of piping system from trapeze support.
   8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
      a. Horizontal (MSS Type 54): Mounted horizontally.
      b. Vertical (MSS Type 55): Mounted vertically.
      c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

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

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

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

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel 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 building structure; attaching to metal roof decks is not permissible.

B. 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 above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

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

F. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Specification Section "Plumbing Fixtures" for plumbing fixtures.

G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.


I. 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.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

N. Insulated Piping: Comply with the following:
   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 according to 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 thermal-hanger shield inserts on insulated piping with vapor barrier. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. **Shield Dimensions for Pipe:** Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

5. **Insert Material:** Length at least as long as protective shield.

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

O. **Insulated Ducts (Mineral Fiber Blanket).** Comply with the following:
   1. At all unistrut supports provide mineral fiber board insert in between ductwork and unistrut. Insert to extend 12” on both sides of unistrut, full length of strut. Extend blanket between structural insert.

3.3 **EQUIPMENT SUPPORTS**

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

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

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

3.4 **METAL 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 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 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.**

3.6 **PAINTING**

A. **Touch Up:** Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

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 23 0553
MECHANICAL IDENTIFICATION

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following mechanical identification materials and their installation:
   1. Equipment nameplates.
   2. Equipment markers.
   3. Equipment signs.
   4. Access panel and door markers.
   5. Pipe markers.
   6. Duct markers.
   7. Stencils.
   8. Valve tags.
   10. Warning tags.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted
   copies) to include in maintenance manuals. Reproduce on 8½ x 11 bond. Tabulate valve
   number, piping system, system abbreviation as shown on tag, room or space location of
   valve, and variations for identification. Mark valves intended for emergency shutoff and
   similar special uses. Indicate normal operating positions (open, closed, modulating, or
   balance).

1.4 QUALITY ASSURANCE
A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping
   Systems," for letter size, length of color field, colors, and viewing angles of identification
   devices for piping.

1.5 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 location of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.
PART 2 - PRODUCTS

2.1 GENERAL

A. Products specified are for applications referenced in other Mechanical sections. In addition to a factory installed equivalent nameplate, all equipment shall have an engraved equipment sign that matches the schedule tag name.

2.2 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
   1. Data:
      a. Manufacturer, product name, model number, and serial number.
      b. Capacity, operating and power characteristics, and essential data.
      c. Labels of tested compliances.
   2. Location: Accessible and visible.
   3. Fasteners: As required to mount on equipment.

B. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
   1. Data: Instructions for operation of equipment and for safety procedures.
   2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
   3. Thickness: 1/8 inch, unless otherwise indicated.
   4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.3 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Manufacturers standard preprinted, semi-rigid, snap-on type.
   1. Colors: Comply with ASME A13.1, unless otherwise indicated.
   2. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
   3. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
   4. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
   5. Lettering: Manufacturers standard preprinted.

2.4 DUCT IDENTIFICATION DEVICES

A. Duct Markers: Engraved, color-coded laminated plastic. Include direction and quantity of airflow and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive. See Execution section for color scheme.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Provide 5/32-inch hole for fastener.
1. Material: 0.032-inch thick aluminum.
3. Size: 1½ inches in diameter, unless otherwise indicated.

2.6 VALVE SCHEDULES

A. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.

B. Frame: Extruded aluminum.

C. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.7 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: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Mechanical Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
1. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
3. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
4. Fans, blowers, primary balancing dampers, and mixing boxes.
5. Packaged HVAC central-station and zone-type units.

B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, ½ 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.
2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
   a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
   b. Fire department hose valves and hose stations.
   c. Meters, gages, thermometers, and similar units.
   d. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
   e. Pumps, compressors, chillers, condensers, and similar motor-driven units.
   f. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
   g. Fans, blowers, primary balancing dampers, and mixing boxes.
   h. Packaged HVAC central-station and zone-type units.
   i. Tanks and pressure vessels.
   j. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

C. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.
   1. Identify mechanical equipment with equipment markers in the following color codes:
      a. Green: For cooling equipment and components.
      b. Yellow: For heating equipment and components.
      c. Green and Yellow, Orange: For combination cooling and heating equipment and components.
      d. Brown: For energy-reclamation equipment and components.
   2. Letter Size: Minimum 1/2 inch for name of units if viewing distance is less than 24 inches, 3/4 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.
   3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
   4. Include signs for the following general categories of equipment:
      a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
      b. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
      c. Pumps, compressors, chillers, condensers, and similar motor-driven units.
      d. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
      e. Fans, blowers, primary balancing dampers, and mixing boxes.
      f. Packaged HVAC central-station and zone-type units.
      g. Tanks and pressure vessels.
      h. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

D. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
1. Pipes with OD, Including Insulation, Less Than 6 Inches: Snap-on application of pretensioned, semi-rigid plastic pipe marker.
2. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with manufacturer’s stainless steel bands.
3. Fasten Option: Laminated or bonded application of pipe marker to pipe or insulation.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; in machine rooms; in accessible maintenance spaces such as shafts, tunnels and plenums; and in exterior nonconcealed locations such as rooftops and chiller yards, 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 nonaccessible 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.

3.4 DUCT IDENTIFICATION
A. Install duct markers with permanent adhesive on air ducts in the following color codes:
   1. Green: For cold-air supply ducts.
   2. Yellow: For hot-air supply ducts.
   3. Blue: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
   4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
   5. Letter Size: Minimum 1/2 inch for name of units if viewing distance is less than 24 inches, 3/4 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.
B. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system. Reduce intervals to 25 feet in areas of high duct congestion.

3.5 VALVE-SCHEDULE INSTALLATION
A. Mount valve schedule on wall in accessible location in each major equipment room.

3.6 WARNING-TAG INSTALLATION
A. Write required message on, and attach warning tags to, equipment and other items where required.

3.7 VALVE TAGS
A. Install on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, plumbing fixture supply stops, shutoff valves, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in valve schedule.
B. Valve Tag Application Schedule: Tag valves according to size, shape, color scheme, and with captions similar to those indicated in the following:

C. Tag Material: Aluminum.

D. Tag Size and Shape: 1-1/2 inches, round.

E. Tag Color: According to the following:
   2. Cold Water: Black.
   3. Hot Water: Red.
   7. Steam: Red.


G. Install mounted valve schedule in each major equipment room.

3.8 EQUIPMENT SIGNS AND MARKERS

A. Install engraved plastic-laminate signs or equipment markers on or near each major item of mechanical equipment. Include signs for the following general categories of equipment:
   1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
   2. Meters, gages, thermometers, and similar units.
   3. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
   4. Pumps, compressors, chillers, condensers, and similar motor-driven units.
   5. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
   6. Fans, blowers, primary balancing dampers, and mixing boxes.
   7. Packaged HVAC central-station and zone-type units.
   8. Tanks and pressure vessels.
   9. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.
   10. Any concealed appurtenances requiring access for maintenance shall be clearly identified by sign (to include but not be limited to unions, strainers, valves, etc.).

B. Duct Systems: Identify air supply, return, exhaust, intake, and relief ducts with duct markers; or provide stenciled signs and arrows showing service and direction of flow.
   1. Location: Locate signs near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.9 ADJUSTING AND CLEANING

A. Relocate mechanical identification materials and devices that have become visually blocked by work of this or other Divisions.

B. Clean faces of identification devices and glass frames of valve charts.

END OF SECTION
PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The work included in this section consists of the furnishing of all labor, instruments, tools, and services required in connection with the testing, adjusting and balancing (TAB) of the heating, ventilating, and air conditioning systems as described in the mechanical specifications and/or shown on the mechanical plans, or reasonable implied therefrom.

B. TAB of the HVAC systems will be performed by an impartial technical firm that is a member of NEBB or AABC and whose operations are limited to the field of professional testing and balancing.

C. General Contractor to obtain bid from TAB Contractors listed below.
   1. EAB
   2. ETAB (Energy Testing and Balance)
   3. TSI
   4. PHI

D. Qualified TAB firms shall submit cost, scope of work, qualifications, timeline, and references.

E. The TAB firm is responsible to and shall submit five (5) copies of all reports directly to the General Contractor. (TAB works for the GC)

F. TAB services shall result in the optimum temperature, airflow, and noise levels in the conditioned space of the project.

G. The following basic components of the HVAC systems shall be tested, adjusted, and balanced:
   1. Air distribution systems.
   2. Air moving equipment.
   3. HVAC pumps (chilled water, hot water, condenser water, etc.).
   5. Control systems verification.

1.2 SUMMARY

A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:
   1. Balancing airflow and water flow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
   2. Adjusting total HVAC systems to provide indicated quantities.
   4. Setting quantitative performance of HVAC equipment.
   5. Verifying that automatic control devices are functioning properly.
   7. Reporting results of the activities and procedures specified in this Section.

B. Related sections include the following:
1. Testing and adjusting requirements unique to particular systems and equipment are included in the Sections that specify those systems and equipment. See all related HVAC mechanical sections.

2. Field quality-control testing to verify that workmanship quality for system and equipment installation is specified in system and equipment Sections.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.

C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

E. Report Forms: Test data sheets for recording test data in logical order.

F. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

G. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

H. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

I. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

K. Test: A procedure to determine quantitative performance of a system or equipment.

L. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

M. NEBB: National Environmental Balancing Bureau.

N. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.4 SUBMITTALS

A. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 2 copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.
B. Contract Documents Examination Report: Within 45 days from the Contractor’s Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3 of this Section.

C. Strategies and Procedures Plan: Within 60 days from the Contractor’s Notice to Proceed, submit 2 copies of the testing, adjusting and balancing strategies and step-by-step procedures as specified in Part 3 “Preparation” Article below. Include a complete set of report forms intended for use on this Project.

D. Certified Testing, Adjusting and Balancing Reports: Submit 2 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting and balancing Agent.

E. Sample Report Forms: Submit 2 sets of sample testing, adjusting and balancing report forms.

F. Warranty: Submit 2 sets of special warranty specified in the “Guarantee” Article below.

1.5 QUALITY ASSURANCE

A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by NEBB.

B. Testing, Adjusting, and Balancing Conference: Meet with the Owner's and the Architect's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, equipment manufacturers’ authorized service representatives, HVAC controls Installer, and other support personnel. Provide 7 days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:
   a. Submittal distribution requirements.
   c. Testing, adjusting, and balancing plan.
   d. Work schedule and Project site access requirements.
   e. Coordination and cooperation of trades and subcontractors.
   f. Coordination of documentation and communication flow.

C. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.


E. Instrumentation Type, Quantity, and Accuracy: As described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every 12 months or more frequently if required by the instrument manufacturer.
A. Partial Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner’s operations.

1.7 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Notice: Provide 7 days’ advance notice for each test. Include scheduled test dates and times.

C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 GUARANTEE

A. General: The national project performance guarantee specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems’ designs that may preclude proper testing, adjusting, and balancing of systems and equipment.
   1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
   2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Architect’s and Engineer’s 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.

D. Examine equipment performance data, including fan and pump curves. 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. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201,
"Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

E. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.

F. Examine system and equipment test reports.

G. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

H. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

I. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes and mixing boxes, to verify that they are accessible and their controls are connected and functioning.

K. Examine plenum ceilings, utilized for supply air, to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

L. Examine strainers for clean screens and proper perforations.

M. Examine 3-way valves for proper installation for their intended function of diverting or mixing fluid flows.

N. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

O. Examine open-piping-system pumps to ensure absence of entrained air in the suction piping.

P. Examine equipment for installation and for properly operating safety interlocks and controls.

Q. Examine automatic temperature system components to verify the following:
   1. Dampers, valves, and other controlled devices operate by the intended controller.
   2. Dampers and valves are in the position indicated by the controller.
   3. The integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
   4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
   5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
   6. Sensors are located to sense only the intended conditions.
   7. Sequence of operation for control modes is according to the Contract Documents.
   8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
   9. Interlocked systems are operating.
   10. Changeover from heating to cooling mode occurs according to design values.

R. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.
3.2 PREPARATION

A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness 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 design conditions for system operations can be met.
   9. Motors are wired properly with appropriate overloads and correct rotation.

3.3 GENERAL TESTING AND BALANCING PROCEDURES

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

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.4 FUNDAMENTAL AIR SYSTEMS' BALANCING PROCEDURES

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check the airflow patterns from the outside-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.

3.5 VARIABLE-AIR-VOLUME SYSTEMS' ADDITIONAL PROCEDURES

A. 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 systems similar to constant-volume air systems.
   2. Set terminal units and supply fan at full-airflow condition.
   3. Adjust inlet dampers of each terminal unit to design airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
   4. Readjust fan airflow for final maximum readings.
   5. Measure operating static pressure at the sensor that controls the supply fan, if one is installed, and verify operation of the static-pressure controller.
   6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
   7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
      a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
   8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.6 FUNDAMENTAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
   1. Open all manual valves for maximum flow.
   2. Check expansion tank liquid level.
   3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
   4. Check flow-control valves for specified sequence of operation and set at design flow.
   5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type, unless several terminal valves are kept open.
   6. Set system controls so automatic valves are wide open to heat exchangers.
   7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
   8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.7 HYDRONIC SYSTEMS' BALANCING PROCEDURES

A. Determine water flow at pumps. Use the following procedures, except for positive-displacement pumps:
   1. Verify impeller size by operating the pump with the discharge valve closed. Verify with the pump manufacturer that this will not damage pump. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the
point on the manufacturer's pump curve at zero flow and confirm that the pump has the intended impeller size.

2. Check system resistance. With all valves open, read pressure differential across the pump and mark the pump manufacturer's head-capacity curve. Adjust pump discharge valve until design water flow is achieved.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on the pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
   1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than design flow.

E. Adjust balancing stations to within specified tolerances of design flow rate as follows:
   1. Determine the balancing station with the highest percentage over design flow.
   2. Adjust each station in turn, beginning with the station with the highest percentage over design flow and proceeding to the station with the lowest percentage over design flow.
   3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures, including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.8 VARIABLE-FLOW HYDRONIC SYSTEMS' ADDITIONAL PROCEDURES

A. Balance systems with automatic 2- and 3-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.9 PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS' ADDITIONAL PROCEDURES

A. Balance the primary system crossover flow first, then balance the secondary system.

3.10 MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
   1. Manufacturer, model, and serial numbers.
   4. Efficiency rating if high-efficiency motor.
   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 for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.
3.11 BOILERS
   A. Measure entering- and leaving-water temperatures and water flow.

3.12 HEAT-TRANSFER COILS
   A. Water Coils: Measure the following data for each coil:
      1. Entering- and leaving-water temperatures.
      2. Water flow rate.
      3. Water pressure drop.
      4. Dry-bulb temperatures of entering and leaving air.
      5. Wet-bulb temperatures of entering and leaving air.
      6. Airflow.
      7. Air pressure drop.
   B. Electric-Heating Coils: Measure the following data for each coil:
      1. Nameplate data.
      2. Airflow.
      3. Entering- and leaving-air temperatures at full load.
      4. Voltage and amperage input of each phase at full load and at each incremental stage.
      5. Calculated kW at full load.
      6. Fuse or circuit-breaker rating for overload protection.

3.13 TEMPERATURE TESTING
   A. During testing, adjusting, and balancing, report need for adjustment in temperature regulation
      within the automatic temperature-control system.
   B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of 2 successive
      8-hour days, in each separately controlled zone, to prove correctness of final temperature
      settings. Measure when the building or zone is occupied.
   C. Measure outside-air, wet- and dry-bulb temperatures.

3.14 TEMPERATURE-CONTROL VERIFICATION
   A. Verify that controllers are calibrated and commissioned.
   B. Check transmitter and controller locations and note conditions that would adversely affect control
      functions.
   C. Record controller settings and note variances between set points and actual measurements.
   D. Verify operation of limiting controllers (i.e., high- and low-temperature controllers).
   E. Verify free travel and proper operation of control devices such as damper and valve operators.
   F. Verify sequence of operation of control devices. Note air pressures and device positions and
      correlate with airflow and water-flow measurements. Note the speed of response to input
      changes.
   G. Confirm interaction of electrically operated switch transducers.
   H. Confirm interaction of interlock and lockout systems.
   I. Verify main control supply-air pressure and observe compressor and dryer operations.
J. Record voltages of power supply and controller output. Determine if the system operates on a grounded or nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.15 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans: -5 to plus 10 percent.
   2. Air Outlets and Inlets: ± 10 percent.
   3. Heating-Water Flow Rate: ± 10 percent.
   4. Cooling-Water Flow Rate: ± 5 percent.

3.16 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in “Examination” Article above, prepare a report on the adequacy of design for systems’ balancing devices. Recommend changes and additions to systems’ balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

C. Preliminary Report: Submit preliminary TAB reports to the design engineer for each floor, the central plant, and the chilled and hot water hydronic system.

3.17 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
   1. Include a list of the instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to the certified field report data, include the following:
   1. Pump Curves.
   2. Fan curves.
   3. Manufacturers’ test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance, but not include approved Shop Drawings and Product Data.

D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:
   1. Title page.
   2. Name and address of testing, adjusting and balancing Agent.
   3. Project name.
   4. Project location.
   5. Architect’s name and address.
6. Engineer’s name and address.
7. Contractor’s name and address.
9. Signature of testing, adjusting and balancing Agent who certifies the report.
10. Summary of contents, including the following:
   a. Design versus final performance.
   b. Notable characteristics of systems.
   c. Description of system operation sequence if it varies from the Contract Documents.
11. Nomenclature sheets for each item of equipment.
12. Data for terminal units, including manufacturer, type size and fittings.
13. Notes to explain why certain final data in the body of reports vary from design values.
14. Test conditions for fans and pump performance forms, including the following:
   a. Settings for outside-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.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:
1. Quantities of outside, 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.
7. Locations of duct traverse(s) of duct layout.

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data: Include the following:
   a. Unit identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer’s serial number.
   f. Unit arrangement and class.
   g. Discharge arrangement.
   h. Sheave make, size in inches and bore.
   i. Sheave dimension, center-to-center and amount of adjustments in inches (mm).
   j. Number of belts, make and size.
   k. Number of filters, type and size.
2. Motor Data: Include the following:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches and bore.
   f. Sheave dimensions, center-to-center and amount of adjustments in inches.
3. Test Data: Include design and actual values for the following:
   a. Unit identification.
   b. Location.
   c. Make and type.
d. Model number and unit size.
e. Manufacturer’s serial number.

G. Apparatus-Coil Test Reports: For apparatus coils, include the following:

1. Coil Data: Include the following:
   a. System Identification.
   b. Location.
   c. Coil type.
   d. Number of rows.
   e. Fin spacing in fins per inch.
   f. Make and model number.
   g. Face area in sq.ft.
   h. Tube size in NPS.
   i. Tube and fin materials.
   j. Circuiting arrangement.

2. Test Data: Include design and actual values for the following:
   a. Airflow rate in cfm.
   b. Average face velocity in fpm.
   c. Air pressure drop in inches wg.
   d. Outside-air, wet and dry-bulb temperatures in deg F.
   e. Return-air, wet and dry-bulb temperatures in deg F.
   f. Entering-air, wet and dry-bulb temperatures in deg F.
   g. Leaving-air, wet and dry bulb temperatures in deg F.
   h. Water flow rate in gpm.
   i. Water pressure differential in feet of head or psig.

H. Water Chiller Test Reports: For chillers (Air Cooled or Water Cooled)

1. Unit Data: Include the following:
   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.

2. Motor Data:
   a. Make and frame type and size.
   b. Volts, phase and hertz.
   c. Full-load amperage and service factor.

3. Test Data:
   a. Total chilled water flow rate in gpm.
   b. Total condenser water flow rate in gpm.
   c. WPD in ft across chilled water.
   d. WPD in ft across condenser water.
   e. Chilled water supply and return temperatures °F.
   f. Condenser water supply and return temperatures °F.

I. Cooling Tower Test Reports: For condenser water cooling tower:

1. Unit Data: Include the following:
   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.
2. Motor Data (Fan or Pump): Include the following:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.

3. Test Data: Include design and actual values for the following:
   a. Total condenser under flow rate in gpm.
   b. Total wpd in ft across condenser water.
   c. Condenser water supply and return temperatures in °F.
   d. Fan rpm.

J. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
1. Unit Data: Include the following:
   a. System identification.
   b. Location.
   c. Coil identification.
   d. Capacity in Btuh (kW).
   e. Number of stages.
   f. Connected volts, phase, and hertz.
   g. Rated amperage.
   h. Airflow rate in cfm.
   i. Face area in sq. ft.
   j. Minimum face velocity in fpm.

2. Test Data: Include design and actual values for the following:
   a. Heat output in Btuh.
   b. Airflow rate in cfm.
   c. Air velocity in fpm.
   d. Entering-air temperature in deg F.
   e. Leaving-air temperature in deg F.
   f. Voltage at each connection.
   g. Amperage for each phase.

K. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data: Include the following:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and size.
   e. Manufacturer’s serial number.
   f. Arrangement and class.
   g. Sheave make, size in inches, and bore.
   h. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).

2. Motor Data: Include the following:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Sheave dimensions, center-to-center and amount of adjustments in inches.
   g. Number of belts, make, and size.

3. Test Data: Include design and actual values for the following:
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

L. 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: Include the following:
   a. System and air-handling unit number.
   b. Location and zone.
   c. Locate traverse location on duct work layout.
   d. Traverse air temperature in deg F.
   e. Duct static pressure in inches wg.
   f. Duct size in inches.
   g. Duct area in sq. ft.
   h. Design airflow rate in cfm.
   i. Design velocity in fpm.
   j. Actual airflow rate in cfm.
   k. Actual average velocity in fpm.
   l. Barometric pressure in psig.

M. Air-Terminal-Device Reports: For terminal units, include the following:
1. Unit Data: Include the following:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Test apparatus used.
   d. Area served.
   e. Air-terminal-device make.
   f. Air-terminal-device number from system diagram.
   g. Air-terminal-device type and model number.
   h. Air-terminal-device size.
   i. Air-terminal-device effective area in sq. ft.
2. Test Data: Include design and actual values for the following:
   a. Airflow rate in cfm.
   b. Air velocity in fpm.
   c. Preliminary airflow rate as needed in cfm.
   d. Preliminary velocity as needed in fpm.
   e. Final airflow rate in cfm.
   f. Final velocity in fpm.
   g. Space temperature in deg F.

N. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data: Include the following:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Room or riser served.
   d. Coil make and size.
   e. Flowmeter type.
2. Test Data: Include design and actual values for the following:
   a. Airflow rate in cfm.
   b. Entering-water temperature in deg F.
   c. Leaving-water temperature in deg F.
   d. Water pressure drop in feet of head or psig.
   e. Entering-air temperature in deg F.
   f. Leaving-air temperature in deg F.

O. Instrument Calibration Reports: For instrument calibration, include the following:
1. Report Data: Include the following:
a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

END OF SECTION
SECTION 23 0719
MECHANICAL INSULATION

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 mechanical insulation for duct, equipment, and pipe, including the following:
   1. Insulation Materials:
      a. Cellular glass.
      b. Flexible elastomeric.
      c. Mineral fiber.
      d. Phenolic
   2. Adhesives.
   3. Mastics.
   4. Sealants.
   5. Factory-applied jackets.
   7. Field-applied tape.
   8. Field-applied jackets.
   10. Corner angles.

B. Related Sections include the following:
   1. Specification Section “Metal Ducts” for duct liners.
   2. Specification Section “Hangers and Supports” for high-density inserts at hangers; **wood inserts at hangers are not acceptable.**
   3. Specification Section “Special Conditions for All Mechanical Work”.
   4. Specification Section “Basic Mechanical Materials and Methods”.

C. Not all items listed within this specification are used. Use only items applicable per application schedule.

1.3 DEFINITIONS
A. ASJ: All-service jacket.
B. CONCEALED: Covered or concealed by a ceiling (gypsum or lay-in acoustical tile) or wall.
C. EXPOSED: Open to view; not concealed by a ceiling or wall of any sort.
D. FSK: Foil, scrim, kraft paper.
E. UNDERFLOOR: Accessible crawl space beneath lowest floor level. (considered “outdoors”)

1.4 SUBMITTALS
A. **Product Data:** For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any). Provide submittal data on all products to be used.

### 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. **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, 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.

### 1.6 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.

B. **All products to be stored in a dry location, protected from the elements. All damaged insulation to be replaced.**

### 1.7 COORDINATION

A. **Coordinate size and location of supports, hangers, and high-density insulation inserts and shields specified in Specification Section "Hangers and Supports."** Coordinate with drawing details where applicable; wood inserts at hangers are not acceptable.

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

### 1.8 SCHEDULING

A. **Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing.** Insulation application may begin on segments that have satisfactory test results.

B. **Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.**

C. **Insulation not to be installed until building is dried in.**

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 INSULATION MATERIALS

A. Refer to Part 3 schedule articles for requirements about 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. Phenolic:
   1. Manufacturers:
      a. Resolco
      b. Dyplast Products
      c. Polyguard
      d. Approved equal.
   2. 100% CFC-free, HCFC-free, and halogen-free, closed cell rigid phenolic foam insulation.
   3. Minimal thermal conductivity @ 75˚ F
      a. Green, 2.5 lb/ft³: 0.15 (Btu.in/hr.ft². F)
      b. Pink, 5.0 lb/ft³: 0.21 (Btu.in/hr.ft². F)

G. Cellular Glass:
   1. Manufacturers:
      a. Pittsburgh Corning Corporation; Foamglas Super K.
   2. Block Insulation: ASTM C 552, Type I.
   3. Special-Shaped Insulation: ASTM C 552, Type III.
   4. Board Insulation: ASTM C 552, Type IV.
   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.
   7. Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Minimal thermal conductivity at 75˚ F of 0.27 (Btu.in/hr.ft². F) (R-value of 10.34@ 3 inches thickness). Factory-applied jacket requirements are specified in Part 2 “Factory-Applied Jackets” Article.

H. Flexible Elastomeric:
   1. Manufacturers:
      a. Aeroflex USA Inc.; Aerocel.
      b. Armacel LLC; AP Armaflex.
   2. Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   3. Minimal thermal conductivity at 75˚ F of 0.25 (Btu.in/hr.ft². F).
I. Mineral-Fiber Blanket Insulation:
   1. Manufacturers:
      a. Johns Manville; Microlite.
      b. Knauf Insulation; Duct Wrap
      c. Owens-Corning; All-Service Duct Wrap.
   2. 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 FSP jacket. Factory-applied jacket requirements are specified in Part 2 “Factory-Applied jackets” Article.
   3. Minimal density of 1.0 lb/ft³, installed R-value of 6.0 (at 2" thick).

J. Mineral-Fiber Board Insulation:
   1. Manufacturers:
      a. Johns Manville; 800 Series Spin-Glas.
      b. Knauf Insulation; Insulation Board.
      c. Owens Corning; Fiberglas 700 Series.
   2. Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 “Factory-Applied Jackets” Article.
   3. Minimal density of 2.25 lb/ft³, with a R-value of 8.7 (at 2" thickness).

K. Mineral-Fiber, Preformed Pipe Insulation:
   1. Manufacturers:
      a. Johns Manville; Micro-Lok.
      b. Knauf Insulation; 1000° Pipe Insulation.
      c. Owens Corning; Fiberglas Pipe Insulation.
   2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Minimum thermal conductivity at 75˚ F of 0.23 (Btu.in/hr.ft². F). Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 “Factory-Applied Jackets” Article.

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. All products are to contain low V.O.C. as defined/governed by LEED IEQ 4.1 and 4.2 (Regardless of project type).

B. Cellular-Glass, Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
   1. Products:
      a. Foamglas: Pittseal 444N or equal

C. Flexible Elastomeric: Comply with MIL-A-24179A, Type II, Class I.
   1. Products:
      a. K-Flex: 720 LVOC or equal

D. Phenolic: Water based adhesive with a service temp of minus 20°F to 700°F.
   1. Products:
      a. Foster 97-15

E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products:
      a. Design Polymerics, DP2502 (or approved equal).
2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II. All products are to contain low V.O.C. as defined/governed by LEED IEQ 4.1 and 4.2 (Regardless of project type).

B. Vapor-BARRIER Mastic: Water based; suitable for outdoor use on below ambient services, or indoor vapor barrier use.
   1. Products:
      a. Childers Products, Division of ITW; CP-35.
   2. Water-Vapor Permeance: ASTM F 1249, 0.09 perm at 55-mils film thickness.
   3. Service Temperature Range: Minus 20 to plus 190 deg F.
   4. Solids Content: ASTM D 1644, 60 percent by volume and 73 percent by weight.
   6. VOC: 36 g/l

2.5 SEALANTS

A. Joint Sealants:
   1. Joint Sealants for Cellular-Glass Products:
      a. Pittsburgh Corning Corporation; Pittseal 444N.
   2. Joint Sealant for Phenolic Products
      a. Foster 95-50

B. Metal Jacket:
   1. Products:
      a. Foster 95-44 or equal.
      b. Childers Products, Division of ITW; CP-76.

C. Mineral Fiber:
   1. Design Polymerics DP 2502.
   2. Childers Products, Division of ITW; CP-35.

D. PVC Jacket:
   1. Childers Products, Division of ITW; CP-35.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   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.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 2.2 oz./sq. yd. 10 x 10 strand count per square inch, minimum 4" wide band.
   1. Available Products:
      a. Chil-glas #10.
      b. Charles Harmon and Co. white weaveset.
2.8 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, 25/50 ASTM-F 84, 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:
      a. Johns Manville; Zeston.
      b. Proto PVC Corporation; LoSmoke.
   3. 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.
   4. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:
   1. Products:
      a. Childers Products, Division of ITW; Metal Jacketing Systems.
      a. Factory cut and rolled to size.
      b. Finish and thickness are indicated in field-applied jacket schedules.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136 and UL listed.
   1. Width: 4 inches.
   2. Thickness: 14.0 mils.
   4. Elongation: 2 percent.
   5. Tensile Strength: 55 lbf/inch in width.
   6. Color: White

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136 and UL listed.
   1. Width: 4 inches.
   2. Thickness: 13 mils.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. Color: Silver

2.10 SECUREMENTS

A. Bands:
   1. Products:
      a. Childers Products; Bands.
   2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 316; 0.015 inch thick, 3/4 inch wide with wing or closed seal.
   3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch with wing or closed seal.

B. Insulation Pins and Hangers:
   1. Cupped-Head, Capacitor-Discharge-Insulated Weld Pins: Zinc-coated steel pin, fully annealed for capacitor-discharge welding, 12 Gauge shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer. **Contractor to field verify, integrity of pin weld on ductwork with sheet metal thickness less than 22-gauge. Integrity to be verified prior to concealment with insulation.**
      a. Products:
         1) GEMCO; Cupped Head Weld Pin or equal.
   2. Metal, “Peel and Press” Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
      a. Products:
         1) GEMCO; Peel and Press or equal.
       b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
       c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 12 Gauge diameter shank, length to suit depth of insulation indicated.
       d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
   3. Insulation-Retaining Washers and Cap: Self-locking cap washers formed from 12 Gauge, 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. Products:
         1) AGM Industries, Inc.; RC-150.
         2) GEMCO; R-150.
       b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

2.11 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

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
3.3 COMMON INSTALLATION REQUIREMENTS

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. 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.

C. 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.

D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

E. Install high-density inserts at hanger locations prior to insulating (duct and pipe); wood or block inserts are not acceptable.

F. Install insulation with longitudinal seams at top and bottom of horizontal runs.

G. Where multiple layers of insulation are required, longitudinal and end seams are to be staggered.

H. Do not weld brackets, clips, pins or other attachment devices to piping, fittings, tanks, coils, equipment, vessel, and specialties.

I. Keep insulation materials clean and dry before, during application, and finishing.

J. Install insulation with tight longitudinal seams and end joints.

K. Install insulation with least number of joints practical.

L. Install insulation so that material is not over compressed. Install corner angles prior to insulating; to protect all insulation from damage.

M. Seal all joints, and seams, including penetrations in insulation, at supports, and other projections with insulation of same material overlapped by 2”. Secure strips with outward clinching staples along edge of overlap, (spaced 1 inch on center) and seal entire joint or seam with mastic and embedded fiberglass reinforcing mesh, minimum 4”, cover mesh with finish coat of mastic.

N. Do not insulate, conceal, or enclose pipe hangers, channel and steel supports, etc. not directly fasten to duct.

O. 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.
P. Apply adhesives, mastics, and sealants at manufacturer’s recommended coverage rate and wet and dry film thicknesses. Do not water down products unless directed by manufacture. Use clean potable demineralized water when required.

Q. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

R. Repair all damage insulation prior to concealment as noted above.

S. Do not insulate or conceal vibration-control devices, labels, stamps, nameplates, data plates, manholes, cleanouts, etc. require for maintenances.

T. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarded integrity, unless otherwise indicated.

U. Insulate pipe elbows, tees, valves, strainers, flanges, etc., using preformed fitting insulation, mitered fittings or oversized preformed pipe insulation made from same material thickness and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. 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, voids, and irregular surfaces with insulating mastic finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation. Provide a removable reusable insulation cover; design that maintains vapor barrier. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts.

V. Cover segmented insulated surfaces with a layer of finishing adhesive and coat with a vapor-barrier mastic. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

W. 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. Secure PVC covers to adjoining insulation facing using staples and ASJ tape. Seal PVC fitting covers with mastic.

X. 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 adhesive and finish with mastic. All connections are to be accessible.

Y. Install removable insulation segment and covers at flanges, valves, controls, unions, equipment access doors, manholes, hand holes, and other elements that require frequent removal for service and inspection. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.4 PENETRATIONS

A. Install insulation continuously through all walls, floors, and partitions penetrations and sleeves.

B. Extend jacket of outdoor installation into wall and roof jacks by 2 inches. Seal jacket to roof flashing with approved flashing sealant.

C. Insulation Installation at Fire-Rated Walls, floors and Partitions Penetrations for duct work were fire/smoke dampers are required: Terminate insulation at fire damper sleeves as require
by damper manufacturer. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

3.5 GENERAL PIPE INSULATION INSTALLATION (IN ADDITION TO COMMON REQUIREMENTS)

A. Preformed Pipe Insulation Installation on Pipe, Fittings, Valves, Flanges, Tanks, Elbows, and Appurtenances for Cellular- Glass, Mineral- Fiber, Flexible Elastomeric, and Phenolic insulations:
   1. Install insulation in a manner that secures material to system being insulated with staples, tape and mastic.
   2. When insulation with preformed pipe insulation, seal all longitudinal seams, end joints, and protrusions with manufacturers recommended tape matching jacket, vapor-barrier mastic, joint sealant, and adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
   3. Secure fittings, jacket, cover, etc. with tape matching jacket and secure with outward clinched staples 1 inch on center. Apply vapor-barrier mastic over staples.
   4. Arrange insulation to permit access to valves packing, flanges, unions, etc. and valve operation for maintenance without disturbing insulation. Install insulation so that it can be removed without damage to surrounding insulation or access enclosure.
   5. Pipe hangers are not to be concealed in insulation.
   6. Seal all exposed insulation ends with mastic.
   7. Seal all mitered joints prior to installing covers with vapor-barrier sealant and mastic.
   8. Install preformed pipe insulation to outer diameter of pipe flange.
   9. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  10. Fill voids between inner circumference of valves, flange, elbows, and bolts insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
  11. Install preformed sections of same material insulation when available. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Install PVC cover over fitting or mitered section.
  12. Arrange insulation to permit access to valves packing, flanges, unions, etc. and valve operation for maintenance without disturbing insulation. Install insulation so that it can be removed without damage to surrounding insulation or access enclosure.

3.6 GENERAL BLANKET AND BOARD INSULATION INSTALLATION (IN ADDITION TO COMMON REQUIREMENTS)

A. Blanket and Board Insulation Installation on Duct, Tanks, Vessels, Elbows, and Appurtenances:
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for a minimum of 50 percent coverage of duct and plenum and 100 percent coverage of equipment, tanks, etc.; to secure insulation to surfaces. Apply adhesive to entire circumference of all surfaces; including fittings and transitions.
   2. Install cupped-head, capacitor-discharge-weld pins surfaces to secure insulation to ductwork. Install on sides and bottom of horizontal and vertical ducts having a width or height greater than 23 inches. Locate 16 inches center and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface as required by manufacturer recommendation. Use approved adhesive stick anchor pins with washers for all equipment, tanks, etc. Cut excess portion of stick anchor pins and install washer's caps. Cover exposed pins and washers caps with tape and mastic matching insulation facing.
   3. Install PVC corner angles prior to installing blanket insulation.
4. Do not over compress insulation during installation. Cover exposed pins and washers with tape matching insulation facing and mastic.

5. 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 3/4-inch outward-clinching staples, 1 inch on center. Coat all seams/joints with mastic and embed with fiberglass reinforced mesh, minimum 4", cover mesh with finish coat of mastic.

6. Repair punctures, tears, penetrations and protrusions with 6-inch-wide strips of same material used to insulate duct. Seal all seams with staples, cover with mastic and cover with embedded fiberglass reinforced mesh, cover mesh with finish coat of mastic.

7. 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.

8. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

9. Insulate hangers attached to duct work. Do not insulate or enclose channel, supports, etc. not directly fasten to duct.

10. Insulation termination: Butt insulation up to termination point. Apply mastic no less than 3" overlap on insulation, and 3" on metal surface. Embed fiberglass reinforced mesh overlapping full 3" of termination point, 6" strip. Cover mesh with finish coat of mastic.

3.7 FIELD-APPLIED JACKET INSTALLATION
A. Install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge. Secure metal jacket with stainless-steel bands 12 inches on center and at end joints.

3.8 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 9 painting Sections.
   1. Flat Acrylic Finish: Two (2) finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

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.

3.9 FIELD QUALITY CONTROL
A. Perform the following field tests and inspections and prepare test reports:
1. Inspect insulated duct, pipe, and equipment, randomly selected by Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to two (3) location(s) for each system.
2. All insulation applications will be considered defective work if sample inspection reveals noncompliance with requirements.
3. Remove all defective work and install new insulation and jackets to replace insulation and jackets removed for inspection. Repeat inspection procedures as needed.

3.10 INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
   1. Indoor, concealed/exposed supply, return, relief and outdoor air.
   2. Outdoor, concealed/exposed supply, return and relief air.

B. Piping Requiring Insulation:
   1. Indoor and outdoor hydronics.
   2. All pipe and appurtenances that are susceptible to sweating.
   3. All pipe and appurtenances carrying water or refrigerant, for space conditioning.
   4. Any piping not specifically scheduled for insulation below to be insulated with the code minimum required insulation.

C. Items Not Insulated:
   1. Fibrous-glass ducts.
   2. Double-wall metal ducts or lined metal ducts, both with sufficient insulation thickness to comply with adopted edition of IECC and ASHRAE/IESNA 90.1.
   3. Factory-insulated flexible ducts.
   5. Flexible connectors.
   7. Factory-insulated access panels and doors.
   8. General building exhaust duct.

3.11 DUCT AND PLENUM INSULATION SCHEDULE

A. Indoor, concealed, all duct insulation shall be of the following (Including dishwasher exhaust):
   1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

B. Indoor, exposed (including mechanical rooms and utility rooms), rectangular, all duct insulation shall be of the following:
   1. Mineral-Fiber Board: 2 inches thick and 2.25-lb/cu. ft. nominal density.

C. Indoor, exposed round or flat oval ductwork shall be double-wall construction.

D. Outdoor (including underfloor), all duct insulation shall be any of the following:
   1. Rectangular Duct: Cellular Glass, 3 inches thick and 7.5-lb/cu. ft. nominal density. (minimum R-value of 8)
   2. Round/Flat Oval: Double wall construction (reference Metal Ducts Specification).

3.12 AIR DEVICE INSULATION SCHEDULE

A. Supply-air devices (all styles/sizes): Field insulate backside of all devices that are not factory lined:
   1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density. Secured to air device with FSK tape, all sides.
# 3.13 EQUIPMENT INSULATION SCHEDULE

A. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

B. Expansion/compression/buffer tanks, Air-separators, filter feeders, etc. insulation shall be any of the following:
   1. Cellular Glass: 3 inches. (chilled water service)
   2. Phenolic: 2 inches. (chilled water service)
   3. Mineral Fiber Board: 3 inches. (hot water service)

C. Steam-to-hot water heat exchanger insulation:
   1. Mineral-Fiber board: 3” thick, 3lb/cu. ft. density.
   2. Cellular Glass: 3” thick, 7.5 lb/cu. ft density.

# 3.14 PIPING INSULATION SCHEDULE

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range.

B. Condensate and Equipment Drains:
   1. All Pipe Sizes: Insulation shall be any of the following:
      a. Flexible Elastomeric: 1 inch thick.

C. Chilled Water Supply and Return:
   1. All Pipe Sizes: Insulation shall be any of the following:
      b. Cellular Glass: (for use indoors and outdoors, not accepted in underfloor or buried). Reference schedule below for thickness.
      c. Phenolic: (for use indoors and outdoors, not accepted in underfloor or buried). Reference schedule below for thickness.

D. Hot Water Supply and Return:
   1. All pipe sizes:
      c. Phenolic: (for use indoors and outdoors, not accepted in underfloor or buried) Reference Schedule below for thickness.
      d. Cellular Glass: (for use indoors and outdoors, not accepted in underfloor or buried) Reference Schedule below for thickness.

E. Phenolic Density Schedule:
   1. Indoors Concealed: 2.5 lb/ft.³ (Green)
   2. Indoors Exposed: 5 lb/ft.³ (Pink)
   3. Outdoors: 5 lb/ft.³ (Pink)

F. Steam and Steam Condensate, 350˚ F and below:
   1. All pipe sizes:
      a. Mineral-Fiber, Preformed pipe, Type I: 3” thick.

### Insulation Thickness Schedule

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CONSTRUCTION DOCUMENTS
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G. Refrigerant Suction and Hot Gas Piping:
   1. All pipe sizes: Insulation shall be the following:
      a. Flexible elastomeric: 1-1/2 inch thick.

3.15 FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Ducts/Piping exposed in finished indoor areas, outdoors, underfloor and mechanical rooms.
   1. Aluminum, Stucco Embossed: 0.016 inch thick.

C. Indoor hydronic piping fitting or elbows.
   1. PVC: 0.015 inch thick.

END OF SECTION
PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes propeller unit heaters with electric-resistance coils.

1.3 SUBMITTALS
   A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each unit type and configuration.
   B. Shop Drawings: Submit the following for each unit type and configuration:
      1. Plans, elevations, sections, and details.
      2. Details of anchorages and attachments to structure and to supported equipment.
      4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
   C. Coordination Drawings: Plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
      1. Suspended ceiling components.
      2. Structural members to which unit heaters will be attached.
      3. Other items, including the following:
         a. Lighting fixtures.
         b. Sprinklers.
   D. Field quality-control test reports.
   E. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

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

PART 2 - PRODUCTS

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

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

2.2 UNIT HEATERS

A. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

B. Comply with UL 2021.

C. Comply with UL 823.

2.3 CASING

A. Cabinet: Removable panels for maintenance access to controls.

B. Cabinet Finish: Stainless steel.

C. Washdown duty rated.

2.4 ELECTRIC-RESISTANCE HEATING ELEMENTS

A. Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.
   2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

2.5 FAN

A. Propeller type, aluminum wheel directly mounted on motor shaft in the fan venturi.

2.6 FAN MOTORS

A. Motor Type: Permanently lubricated, open drip proof.

2.7 CONTROLS

A. Control Devices:
   1. Unit-mounted thermostat.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Examine roughing-in for piping and electrical connections to verify actual locations before propeller unit-heater installation.

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

3.2 INSTALLATION

A. Install propeller unit heaters level and plumb.

B. Install propeller unit heaters to comply with NFPA 90A.

C. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers. Hanger rods and attachments to structure are specified in Specification Section "Hangers and Supports."

D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls.

3.3 CONNECTIONS

A. Ground equipment according to Specification Section "Grounding and Bonding."

B. Connect wiring according to Specification Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing and report results in writing:
   1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
   3. Test and adjust controls and safeties.

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

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters. Refer to Section "Demonstration and Training."

END OF SECTION 23 0767
SECTION 23 2300

REFRIGERANT PIPING

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes refrigerant piping used for air-conditioning applications.
   B. Related Sections include the following:
      1. Specification Section "Hangers and Supports" for pipe supports and installation requirements.
      2. Specification Section "Mechanical Identification" for labeling and identifying refrigerant piping.

1.3 SUBMITTALS
   A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for thermostatic expansion valves, solenoid valves, and pressure-regulating valves.
   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 relationship between piping and equipment.
      1. Refrigerant piping indicated is schematic only. Size piping and design the actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes, to ensure proper operation and compliance with warranties of connected equipment.

1.4 QUALITY ASSURANCE
   B. ASME Standard: Comply with ASME B31.5, "Refrigeration Piping."
   C. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Nonelectrical"; or UL 429, "Electrically Operated Valves."

1.5 COORDINATION
   A. Coordinate layout and installation of refrigerant piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
   B. Coordinate pipe sleeve installations for foundation wall penetrations.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Refrigerants:
      a. Allied Signal, Inc./Fluorine Products; Genetron Refrigerants.
      b. DuPont Company; Fluorochemicals Div.
      d. ICI Americas Inc./ICI KLEA; Fluorochemicals Bus.
   2. Refrigerant Valves and Specialties:
      a. Climate & Industrial Controls Group; Parker-Hannifin Corp.; Refrigeration & Air Conditioning Division.
      b. Danfoss Electronics, Inc.
      c. Emerson Electric Company; Alco Controls Div.
      d. Henry Valve Company.
      e. Sporlan Valve Company.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: ASTM B 280, Type ACR

B. Annealed-Temper Copper Tube: ASTM B 280, Type ACR

C. Wrought-Copper Fittings: ASME B16.22.

D. Wrought-Copper Unions: ASME B16.22.

E. Bronze Filler Metals: AWS A5.8, Classification BAg-1 (silver)

2.3 REFRIGERANT PIPING SPECIALITIES

A. Straight- or Angle-Type Strainers: 500-psig working pressure; forged-brass or steel body with stainless-steel wire or brass-reinforced Monel screen of 80 to 100 mesh in liquid lines up to 1-1/8 inches, 60 mesh in larger liquid lines, and 40 mesh in suction lines; with screwed cleanout plug and solder-end connections.

B. Moisture/Liquid Indicators: 500-psig maximum working pressure and 200 deg F operating temperature; all-brass body with replaceable, polished, optical viewing window with color-coded moisture indicator; with solder-end connections.

2.4 REFRIGERANTS

A. ASHRAE 34, R-134a: Tetrafluoroethane.

B. ASHRAE 34, R-410a: Difluoromethane/Pentafluoroethane blend.

PART 3 – EXECUTION
3.1 PIPING APPLICATIONS
   A. Aboveground, within Building: Type ACR drawn-copper tubing

3.2 SPECIALTY APPLICATIONS
   A. Install liquid indicator upstream of filter-dryer in liquid line leaving condenser.
   B. Install permanent filter-dryers in systems using hermetic compressors.
   C. Install moister-liquid indicators in liquid lines between filter-dryers and fan/coil units.
   D. Install strainers immediately upstream from each automatic valve, including expansion valves, solenoid valves, hot-gas bypass valves.

3.3 PIPING INSTALLATION
   A. Install refrigerant piping according to ASHRAE 15.
   B. Basic piping installation requirements are specified in Specification Section "Basic Mechanical Materials and Methods."
   C. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
   D. Arrange piping to allow inspection and service of compressor and other equipment. Install valves and specialties in accessible locations to allow for service and inspection.
   E. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
   F. Slope refrigerant piping as follows:
      1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
      2. Install horizontal suction lines with a uniform slope downward to compressor.
      3. Install traps and double risers to entrain oil in vertical runs.
      4. Liquid lines may be installed level.
      5. Install bypass around moisture-liquid indicators in lines larger than NPS 2.
      6. Install unions to allow removal of solenoid valves, press-regulating valves, and expansion valves and at connections to compressors and evaporators.
   H. When brazing, 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.
   I. Hanger, support, and anchor products are specified in Specification Section "Hangers and Supports."
   J. Install the following pipe attachments:
      1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
      2. Roller hangers and spring hangers for individual horizontal runs, 20 feet or longer.
      3. Pipe rollers for multiple horizontal runs 20 feet or longer, supported by a trapeze.
      4. Spring hangers to support vertical runs.
   K. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

L. Support vertical runs at each floor.

3.4 PIPE JOINT CONSTRUCTION
A. Braze joints according to Specification Section “Basic Mechanical Materials and Methods.”
B. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide) during brazing to prevent scale formation.

3.5 FIELD QUALITY CONTROL
A. Test and inspect refrigerant piping according to ASME B31.5, Chapter VI.
   1. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure.
   2. Test high- and low-pressure side piping of each system at not less than the lower of the design pressure or the setting of pressure relief device protecting high and low side of system.
   3. System shall maintain test pressure at the manifold gage throughout duration of test.
   4. Test joints and fittings by brushing a small amount of soap and glycerin solution over joint.
   5. Fill system with nitrogen to raise a test pressure of 150 psig or higher as required by authorities having jurisdiction.
   6. Remake leaking joints using new materials and retest until satisfactory results are achieved.

3.6 ADJUSTING
A. Perform the following adjustments before operating the refrigeration system, according to manufacturer’s written instructions:
   1. Check compressor oil level above center of sight glass.
   2. Open compressor suction and discharge valves.
   3. Open refrigerant valves, except bypass valves that are used for other purposes.
   4. Check compressor-motor alignment, and lubricate motors and bearings.

3.7 SYSTEM CHARGING
A. Charge system using the following procedures:
   1. Install permanent-type filter-dryer after leak test but before evacuation.
   2. Evacuate entire refrigerant system with a vacuum pump to a vacuum of 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
   3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
   4. Charge system with a new permanent-type filter-dryer in charging line. Provide full-operating charge.
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.

1.2 SUMMARY

A. Section Includes:
1. Single-wall rectangular ducts and fittings.
2. Double-wall rectangular 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.
10. Ductwork Cleaning

B. Related Sections:
1. Mechanical Specification Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing requirements for metal ducts.
2. Mechanical Specification Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
3. Mechanical Specification Section "Hangers & Supports".
4. Mechanical Specification Section "Basic Mechanical Materials and Methods".
5. Mechanical Specification Section "Special Conditions for Mechanical Work".

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated.

1. Static-Pressure Classes: Variable Volume Systems
   a. Supply Ducts: (Upstream from Air Terminal Units): 3-inch wg.
   b. Supply Ducts (Downstream from Air Terminal Units): 1-inch wg.
   d. Outside Air Ducts (Negative Pressure): 1-inch wg.

2. Static-Pressure Classes: Constant Volume Systems
   a. Supply Ducts: 2-inch wg.
   c. Outside Air Ducts (Negative Pressure): 1-inch wg.

3. Static-Pressure Classes: Other Systems
   b. General Exhaust (Negative Pressure): 1-inch wg.
   c. Relief Air: 1-inch wg.
4. Leakage Class:
   a. Round Supply-Air Duct: 3 cfm/100 sq. ft. at static pressure class.
   b. Flat-Oval Supply-Air Duct: 3 cfm/100 sq. ft. at static pressure class.
   c. Rectangular Supply-Air Duct: 6 cfm/100 sq. ft. at static pressure class.
   d. Flexible Supply-Air Duct: 6 cfm/100 sq. ft. at static pressure class.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1.4 DEFINITIONS

A. Exposed: Open to view; not concealed by a ceiling.
   1. Includes mechanical rooms.
   2. Includes outdoors.
   3. Includes crawlspace.

B. Concealed: Covered or Concealed by a ceiling, solid inaccessible or lay-in acoustical tile.

1.5 SUBMITTALS

A. Product Data: For each type of the following products:
   1. Liners and adhesives.
   2. Sealants and gaskets.
   3. Insulation.
   4. Metal.
   5. Fasteners.
   6. Hangers.
   7. Double Wall Ductwork (Round or Flat Oval).
   8. Single Wall (Round or Flat Oval).

B. Shop Drawings/Coordination Drawings: CADD generated, ¼" scale. Show fabrication and installation details for metal ducts.
   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 (where applicable).
   13. Ceiling suspension assembly members.
   14. Other systems installed in same space as ducts, including fire sprinkler piping; electrical conduits; cable trays; hydronic, domestic, and sanitary piping; and structural members.
   15. Ceiling-and-wall-mounting access doors and panels required to provide access to dampers and other operating devices.
16. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

C. Welding certificates.

D. Field quality-control reports.

E. Field Pressure test Reports.

1.6 QUALITY ASSURANCE

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

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 1-4, "Transverse (Girth) Joints," for static-pressure class, 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 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, 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 2, "Fittings and Other Construction," for static-pressure class, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Seal all duct transverse joints, longitudinal seams, flanges, and duct wall penetrations (SMACNA Seal Class-A regardless of static pressure construction class).

2.2 DOUBLE-WALL RECTANGULAR DUCTS AND 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. McGill Airflow LLC.

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 1-4, "Transverse (Girth) Joints," for static-pressure class, 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 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Thickness:
   a. 1 inch, minimum for INDOOR, exposed ducts in conditioned spaces.
   b. 1-1/2 inches, minimum for INDOOR ducts in unconditioned spaces, including, but not limited to return-air plenums and mechanical rooms.
   c. 2-1/2 inches, minimum for OUTDOOR ducts.
3. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
4. Coat insulation with antimicrobial coating.

G. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, " Traverse (Girth) 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."

H. Seal all duct transverse joints, longitudinal seams, flanges and duct wall penetrations (SMACNA Seal Class-A regardless of static pressure construction class).

2.3 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Spiral seams complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class. Longitudinal-seams (snap-lock) are not acceptable for any application.
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. Lindab Inc.
   b. McGill AirFlow LLC.
   c. SEMCO Incorporated.
   d. Spiral Pipe of Texas
   e. Direct Duct

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter (diameter of the round sides connecting the flat portions of the duct).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, 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. Seams: Fabricate according to the **spiral seam requirements** of SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." **Longitudinal-seams (snap-lock) are not acceptable for any application, except where indicated below.**

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 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "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."

F. Seal all duct transverse joints, longitudinal seams, flanges and duct wall penetrations (SMACNA Seal Class-A regardless of static pressure construction class).

2.4 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND 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. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated.
4. Spiral Pipe of Texas
5. Direct Duct

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter (diameter of the round sides connecting the flat portions of the duct) of the inner duct.

C. Outer Duct Fabrication Requirements: **Spiral seams** complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class. **Longitudinal-seams (snap-lock) are not acceptable for any application.**

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," 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. Seams: Fabricate according to the **spiral seam requirements** of SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," 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." **Longitudinal-seams (snap-lock) are not acceptable for any application, except where indicated below.**
   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 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "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."

D. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent.

E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
   2. Thickness:
      a. 1 inch, minimum for INDOOR, exposed ducts in conditioned spaces.
      b. 1-1/2 inches, minimum for INDOOR ducts in unconditioned spaces, including, but not limited to return-air plenums and mechanical rooms.
      c. 2-1/2 inches, minimum for OUTDOOR ducts.
   3. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
   4. Coat insulation with antimicrobial coating.
   5. Cover insulation with polyester film complying with UL 181, Class 1.

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, rust, stains, discolorations, and other imperfections. All ductwork shall be a minimum of 24 gage, with a minimum thickness of 0.023 inches. Where in the SMACNA “HVAC Duct Construction Standards-Metal Flexible” it is indicated that a lighter gage to a minimum of 24 gage.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60 (Z180).
   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 (Z180).
   2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 4 mils thick on opposite surface.
   3. 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 (ASTM B 209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. 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.

H. 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.

I. Plastic Connectors are not acceptable.

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. CertainTeed Corporation; Insulation Group.
      b. Johns Manville.
      c. Knauf Insulation.
      d. Owens Corning.
      e. Maximum Thermal Conductivity:
         1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
         2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
   2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
   3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916. Equal to DP 2502.

B. Insulation Pins and Washers:
   1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer. Equal to CS-10.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "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. 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.
7. 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.

8. 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. All products are to contain low V.O.C. as defined/governed by LEED IEQ 4.1 and 4.2 (Regardless of project type).

B. Water-Based Joint and Seam Sealant (for indoor installation):
   1. Application Method: Brush on.
   2. Solids Content: Minimum 68 percent.
   3. Water resistant.
   4. Mold and mildew resistant.
   5. VOC: less than 30 g/l (less water).
   6. Maximum Static-Pressure Class: 15-inch wg, positive and negative.
   7. Service: Indoor.
   8. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
   9. DP 1020 or approved equal.

C. Water-Based Joint and Seam Sealant (for outdoor installation):
   1. Application Method: Tube application or dry tooling.
   3. Water resistant.
   4. Mold and mildew resistant.
   5. Service: Indoor.
   6. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
   7. Sonolastic NP-1 or approved equal.

D. Flanged Joint Sealant: Comply with ASTM E-84.
   1. General: Butyl gasket tape.
   2. Type: Butyl Rubber.
   3. Service Temperature: Minus 40°F to 245°F
   4. Pressure Class: All
   5. DP 1040

2.8 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

E. Trapeze and Riser Supports:
   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. All ductwork sizes indicated on drawings are internal, free area dimensions. 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".

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

H. Coordinate layout with suspended ceiling, fire-and smoke-control dampers, lighting layouts, and similar finished work.

I. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws. Sealant of seams/joints to include (but not limited to): all joints (including gasketed joints) metal seams, taps, any connections, etc.

J. Paint interiors of metal ducts that do not have duct liner, for 24 inches (600 mm) upstream of return air registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 9 painting Sections.

K. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
L. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness. Compression of insulation by other trades (pipe, conduit, etc) is not acceptable.

M. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

N. Where ducts pass through non-fire-rated interior partitions and exterior walls, 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.

O. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Mechanical Specification Section "Air Duct Accessories" for fire and smoke dampers.

P. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

Q. Horizontal ductwork in mechanical rooms must be installed a minimum of 8'-0" AFF.

R. All duct floor penetrations must have a water-tight, continuous concrete curb surrounding them. Minimum curb size shall be 3-1/2" tall X 3-1/2" wide.

3.2 DUCTWORK HANDLING AND PLENUM PROTECTION

A. All ductwork shall be delivered to site and stored with all openings protected from the elements. Protection to include 2.5 mil thick polyethylene plastic film secured with tape or integral elastic band.

B. Each segment/section of ductwork installed is to be appropriately protected from elements.

C. Any ductwork damaged during delivery, installation, or at any time during construction will be removed from job and replaced.

D. Ductwork found onsite (installed or stored) without approved protection will be removed from job and replaced.

E. Ductwork installed exposed to the elements to be sealed (joints and seems) immediately after installation. Any ductwork not sealed is susceptible to rejection and removed from job.

F. Under no circumstances shall insulation be applied to ductwork prior to the building being fully dried in (i.e.: building sealed, windows and roof installed, etc). Any ductwork being insulated prior to building dry-in is susceptible to rejections and removed from job.

G. If ductwork is found onsite not protected or the newly installed ductwork is deemed as dirty, engineer can elect for the contractor to clean all duct at no cost to the owner per NADCA 1992.

3.3 SEAM AND JOINT SEALINGS

A. Seal all duct transverse joints, longitudinal seams, flanges and duct wall penetrations (SMACNA Seal Class-A regardless of static pressure construction class).

3.4 HANGERS AND SUPPORT INSTALLATION
A. Comply with SMACNA’s “HVAC Duct Construction Standards – Metal and Flexible,” Chapter 4 “Hangers and Supports,” unless otherwise indicated.
   1. Support rectangular ducts greater than 36 inches with width with trapeze threaded rod and angle or channel supports. Straps not acceptable.
   2. Rectangular Duct Hangers Exposed to View: Threaded rod and channel supports (do not use steel angles).

B. Building Attachments: Concrete inserts or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.

C. Hanger Spacing: Comply with SMACNA’s “HVAC Duct Construction Standards-Metal and Flexible,” Table4-1 (Table 4-1M), “Rectangular Duct Hangers Minimum Size,” and Table 4-2, “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. Elbows 36” and larger to be individually supported.

D. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16’ feet. Support vertical ducts in a manner that introduces minimal weight onto the roof curb flange.

E. 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.
   1. Do not attach hangers to metal deck roof assemblies with built-up insulation only (no concrete). Attach only to structural steel members.

3.5 CONNECTIONS

A. Make all connections to all fan-bearing equipment with flexible connectors complying with Specification Section “Air Duct Accessories”.

B. Comply with SMACNA’s “HVAC Duct Construction Standards – Metal and Flexible” for branch, outlet and inlet, and terminal unit connections. Reference detail for specific additional items required.

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 Division 09 painting Sections.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:
   1. Comply with SMACNA’s “HVAC Air Duct Leakage Test Manual.” Leakage Class defined in previous sections of specification. Amount of ductwork to be tested to be determined by Engineer or Field Inspector).
   2. Test the following systems:
a. Medium Pressure Ductwork (3-Inch wg), up to Air Terminal (branch taps included): Test representative duct sections totaling no less than 100 percent of total installed duct area.
b. Low Pressure Supply Ducts: Test representative duct totaling no less than 20 percent of total installed duct area.
c. Return Ducts: Test representative duct sections totaling no less than 20 percent of total installed duct area.
d. Exhaust Ducts: Test representative duct sections totaling no less than 20 percent of total installed duct area.
e. Outdoor Air Ducts: Test representative duct sections totaling no less than 20 percent of total installed duct area.
f. Grease Laden/Dishwasher Exhaust: Test representative duct sections per IMC “Light Test.”

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before insulation application.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Contractor to disassemble, reassemble and seal segments of systems to accommodate leakage testing and for compliance with test requirements / leakage rates.

E. All testing equipment to be calibrated (by manufacturer) within 3 years of onsite duct pressure testing. Documentation to be provided for verification of certification to Engineer through submittal process.

F. Test Coupons: Cut out three (3) 4x4” test coupons in random locations selected by the design engineer for verification of gage thickness. Coupons shall be taken at the time of pressure testing.

G. Prepare test and inspection reports.

3.8 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as follows:

1. Acid-Resistant (Fume-Handling) Ducts:
   a. Type 304, stainless-steel sheet – welded.
   b. Exposed to View: No. 4 finish.
   c. Concealed: No. 2D finish.
3. Spaces with pools, spas, hot tubs or water features: Aluminum.

B. Intermediate Reinforcement:
2. Stainless-Steel Ducts: Galvanized steel.
3. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.

C. Liner:
1. Transfer Ducts: Fibrous glass, Type I 1 inch thick.

D. Double-Wall Duct Schedule:
1. All exposed Round/Flat Oval Ductwork.

E. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA’s “HVAC Duct Construction Standards – Metal and Flexible,” Figure 2-2, “Rectangular Elbows”.
   a. Velocity 1000 fpm or Lower:
      1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      2) Mitered Type RE 4 without vanes.
   b. Velocity 1000 to 1500 fpm:
      1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with vanes complying with SMACNA’s “HVAC Duct Construction Standards – Metal and Flexible,” Figure 2-3, “Vanes and Vane Runners,” and Figure 2-4, “Vane Support Elbows.”
   c. Velocity 1500 fpm (7.6 m/s) or Higher:
      1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with vanes complying with SMACNA’s “HVAC Duct Construction Standards – Metal and Flexible,” Figure 2-3, “Vanes and Vane Runners,” and Figure 2-4, “Vane Support in Elbows.”

2. Round Duct: Comply with SMACNA’s “HVAC Duct Construction Standards – Metal and Flexible,” Figure 3-3, “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) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      3) Velocity 1500 fpm or higher: 1.5 radius-to-diameter and five segments for 90-degree elbow.
   b. Round Elbows, 12 inches and smaller diameter: Stamped or pleated.
   c. Round Elbows, 14 inches and larger in diameter: Welded.

F. Branch Configuration
   1. Rectangular Duct: Comply with SMACNA’s “HVAC Duct Construction Standards-Metal and Flexible,” Figure 2-6, “Branch Connections.”
      a. Rectangular Main to Rectangular Branch: 45-degree entry.
      b. Rectangular Main to Round Branch: Side takeoff fitting.
   2. Round and Flat Oval: Comply with SMACNA’s “HVAC Duct Construction Standards – Metal and Flexible,” Figure 3-4, “90 Degree Tees and Laterals,” and Figure 3-5, “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.

3.9 CLEANING NEW SYSTEMS

A. If ductwork is found onsite not protected or the newly installed ductwork is deemed as dirty, engineer can elect for the contractor to clean all duct at no cost to the owner per NADCA 1992.

B. System Cleaning: (If required)
   1. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.
2. Provide service openings (approved duct access doors), as required, for physical and mechanical entry during cleaning and for inspection. All duct access doors to be installed prior to any duct pressure tests.
   a. Removed and reinstall ceiling sections to gain access during the cleaning process.
3. Vent vacuuming system to the outside. Include filtration to conation debris removed from HVAC systems, and locate exhaust down wind and minimum of 20 feet away from air intakes and other points of entry into building.
4. Clean the following metal duct systems by removing surface contaminants and deposits:
   a. Air outlets and inlets (registers, grilles and diffusers).
   b. 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.
   c. Air-handling unit internal surfaces and components including mixing box, coil section, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   d. Coils and related components.
   e. Return-air ducts, dampers and actuators except in ceiling plenums and mechanical equipment rooms.
   f. Supply-air ducts, dampers, actuators and turning vanes.
5. Mechanical Cleaning Methodology:
   a. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
   b. 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.
   c. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner or duct accessories.
   d. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do no permit duct liner to get wet.
   e. 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. Cleanliness Verification:
   a. Visually inspect metal ducts for contaminants.
   b. Where contaminants are discovered, re-clean and re-inspect ducts.

END OF SECTION
SECTION 23 3300
DUCT ACCESSORIES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Backdraft dampers.
   3. Fire dampers.
   4. Fire and smoke dampers.
   5. Turning vanes.
   6. Duct-mounted access doors and panels.
   7. Flexible ducts.
   8. Flexible connectors.
  10. Duct accessory hardware.
  11. Motorized control dampers.

B. Related Sections include the following:
   2. Specification Section "Louvers and Vents" for intake and relief louvers and vents connected to ducts and installed in exterior walls.
   3. Specification Section "Air Terminals" for constant-volume and variable-air-volume control boxes and reheat boxes.
   4. Specification Section "Air Inlets and Outlets."
   5. Specification Section "HVAC Controls" for electric damper actuators.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Backdraft dampers.
   3. Fire dampers.
   4. Fire and smoke dampers.
   5. Duct-mounted access doors and panels.
   6. Flexible ducts.
   7. Motorized control dampers.
   8. Side takeoff fittings

1.4 QUALITY ASSURANCE

A. NFPA Compliance: Comply with the following NFPA standards:
   1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
   1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. Galvanized, Sheet Steel: Lock-forming quality; ASTM A 653/A 653M, G90 (Z275) coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.

B. Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

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

2.2 BACKDRAFT DAMPERS

A. Description: Suitable for horizontal or vertical installations.

B. Frame: 0.063-inch thick extruded aluminum, with mounting flange.

C. Blades: 0.050-inch thick aluminum sheet.

D. Blade Seals: Felt.

E. Blade Axles: Nonferrous.

F. Tie Bars and Brackets: Aluminum.

G. Return Spring: Adjustable tension.

2.3 MANUAL-VOLUME DAMPERS

A. General: Factory fabricated with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
   1. Pressure Classifications of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

B. Standard Volume Dampers: Multiple- or single-blade, opposed-blade design, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
   1. Roll-Formed Steel Blades: 0.064-inch thick, galvanized, sheet steel.
   3. Tie Bars and Brackets: Galvanized steel.
   4. 1-1/2-inch insulation buildout with locking quadrant.
C. Low-Leakage Volume Dampers: Multiple- or single-blade, opposed-blade design, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
   1. Steel Frames: Hat-shaped, galvanized, sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
   2. Roll-Formed Steel Blades: 0.064-inch thick, galvanized, sheet steel.
   5. Tie Bars and Brackets: Galvanized steel.
   6. 1-1/2-inch insulation buildout with locking quadrant.

D. Jackshaft: 1-inch diameter, galvanized steel pipe rotating within a pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
   1. Length and Number of Mountings: Appropriate to connect linkage of each damper of a multiple-damper assembly.

E. Damper Hardware: 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. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.4 FIRE DAMPERS

A. General: Labeled to UL 555 (sixth edition). Ruskin Model D1BD2-B (or design engineer approved equivalent). Dampers shall be marked with a UL-Classified fire protection rating and marked “For Use in Dynamic Systems”.

B. Fire Rating: One and one-half and/or three hours as indicated.

C. Frame: SMACNA Type B with blades out of airstream; fabricated with roll-formed, 0.034-inch thick galvanized steel; with mitered and interlocking corners.

D. Mounting Sleeve: Provide factory-mounted sleeve and retaining angles.
   1. Minimum Thickness (Sleeve shall not extend more than 6” past wall or floor without factory installed access door): 16 gauge and length to suit application.

E. Mounting Orientation: Vertical or horizontal as indicated.

F. 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.

G. Horizontal Dampers: Include a blade lock and stainless-steel negator closure spring.

H. Fusible Link: Replaceable, 165 deg F rated as indicated.

2.5 COMBINATION FIRE / SMOKE DAMPERS (SFD)

A. General: Labeled to UL 555/UL 555S (sixth and fourth edition respectively) Combination fire and smoke dampers shall be labeled for one-and-one-half-hour rating to UL 555S. Provide Class II leakage rating. Dampers shall be marked with a UL-classified fire rating. Ruskin FSD-60 or approved equivalent. The SFD shall be listed to operate from the fire alarm control panel (FACP). Each SFD shall have an associated smoke detector that shall be addressable from the FACP. The smoke detector shall be provided by the Fire Alarm Contractor and installed by the Electrical Contractor. Coordinate damper installation with these trades.
B. Electric Fusible Link (EFL): 165 or 212 deg F rated as applicable.

C. Frame and Blades: 16 gauge, galvanized, sheet steel. Damper blades shall be airfoil-shaped, single-piece construction, with blade seals mechanically locked into blade edge (adhesive clip-on seals are not acceptable). Ruskin FSD-60 or equivalent. Damper blades shall be minimum 14 gauge. SFD’s installed off vertical chases shall have vertical airfoil blades (Ruskin FSD 60-V or equivalent).

D. Mounting Sleeve: Factory-installed, 16 gauge, galvanized, sheet steel; length to suit wall or floor application. Sleeve shall not extend more than 6” past wall or floor without factory installed access door. SFD shall be capable of mounting on either side of wall and working with airflow in either direction. Provide manufacturer-recommended duct-to-sleeve joints.

E. Electric controlled closure is not less than 7 seconds or more than 10 seconds to prevent HVAC and duct damage. Damper shall have local reset button and shall have automatic reset after test, smoke detection or power failure conditions. Damper shall close upon loss of power or AHU shut down. Actuator shall be 120V.

F. Provide with stainless steel jam seals and bearings. (Bronze bearings are not acceptable)

G. Furnish and install dampers according to manufacturer’s instructions and in compliance with the latest edition of the SMACNA Duct Manual and NFPA Standards (90, 92A, and 92B).

2.6 TURNING VANES

A. Fabricate to comply with SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible."

B. Manufactured Turning Vanes: Fabricate of 1-1/2-inch wide, curved blades set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into side strips suitable for mounting in ducts.

2.7 DUCT-MOUNTED ACCESS DOORS AND PANELS

A. Provide where indicated on drawings low leakage spin-in access doors for sheet metal applications. Flexmaster Inspector series.

B. The outer frame shall be constructed of a single piece of 24-gauge G90 galvanized steel roll formed and notched for spin-in applications. The entry side shall be roll formed and double hemmed for safe entry and exit.

C. The inner door shall be constructed of a 24-gauge draw quality steel, filled with a 1-inch thick polystyrene insulation and held in place by a galvanized steel backplate (stainless steel backplate may be substituted as required).

D. A continuous .375-inch wide by .1875-inch thick open cell adhesive neoprene gasket shall be installed in the door frame to provide a positive seal upon insertion and locking of the door.

E. The door shall be held secure with evenly spaced cast aluminum cam latches for even pressure against the gasket.

2.8 FLEXIBLE CONNECTORS

A. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
B. Standard Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches wide attached to two strips of 2-3/4-inch wide, 0.028-inch thick, galvanized, sheet steel or 0.032-inch aluminum sheets. Select metal compatible with connected ducts.

   1. Minimum Weight: 26 oz./sq. yd.
   2. Tensile Strength: 480 lbf/inch in the warp, and 360 lbf/inch in the filling.

D. Conventional, Outdoor System Flexible Connector Fabric: Glass fabric double coated with a synthetic-rubber, weatherproof coating resistant to the sun's ultraviolet rays and ozone environment.
   1. Minimum Weight: 26 oz./sq. yd.
   2. Tensile Strength: 530 lbf/inch in the warp, and 440 lbf/inch in the filling.

2.9 INSULATED FLEXIBLE DUCT, LOW PRESSURE

A. Flexmaster type 1M UL181 Class I Air Duct. (No exceptions)

B. The duct shall be constructed of a PE fabric supported by helical wound galvanized steel. The fabric shall be mechanically locked to the steel helix without the use of adhesives or chemicals.

C. The internal working pressure rating shall be at least 6" w.g. positive and 4" w.g. negative, with a bursting pressure of at least 2-1/2 times the working pressure.

D. The duct shall be rated for a velocity of at least 4000 feet per minute.

E. The duct must be suitable for continuous operation at a temperature range of -20 deg F to +250 deg F.

F. Acoustical performance, when tested by an independent laboratory in accordance with the Air Diffusion Council's *Flexible Air Duct Test Code FD 72-R1*, Section 3.0, Sound Properties, shall be as follows:
   1. The insertion loss (dB) of a 6-foot length of straight duct when tested in accordance with ASTM E 477, at a velocity of 500 feet per minute, shall be at least:

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G. Factory insulate the flexible duct with fiberglass insulation. The R-value shall be at least 6 at a mean temperature of 75 deg F.

H. Cover the insulation with a fire retardant metalized vapor barrier jacket reinforced with crosshatched scrim (FSK) having a permeance of not greater than 0.05 perms when tested in accordance with ASTM E 96, Procedure A.

2.10 SIDE TAKEOFF FITTINGS
A. Provide Flexmaster Model STOD or SBMD takeoff for sheet metal for all taps connecting to flex duct, except for air devices with OBD's and flow bar. For devices with OBD, use Flexmaster Model STO- or SBM no exceptions.

B. The side takeoff fittings shall maintain a ratio of 1:1 of inlet to outlet on all units over 7-inch diameter to allow proper sizing of the duct system.

C. Model STOD side takeoff shall have a 1-inch offset rear edge for enhanced pressure drop characteristics and 1-1/2-inch insulation buildout with locking hand quadrant.

D. Fittings shall have a 1-inch-wide prepunched mounting flange with corner clips and adhesive gasket for minimal leakage and ease of installation.

E. The fittings shall be constructed of a two-piece 26-gauge G-90 galvanized steel body and collar.

F. The overall length of the fitting shall be 13 inches with or without damper to reduce turbulence in the airstream.

G. The round outlet shall be provided with a rolled stiffener bead for strength and ease of installation and sealing of spiral and flexible ductwork joints.

2.11 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 length to suit duct insulation thickness.

B. Splitter Damper Accessories: Zinc-plated damper blade bracket; 1/4-inch, zinc-plated operating rod; and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.

C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 to 18 inches to suit duct size.

D. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.12 MOTORIZED CONTROL DAMPERS

A. Manufacturers:
   1. Greenheck.
   2. Nailor Industries Inc.
   3. Ruskin Company.
   4. Pottorf.

B. General Description: AMCA-rated, opposed-blade design; minimum of 0.1084-inch thick, galvanized-steel frames with holes for duct mounting; minimum of 0.0635-inch thick, galvanized-steel damper blades with maximum blade width of 8 inches.
   1. Secure blades to ½-inch diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
   2. Operating Temperature Range: From minus 40 to plus 200 deg F.
   3. Provide parallel- or opposed-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm per sq. ft. of damper
area, at differential pressure of 4-inch wg when damper is being held by torque of 50 in.\texttimes lbf (5.6 N\texttimes m); when tested according to AMCA 500D.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details shown in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and NAIMA's "Fibrous Glass Duct Construction Standards" for fibrous-glass ducts.

B. When installing volume dampers in lined duct, avoid damage to and erosion of duct liner.

C. Install manual volume dampers at all main branch lines for ease of balancing.

D. Provide test holes at fan inlet and outlet and elsewhere as indicated.

E. Install fire and smoke dampers according to manufacturer's UL-approved written instructions.
   1. Install fusible links in fire dampers.

F. Install mounting angles, minimum of 1 \( \frac{1}{2} \) "x 1 \( \frac{1}{2} \) "x 20 gauge steel on both sides of SFD or FD.

G. Install duct access panels for access to both sides of duct coils. Install duct access panels downstream from volume dampers, fire dampers, smoke-fire dampers, turning vanes, and equipment.

H. Install duct access panels to allow access to interior of ducts for cleaning, inspecting, adjusting and maintaining accessories and terminal units.
   1. Install access panels on side of duct where adequate clearance is available.
   2. Label access doors according to Specification Section "Mechanical Identification."

3.2 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Specification Section "Testing, Adjusting, and Balancing."

END OF SECTION
SECTION 23 3423
HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Ceiling-mounting ventilators.
   2. Centrifugal roof ventilators
   3. Destratification fans
   4. In-line centrifugal fans.
   5. Propeller fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

C. Fan Unit Schedule: The following information is described in an equipment schedule on the Drawings.
   1. Fan performance data including capacities, static pressure, sound power characteristics, motor requirements and electrical characteristics.
   2. Fan arrangement, including wheel configuration inlet and discharge configurations and required accessories.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties and accessories for each type of product indicated and include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages and operators.
   6. Roof curbs.
   7. Fan speed controllers.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components and location and size of each field connection.
   2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and base weights.

C. Coordination Drawings: Show roof penetration requirements and reflected ceiling plans drawn to scale and coordinating roof penetrations and units mounted above ceiling. Show the following:
   1. Roof framing and support members relative to duct penetrations.
   2. Ceiling suspension assembly members.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

D. Maintenance Data: For power ventilators to include in maintenance manuals specified in Division 1.

1.5 QUALITY ASSURANCE

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

B. AMAC Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

E. Listing and labeling: Provide electrically operated fixtures specified in this section that are listed and labels.
   1. The terms “Listed” and “Labeled”. As defined in the Nations Electrical Code, Article 100.
   2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing laboratory" (NTRL) as defined in OSHA Regulation 1910.7.

F. UL Standard: Provide Power Ventilators that comply with UL 762, grease laden air at 300 deg. F where applicable (kitchen exhaust).

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, are required for moving to final location, according to manufacturer’s written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.
B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Specification Section “Cast-In-Place Concrete”.

C. Coordinate installation of roof curbs, equipment supports and roof penetrations. These items are specified in Specification Section “Roof Accessories”.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Belts: One set for each belt-driven unit.

1.9 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field Measurements. Verify clearances.

B. Do not operate fans until ductwork is clean, filters are in place, bearings are lubricated and fans have been commissioned.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Centrifugal Roof Ventilators:
      a. Cook, Loren Company
      b. Envirofan
      c. Greenheck Fan Corp.
      d. Leading Edge

2.2 CEILING-MOUNTING VENTILATORS

A. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.

B. Housing: Steel, lined with acoustical insulation

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor and fan wheel shall be removable for service.

D. Grille: Painted aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Filter: Washable aluminum to fit between fan and grille.
4. Manufacturer’s standard roof jack or wall cap and transition fittings.

G. Capacities and Characteristics: Refer to drawing schedules.

2.3 CENTRIFUGAL ROOF VENTILATORS – DOWNBLAST

A. Description: Belt-driven or direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base and accessories.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, two-piece, aluminum base with venturi inlet cone.

C. Fan Wheels: aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
   1. Fan Shaft: turned, ground, and polished stainless steel; keyed to wheel hub.
   2. Shaft Bearings: Heavy-duty re-greasable ball type in a pillow block cast iron housing, selected for a minimum L50 life in excess of 200,000 hours.
   4. Fan and motor isolated from exhaust airstream.
   5. Belts: Oil and heat resistant, nonstatic.

E. Accessories: The following items are required as indicated:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to less than 50 percent (required on direct drive fans only).
   2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
   3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
   4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base. Built in cant and mounting flange.
   2. Overall Height: 18 inches
   3. Pitch Mounting: Manufacture curb for roof slope, if necessary.

2.4 CENTRIFUGAL ROOF VENTILATORS – UPBLAST

A. Description: Belt-driven or direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories. Grease laden fans to comply with UL 762 Grease Laden Air.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, two-piece, aluminum base with venturi inlet cone.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
   1. Fan Shaft: Turned, ground and polished stainless steel; keyed to wheel hub.
2. Shaft Bearings: heavy-duty re-greasable ball type in a pillow block cast iron housing, selected for a minimum L50 life in excess of 200,000 hours.
4. Fan and motor isolated from exhaust airstream.

E. Accessories: The following items are required as indicated:
   1. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through in internal aluminum conduit.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
   2. Overall Height: 18 inches
   3. Pitch Mounting: Manufacture curb for roof slope, if necessary.
   5. Vented Curb Extension, with hinged curb cap.

2.5 DESTRATIFICATION FANS

A. Ceiling Fans 60” diameter 3 blade fan, dynamically balanced with permanently lubricated ball bearing motor, U.L. listed (UL 507), with all necessary hooks and supports for a complete installation. Provide solid state speed controllers and secondary support cable.


2.6 IN-LINE CENTRIFUGAL FANS

A. Description: In-line, direct or belt-driven (as scheduled on the drawings) centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets and accessories.

B. Housing: Spilt, spun aluminum with aluminum straightening vanes, inlet and outlet flanges and support bracket adaptable to floor, side wall or ceiling mounting.

C. Direct-Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Aluminum, air foil blades welded to aluminum hub.

F. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Companion Flanges: For inlet and outlet duct connections.
   3. Fan Guards: 1/2 by 1 inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
   4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

G. Capacities and Characteristics: Refer to drawing schedules.
2.7 PROPELLER FANS

A. Description: Direct-or belt-driven (as scheduled on the drawings) propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly and accessories.

B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.

D. Fan Wheel: Replaceable, extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factor set pitch angle of blades.

E. Belt-Drive Drive Assembly: Resistently mounted to housing, statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
   1. Service Factor Based on Fan Motor Size: 1.4.
   2. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.
      a. Ball-Bearing Rating Life: ABMA 9, L_{10} of 100,000 hours.
   4. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
   5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   6. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

F. Accessories:
   1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
   3. Wall Sleeve: Galvanized steel to match fan and accessory size.
   4. Weathershield Hood: Galvanized steel to match fan and accessory size.
   5. Weathershield Front Guard: Galvanized steel with expanded metal screen.

G. Capacities and Characteristics: Refer to drawing schedules.

2.8 MOTORS

A. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.

B. Enclosure Type: The following features are required as indicted.
   1. Open drip proof motors where satisfactorily housed or remotely located during operation.
   2. Guarded drip proof where exposed to contact by employees or building occupants.

C. All motors shall be pre-wired to the disconnect at the factory.

2.9 SOURCE QUALITY CONTROL

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation and efficiency by factory tests and ratings according to AMCA 210, “Laboratory Methods of Testing Fans for Rating.”

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support inline fans with galvanized all thread and spring isolators with a static deflection of 1 inch.

C. Support suspended units from structure using galvanized threaded steel rods and spring hangers. Vibration control devices are specified in Specification Section “Mechanical Vibration controls and Seismic Restraints.”

D. Secure roof-mounting fans to roof curbs with stainless steel hardware. Anchor fan to curb with a minimum of two (2) fasteners per side. Refer to Specification Section “Roof Accessories” for installation of roof curbs.

E. Ceiling Units: Suspect units from structure; use steel wire or metal straps.

F. Install units with clearances for service and maintenance.

G. Label units according to requirements specified in Specification Section “Mechanical Identification.”

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Mechanical Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors for all fans; no exceptions. Flexible connectors are specified in Specification Section “Duct Accessories.”

B. Install duct adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Specification Section “Grounding and Bonding.”

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Verify that shipping, blocking and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction and verify fan wheel
   free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust
   belts and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in
   connected ductwork system are in fully open positions.
9. Disable automatic temperature-control operators, energize motor and adjust fan to
   indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

B. Starting Procedures:
1. Energize motor and adjust fan to indicated rpm.
2. Measure and record motor voltage and amperage.

C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor
   rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and
   equipment.

E. Shut unit down and reconnect automatic temperature-control operators.

F. Refer to Specification Section “Testing, Adjusting and Balancing” for testing, adjusting, and
   balancing procedures.

G. Replace fan and motor pulleys as required to achieve design airflow.

H. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements
   are made.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Refer to Specification Section “Testing, Adjusting and Balancing for HVAC” for testing, adjusting
   and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

3.5 CLEANING

A. On completion of installation, internally clean fans according to manufacturer’s written
   instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

B. After completing system installation, including outlet fitting and devices, inspect exposed finish.
   Remove burns, dirt and construction debris and repair damaged finished.
3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain power ventilators.
   1. Train owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting servicing, and maintaining equipment and schedules.
   2. Review data in maintenance manuals. Refer to Specification Section “Closeout Procedures.”
   3. Review data in maintenance manuals. Refer to Specification Section “Operation and Maintenance Data.”
   4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

3.7 COMMISSIONING

A. Final Checks before Startup: Perform the following operations and checks before startup:
   1. Verify that shipping, blocking and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections for piping, ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters and disconnects.
   3. Perform cleaning and adjusting specified in this Section.
   4. Disconnect fan drive from motor, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts and install belt guards.
   5. Lubricate bearings, pulleys, belts and other moving parts with factory-recommended lubricants.
   6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in the fully open position.
   7. Disable automatic temperature-control operators.

B. Starting Procedures for fans are as follows:
   1. Energize motor; verify proper operation of motor, drive system and fan wheel. Adjust fan to be indicated RPM.
   2. Measure and record motor voltage and amperage.

C. Shut unit down and reconnect automatic temperature-control operators.

D. Refer to Specification Section “Testing, Adjusting and Balancing,” for procedures for air-handling system testing, adjusting and balancing.

E. Replace fan and motor pulleys as required to achieve design conditions.

END OF SECTION
SECTION 23 3713
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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

B. Related Sections include the following:
1. Specification Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.
2. Specification Section "Testing, Adjusting, and Balancing" for balancing diffusers, registers and grilles.

1.3 DEFINITIONS

A. Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.

B. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.

C. Register: A combination grille and damper assembly over an air opening.

1.4 SUBMITTALS

A. Product Data: For each model indicated, include the following:
1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
3. Schedule of diffusers, registers, and grilles indicating drawing designation, model number, size, and accessories furnished.
4. Assembly Drawing: For each type of air outlet and inlet; indicate materials and methods of assembly of components.

1.5 QUALITY ASSURANCE


PART 2 - PRODUCTS
2.1 MANUFACTURED UNITS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Krueger
      2. Metalaire
      3. Price
      4. Titus
   B. Performance characteristics, specific models, material, features, dimensions and finishes of diffusers, registers, and grilles are scheduled on Drawings.

2.2 SOURCE QUALITY CONTROL
   A. Testing: Test performance according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION
   A. Install diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.
   B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Coordinate with architectural Reflected Ceiling Plans. Locate devices where indicated, as much as practical. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
   C. Install diffusers, registers, and grilles with airtight connection to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

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
   A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.
END OF SECTION
SECTION 23 8126
SPLIT-SYSTEM AIR-CONDITIONING UNITS

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 split system air conditioning and heat pump units consisting of separate evaporator fan and compressor condenser components. Units are designed for exposed or concealed mounting and may be connected to ducts.

1.3 SUBMITTALS
   A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
   B. Specification Compliance Review:
      1. Manufacturers and bidders must provide the consulting engineer with a Compliance Review of the Specifications and Addenda’s. The Compliance Review shall be a paragraph-by-paragraph review of the Specifications and schedule with the following information “C”, “D”, or “E” marked in the margin of the original Specifications and any subsequent Addenda’s. If the manufacturer or bidder does not provide the Compliance Review to the engineer for review, with the submittal, the submittal will be subject to rejection as non-compliant.
         a. “C” Comply with no exceptions.
         b. “D” Comply with deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.
         c. “E” Exception do not comply. For each and every exception, provide a numbered footnote with reasons and possible alternatives. Non-compliance with the specifications is grounds for rejection as unacceptable. A bid from any alternative or listed equipment manufacturer with any number of exceptions will be reason for rejection for non-compliance without further review.
         d. Unless a deviation or exception is specifically noted in the Compliance Review, the manufacturer shall provide full compliance with entire specification. Deviations or exceptions taken in letters or cover letters in a bid document, subsidiary documents, by omission or by contradiction do not release the manufacturer or bidder from being in complete compliance, unless the exception or deviation has been specifically noted in the Compliance Review and approved by the consulting engineer.
         e. Equipment manufacturers or bidders that do not meet the specifications thru the above process will be subject to rejection without further review.
   C. Shop Drawings: Diagram power, signal, and control wiring.
D. Samples for Initial Selection: For units with factory-applied color finishes.
E. Field quality-control test reports.
F. Operational and Maintenance Data: For split-system air-conditioning units to include in emergency operation, and maintenance manuals.

1.4 QUALITY ASSURANCE
A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Specification Section “Product Requirements.”
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, “Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.”
E. Units shall be designed to operate with HCFC-free refrigerants.

1.5 COORDINATION
A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Specification Section “Special Conditions for All Mechanical Work.”
B. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Specification Section “Special Conditions for All Mechanical Work.”

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier Air Conditioning; Div. of Carrier Corporation
   2. Lennox Industries, Inc.
   3. Trane Company (The); Unitary Products Group.
   4. York International Corp.

2.2 CONCEALED EVAPORATOR-FAN COMPONENTS
A. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
   1. Insulation: Faced, glass-fiber duct liner.
   2. Drain Pans: Galvanized steel, with connection for drain; insulated.
B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.

D. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

E. Fan Motors:
   1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.

F. Disposable Filters: 1 inch (25 mm) thick, in fiberboard frames.

G. Wiring Terminations: Connect motor to chassis wiring with plug connection.

2.3 WALL-MOUNTING, EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends, and discharge drain pans with drain connection.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal expansion valve.

C. Electric Coil: Helical, nickel chrome, resistance wire heating elements with refractory ceramic support bushings; automatic reset thermal cutout; built in magnetic contactors; manual reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.

D. Fan: Direct drive, centrifugal fan.

E. Fan Motors:
   1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.

F. Filters: Permanent, cleanable.

2.4 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current sensitive overload devices, start capacitor, relay, and contactor.
   1. Compressor Type: Scroll
   4. 1 Compressor per unit
C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid sub-cooler.

D. Heat Pump Components: Reversing valve and low temperature air cut-off thermostat.

E. Fan: Aluminum propeller type, directly connected to motor.

F. Motor: Permanently lubricated, with integral thermal overload protection.

G. Coordinate with drawing schedule for additional requirements.

2.5 ACCESSORIES

A. Unit shall have local control unless specified to be part of central control system.

B. Low-Voltage Control Wiring: Provide plenum-rated cabling (six-conductor) per manufacturer.

C. Thermostat: Low-voltage, programmable, with the following functions and features:
   1. Auto changeover (heat/cool).
   2. Seven-day programmable with three (3) different occupied settings per day.
   3. Large backlit liquid crystal display indicating temperature, setpoint temperature, time setting, operating mode, and cool/heat mode.
   4. Three (3) security levels with keypad lockout.
   5. Non-volatile memory.
   6. Four-hour override/setback.
   7. Seven-day holiday setback.

D. Automatic reset timer to prevent rapid cycling of compressor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install ground mounting, compressor condenser components on 4-inch- (100-mm-) thick, reinforced concrete base; 4 inches (100 mm) larger on each side than unit. Concrete, reinforcement, and formwork are specified in Specification Section “Special Conditions for All Mechanical Work.” Coordinate anchor installation with concrete base.

D. Install compressor condenser components on equipment supports specified in Specification Section "Special Conditions for All Mechanical Work." Anchor units to supports with removable, cadmium plated fasteners.

E. Install condensing unit on Korfund or equal pads and secure to housekeeping pad.

F. Charge unit with manufacturer required refrigerant and amount.

G. Support refrigerant piping from structure with hangers and saddles.
H. Insulate refrigerant lines with Armaflex. Provide aluminized jacket for exterior insulation.

I. Install t-stat in room on wall not in airflow stream. Connect t-stat to compressor/evaporator.

J. Provide condensate overflow switch to de-energize unit.

K. Provide and install plenum rated control cabling between condensing unit and evaporator.

3.2 CONNECTIONS

A. Connect condensate line to unit. Route condensate to floor drain. Support piping from structure with pipe hangers. Insulate condensate line with Armaflex.

B. Connect unit to controls system. Controls shall alarm with unit failure.

C. Piping installation requirements are specified in other Mechanical and Plumbing Sections.

D. Install piping adjacent to unit to allow service and maintenance.

E. Duct Connections: Duct installation requirements are specified in Specification Section "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 Specification Section "Duct Accessories."

F. Ground equipment according to Specification Section "Grounding and Bonding."

G. Electrical Connections: Comply with requirements in electrical specification sections for power wiring, switches, and motor controls. Install control wiring in conduit per electrical specification sections. All cabling shall be plenum rated. Disconnects shall be provided for the evaporator and condensing unit. Provide conduit and conductors from condensing unit to evaporator in conduit. Minimum #10 wire.

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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

END OF SECTION
SECTION 23 8561

AIR FILTERS

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 factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.

1.3 SUBMITTALS

A. Product Data: Include dimensions; shipping, installed, and operating weights; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Shop Drawings: Include plans, elevations, sections and details to illustrate component assemblies and attachments.
   1. Show filter rack assembly, dimensions, materials and methods of assembly of components.
   2. Include setting drawings, templates and requirements for installing anchor bolts and anchorages.
   3. Wiring Diagrams: Detail wiring for power, signal and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Maintenance Data: for each type of filter and rack to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Electronic Air Cleaners and Electrical Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100 by a testing agency acceptable to authorities having jurisdiction.

B. Comply with NFPA 90A and NFPA 90B.

C. ASHRAE Compliance: Comply with provisions of ASHRAE 52.1 for method of testing and rating air-filter units.

D. Comply with NFPA 70 for installing electrical components.

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
B. Complete a “minimum” of three (3) complete sets of “construction” filters consisting of standard commercial 2" thick throwaway type filters fiberglass media type filters equal to American Air Filter "5700" Industrial filters shall be provided, installed and maintained prior to initial equipment start up, through construction and until final acceptance of the facility for operation by the Owner.

C. One complete set of “permanent” filters (the filters indicated to be provided for “permanent installation in the filter racks, frames, etc. shall be installed, by the Contractor, at time of final acceptance of the air handling units by the Owner. Provide and deliver to the Owner at the project site, one (1) additional complete set of “permanent” filters for each filter rack, frame, etc. Delivery shall occur prior to final acceptance of the air handling systems by the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   1. Air Filters and Filter-Holding Systems:
      a. AAF International.
      b. Continental Air Filter Div.; NiCon Filter Corp.
      c. Farr Co.
      d. Flanders Filters, Inc.
   2. Filter Gages:
      a. Airguard Industries, Inc.
      b. Dwyer Instruments Inc.

2.2 DISPOSABLE PANEL FILTERS

A. Description: Factory-fabricated, viscous-coated, flat-panel type, disposable air filters with holding frames.

B. Media: Interlaced glass fibers sprayed with nonflammable adhesive.

C. Frame: Cardboard frame with perforated metal retainer.
   1. Frame: Galvanized steel with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.
   2. Duct-Mounting Frames: Welded, galvanized steel with gaskets and fasteners and suitable for bolting together into built-up filter banks.

2.3 EXTENDED-SURFACE, DISPOSABLE PANEL FILTERS

A. Description: Factory-fabricated, dry, extended-surface filters with holding frames.

B. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.

C. Media and Media-Grid Frame: Galvanized steel.

D. Duct-Mounting Frames: Welded, galvanized steel with gaskets and fasteners, and suitable for bolting together into built-up filter banks.

2.4 EXTENDED-SURFACE, NONSUPPORTED-MEDIA FILTERS
A. Description: Factory-fabricated, dry, extended-surface, self-supporting filters with holding frames.
   1. Media: Fibrous material constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions.
   3. Duct-Mounting Frames: Welded galvanized steel with gaskets and fasteners, and suitable for bolting together into built-up filter banks.

2.5 AIR HANDLING UNIT MANUFACTURER FRAMES

A. Refer to Air Handling Unit Specifications and Drawings for Filter Frames to be provided as part of the Air Handling Unit Equipment.

2.6 FRONT- AND REAR-ACCESS FILTER FRAMES

A. Framing System: Aluminum framing members with access for either upstream (front) or downstream (rear) filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters prevent deflection of horizontal members without interfering with either filter installation or operation.

B. Prefilters: Incorporate a separate track, removable from front or back.

C. Sealing: Factory-installed, positive-sealing device for each row of filters to ensure seal between gasketed filter elements to prevent bypass of unfiltered air.

2.7 SIDE-SERVICE HOUSINGS

A. Description: Factory-assembled, side-service housings, constructed of galvanized steel, with flanges to connect to duct system.

B. Prefilters: Integral tracks to accommodate 2-inch50-mm disposable or washable filters.

C. Access Doors: Continuous gaskets on perimeter and positive-locking devices. Arrange so filter cartridges can be loaded from either access door.

D. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

2.8 FILTER GAGES

A. Description: Diaphragm type with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
   1. Diameter: 4-1/2 inches.
   2. Range: 0- to 2.0-inch wg.

B. Manometer-Type Filter Gage: Molded plastic with epoxy-coated aluminum scale, logarithmic-curve tube gage with integral leveling gage, graduated to read from 0- to 3.0-inch wg, and accurate within 3 percent of full scale range.

C. Accessories: Static-pressure tips, tubing, gage connections, and mounting bucket.

PART 3 - EXECUTION
3.1 INSTALLATION

A. Install filter frames according to manufacturer's written instructions.

B. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

C. Install filters in position to prevent passage of unfiltered air.

D. Install filter gage for each filter bank.

E. Install filter gage static-pressure tips upstream and downstream from filters to measure pressure drop through filter. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.

F. Coordinate filter installations with duct and air-handling unit installations.

G. Electrical wiring and connections are specified in Electrical Sections.

H. Ground equipment.
   1. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

3.2 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect field-assembled components, filter and filter-frame installation, and electrical wiring. Report results in writing.

B. Operate automatic roll filters to demonstrate compliance with requirements. Test for leakage of unfiltered air while system is operating. Correct malfunctioning units, then retest to demonstrate compliance. Remove and replace units that cannot be corrected with new units and retest.

3.3 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION
PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including Conditions of the Contract (General and Supplementary Conditions) and Division 1 specification sections, apply to work of this section.

B. The requirements of this section apply to all sections of electrical, signal, and life safety, and all sections that are installed by the electrical contractor to include electrical work done under the mechanical contractor.

1.2 DESCRIPTION OF WORK

A. This section covers the general provisions of the electrical specifications applicable to the following systems:
   1. Electrical power and lighting to include generators, UPS Systems, and passive electrical generating equipment (solar).
   2. All Special Systems (fire alarm, security, telephone, data, television, and annunciators associated with power).
   3. Control wiring associated with electrical or mechanical equipment.

B. The use of the word “electrical” in any specification contained within the electrical, signal, or lift safety division sections shall include all aspects of each systems complete install. This shall be extended to mechanical or plumbing signal systems.

C. The use of the work “life safety” shall refer to all fire alarm, fire protection, and mass notification systems installed by the electrical contractor.

D. The use of the word “mechanical” shall refer to both mechanical and plumbing.

E. The use of the word “pipe” shall refer to all electrical raceway.

1.3 DRAWINGS

A. These specifications are accompanied by drawings of the building and details of the installations showing the locations of equipment, lighting, panels, etc. The drawings and these specifications are complementary to each other, and what is called for by one shall be as binding as if called for by both.

B. Drawings and specification conflicts shall be identified as early as possible to ensure conflict resolution prior to installation. The contractor shall not install any equipment with known conflicts or pending information requests. The contractor shall contact the Engineer of Record or their representative for information clarification prior to installing any item that is in question. The contractor shall not install any equipment that is not consistent with the manufacturers approved installation instructions unless directed by the engineer.
C. In all cases all installations shall be at least in accordance with all the approved codes and their local amendments. The drawings and specifications may exceed local code allowances and the most stringent applies. The existence or allowance of a practice or product by code does not supersede requirements of the drawings and specifications. In other words, just because it is allowed by code does not mean that it is allowed on this project.

D. If any departures from the drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted to the Owner's Representative for approval. No departures shall be made without prior written approval by the Owner's Representative.

E. There are intricacies of construction which are impractical to specify or indicate in detail; however, in such cases, the current rules of good practice and applicable specifications shall govern. In all cases the requirements specified in the NEC and local jurisdiction shall be followed.

F. It is the Contractor's responsibility to properly use all information found on the Architectural, Structural, Mechanical, and Electrical drawings and applicable shop drawings where such information affects his work. The contractor shall review the entire construction document set both prior to bid and construction.

G. All dimensional information related to new structures shall be taken from the appropriate drawings. All dimensional information relative to existing facilities shall be taken from actual measurements made by the Contractor on the site.

H. Any duplicate circuiting listed on the drawings shall be bid as multiple circuits with the intention of the next available circuit and breaker to be used. The contractor shall bring this to the attention of the engineer for clarification and updating the drawings. The new circuit numbers shall be annotated on both the panel schedules and the record drawings. The contractor is not required to follow the exact circuit numbers on the panel schedules (balancing phases, wiring convenience, or conduit routing installation), however, the contractor is responsible for keeping the panel schedules accurate and up to date in addition to ensuring the circuit numbers are identified correctly.

I. Any installation that is not in compliance with these requirements shall be corrected at the contractors cost and responsibility.

1.4 BIDDING

A. The contractor is responsible for bidding complete and working systems. In the event that some part of the system is not included in the construction document or the specifications and it is a necessary part of the system to work properly, the contractor shall include that work as part of the bid amount. This includes, but not limited to:

1. Power for equipment shown on the drawings. Examples include, but are not limited to:
   a. Equipment Panels
   b. Controllers
   c. Electronic Devices
   d. Mechanical Equipment
   e. Plumbing Equipment

2. Cabling to communicate with the head end equipment. Examples include, but are not limited to:
   a. Generator to Annunciator
   b. Generator and ATS
   c. Security
d. Access Control  
e. Switching  
f. Equipment starters and the switching locations  
g. Monitoring equipment  

B. The contractor is not responsible for interpreting additional accessory options that are not included in the drawings or specifications or equipment that is not shown or indicated as part of the entire contract documents or specifications.  

C. The contractor shall review the entire set of specifications and contract documents for all equipment and connections requiring electrical work.  

D. Equipment Substitutions or Proposed Equivalents:  
   1. Contractor shall submit proposed substitutions or equivalents to the Architect or engineer during the bidding process prior to any final dates for questions as indicated on the bid forms or RFP's and provide a reasonable time to complete to comparison. All changes to the documents indicated a deviation from the specifications or drawings shall be part of the addenda process or written notification from the engineer of record, architect, owner, or a designated representative. Reasonable time for review is minimum one working week. The contractor shall retain the written notification of approval (if not published in an addenda) for purposes of future verification.  
   2. The contractor is responsible for providing full comparison information for the products to be substituted. Incomplete information is subject to immediate rejection.  
   3. Bids taken for equipment that is not approved is under the contractors own risk. Should the equipment be rejected under the post bid submittal process, the contractor is responsible for providing the specified equipment at no cost to the owner.  
   4. Under no circumstances should the contractor accept bids for non-specified equipment from vendors who do not have prior approval or speculate that it will be approved. This is subject to immediate rejection and the specified equipment shall be required to be installed.  
   5. No response from the architect, owner, or engineer shall not be considered an approval.  

1.5 CONSTRUCTION REQUIREMENTS  

A. The architectural, structural, and electrical plans and specifications and other pertinent documents issued by the Architect are a part of these specifications and the accompanying electrical drawings, and shall be complied with in every respect. All the above is included in the Contract Documents, and shall be examined by all bidders. Failure to comply shall not relieve the Contractor of responsibility or be used as a basis for additional compensation because architectural, structural, or mechanical details were not included in the electrical drawings.  

B. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details or special construction may be 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 same as well as to provide material and equipment usually furnished with such systems or required to complete the installation, whether mentioned or not.  

C. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to comply with Codes, to facilitate the work of other trades, to conform to the
details of the installation supplied by the manufacturer of the equipment to be installed, and thereby to provide an integrated satisfactory operating installation.

D. The mechanical, electrical, and associated drawings are necessarily diagrammatic in character and do not show every connection in detail or every pipe or conduit in its exact location. These details are subject to the requirements of ordinances and also structural and architectural conditions. It shall be the contractor's responsibility to coordinate with other disciplines to facilitate their equipment installation.

E. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases and above suspended ceilings, etc. in finished portions of the building, unless specifically noted 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. All work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

F. Conduit and equipment are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner. The plans do not show all required offsets, elbows, and other location details. Work shall be concealed in all finished areas. Conduit is intended to be installed with factory fittings or bent in a professional, workmanlike manner.

G. All parts of equipment requiring adjustment shall be easily accessible. Equipment shall be so located and installed as to permit convenient and safe maintenance and future replacement. The trade furnishing the equipment shall be responsible for notifying the Contractor, who shall notify the Owner's Representative prior to ordering same in the event that equipment specified and/or proposed is incompatible with this requirement.

H. Location of Lighting and Outlets in Rooms:
1. All lighting, plumbing, acoustical tile, modular lighting outlets, diffusers, sprinkler heads, grilles, registers, 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 acoustical tile panels and other similar panels with respect to the mechanical outlets and electrical lighting and devices. Those mechanical and electrical outlets shall be referenced to such features as wall and ceiling furring’s, balanced border widths, masonry joints, etc. Outlets in acoustical tile shall occur symmetrically in tile joints or in the centers of whole tiles. The final determination of the exact location of each outlet and the arrangements to be followed shall be acceptable to the Owner's Representative.

2. The drawings show diagrammatically the locations of the various outlets and apparatus. Exact locations of these outlets and apparatus shall be determined by reference to the general plans and to all detail drawings, equipment drawings, roughing-in drawings, etc. by measurements at the building, and in cooperation with the other trades. The Owner reserves the right to make any reasonable change in location of any outlet or apparatus before installation, without additional cost to the Owner or the Architect. Contractor shall coordinate work with architectural reflective ceiling plan.

I. The Contractor, by submitting a bid on this work, sets forth that he has the necessary technical training and ability, and that he will install his work in a satisfactory and workmanlike manner which is up to the best standards of the trade, complete and in good working order. If any of the requirements of the plans and specifications are impossible of performance, or if
the installation when made in accordance with such requirements will not perform satisfactorily, he shall report same to the Owner’s Representative for correction promptly after discovery of the discrepancy.

J. No extra compensation will be allowed for extra work or change caused by failure to comply with the above requirements.

1.6 JOB CONDITIONS

A. Submittal of bid implies bidder has read paragraphs of the specifications and will be bound by their conditions.

B. Contractor Qualifications: A minimum of five years’ experience installing commercial electrical power lighting and special systems, similar to those described in these specifications, and make available at the owner or engineer’s request a list of five previous projects including name of project and contact person names and phone numbers as a separate document in addition to the bid or proposal submitted.

C. Contractor must be licensed and hold a current contracting license that has been valid for a minimum of five years in the local State.

D. Contractor must be able to bond work for performance of work being bid and provide a written statement from the bonding agency proposed to be used for this project as a separate document in addition to the bid or proposal submitted. The bonding agency proposed to be used shall have a Best’s insurance rating of A or A+.

1.7 INSPECTION OF THE SITE

A. The Contractor shall visit the site, verifying all existing items indicated on drawings and/or specified, and familiarize himself with the existing work conditions, hazards, grades, actual formations, soil conditions, structures, utilities, equipment, systems, facilities, and local requirements. The submission of bids shall be deemed evidence of such visits. All proposals shall take these existing conditions into consideration, and the lack of specific information shall not relieve the Contractor of any responsibility.

1.8 PERMITS, UTILITY CONNECTIONS, AND INSPECTIONS

A. Fees and Costs: The contractor shall obtain and pay for all permits, utility connections, utility extensions, and/or relocations and pay all costs required by the utility, including inspection fees, for all work included therein.

B. Compliance: The Contractor shall comply in every respect with all requirements of local inspection departments, Board of Fire Underwriters, local ordinances and codes, and utility company requirements. In no case does this relieve the Contractor of the responsibility of complying with these specifications and drawings where specified conditions are of a higher quality than the requirements of the above-specified offices. Where requirements of the specifications and drawings are below the requirements of the above offices having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above offices.

C. Utilities: The Contractor shall check with the various utility companies involved in this project and shall provide complete in all respects the required utility relocations, extensions, modifications, and/or changes. Contractor shall verify the location of all existing utilities with
the applicable Utility Company. The Contractor shall be responsible for all damages to existing utilities caused by his construction work, whether indicated on drawings or not, and repair all damage to existing utilities as acceptable to the Utility Company concerned.

D. Utility Services:
1. Power for the building service shall be obtained from local utility service. Contractor shall coordinate with the local utility for shutdowns and transformer installations. Contractor shall coordinate underground feeders with other underground piping and mark his conduit clearly. Contractor shall install feeders to the building transformer in accordance with
2. Contractor shall coordinate meter location and provide access in accordance with local utility requirements.
3. Transformer and ductbank rough-ins shall be in accordance with Utility provider requirements.

E. Contractor Temporary Power: The contractor shall obtain temporary power in their name, from the local utility for the construction trailer and any equipment needed to perform his work. The contractor shall be responsible for the installation and removal of the temporary service at the conclusion of the project.

F. Certification: Prior to final acceptance, the Contractor shall furnish a certificate of acceptance from the inspection departments having jurisdiction over the work for any and all work installed under this Contract. Any additional labor costs incurred as a result of a substitution shall be the Contractor's responsibility.

1.9 EXISTING FACILITIES

A. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection, and in-service maintenance of all electrical and special systems 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. Barricades shall clearly indicate with signage that which they are protecting. Contractor shall observe all OSHA rules.

B. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.

C. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, light fixtures, and equipment, etc. to provide this access and shall reinstall same upon completion of work in the areas affected.

D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed, all Contractors shall remove and reinstall in locations approved by the Architect/Engineer all devices required for the operation of the various systems installed in the existing construction. This is to include but is not limited to temperature controls system devices, electrical switches, relays, fixtures, piping, conduit, etc.

E. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner two weeks in order to
schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, shall be included in the contract amount. Unless otherwise scheduled by the Owner, planned shutdowns of the existing facilities shall occur between 6 p.m. Friday through 5 am Monday. The existing building shall be ready for morning start-up by 5 am Monday.

1.10 DEMOLITION AND RELOCATION

A. The Contractor shall modify, remove, and/or relocate all materials and items so indicated on the drawings or required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination or otherwise disposed of as directed by the Owner. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition. The Contractor may, at his discretion, and upon the approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.

B. All items which are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved.

C. When 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.

D. Service lines and wiring to items to be removed, salvaged, or relocated shall be removed to points indicated on the drawings, specified, or acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied off or disconnected in a safe manner acceptable to the Owner. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities which must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner as hereinbefore specified.

1.11 SUBMITTAL DATA

A. General: As soon as practical and within 30 days after the date of award of contract and before purchasing or starting installation of any materials or equipment, the Contractor prepare or cause to be prepared shop drawings, product data, materials and equipment lists, diagrams, data, samples, and other submittals as required by the contract documents, hereinafter referred to as “Submittal Data.” The Contractor shall review and approve all submittal data for compliance with the contract documents, manufacturer’s recommendations, adequacy, clearances, code compliance, safety, and coordination with associated work.

B. The Contractor shall submit approved submittal data to the Owner’s Representative for review and comment as to general conformance with the design concept and general compliance with information given in the contract documents. Owner’s Representative’s
review shall not include review of quantities, dimensions, weights or gauges, fabrication processes, construction methods, coordination with other trades or work, or construction safety and precautions, all of which are the sole responsibility of the Contractor. The reviewers shall make every effort to “catch” discrepancies and identify these to the contractor prior to ordering equipment. However, it shall remain the contractor’s responsibility to order and install the equipment as listed in the drawings and specifications. At the owner’s representative’s discretion a detailed submittal may be required.

C. Substitutions shall be clearly identified as such in the submittal by a cover sheet indicating that items are different from what is specified or scheduled. It shall be the contractor responsibility to provide complete substitution information so an accurate comparison can be made.

D. Detail Submittals: Materials and equipment requiring detailed submittal data shall be submitted with sufficient data to indicate that all requirements of the specifications have been met and samples shall be furnished when requested. All manufacturer's data used as part of the submittal shall have all non-applicable features crossed out or deleted in a manner that will clearly indicate exactly what is to be furnished. The detailed submittals shall be accompanied by the same number of sets of pictorial and descriptive data derived from the manufacturer's catalogs and sales literature, or incorporated in the shop drawings. The Contractor may provide a detailed submittal on any item even though not required by the Owner's Representative.

E. 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. 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.

F. The Contractor shall clearly and specifically identify and call to the attention of the Owner's Representative any deviation from the contract documents for which Owner acceptance is desired. The responsibility for such a deviation accepted by the Owner shall remain with the Contractor.

G. Timeliness: The burden of timeliness in the complete cycle of submittal data is on the Contractor. The Contractor shall allow a minimum of four (4) weeks' time frame for the submittal cycle of each submission by the Owner's Representative. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all re-submission cycles on non-conforming materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not justify any request for scheduled construction time extensions or extra compensation.

H. Work performed in accordance with approved submittal data that is not in accordance with the Contract Documents and did not have the specific acceptance of the Owner's Representative shall be replaced at Contractor's cost.

I. Submittals shall be provided in the following format:
1. The submittal brochures shall be contained in a three-ring hard back binder. The cover of the binder and the first page shall be titled “ELECTRICAL SUBMITTAL INFORMATION” and shall list the name and location of project, the Owner, the Engineer(s), the General Contractor, and the Subcontractors installing equipment represented in the brochure.
2. A table of contents will follow the first page and shall list all of the sections contained in
the specifications manual. Each section will be tabbed and will include its' respective
brochures. All brochures will be three-hole punched and folded (if required). Each
submittal section will correspond to the appropriate specification section number.

3. Provide submittal data for all materials to be used on this project as indicated in each
specifications manual section.

4. Brochures submitted shall contain only information which is relevant to the particular
equipment 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.

5. 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.

6. 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 Engineer reserves the right to require the Contractor to furnish items
exactly as described in the Contract Documents.

7. Unless a greater number is indicated within Division 1 of these specifications, submit
six (6) copies of all submittal materials for review.

8. 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, Architect, or Engineer. 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 Engineer.

9. Submittal shall have the certification information as listed hereafter.

10. Shop Drawings:
    a. All shop drawings shall have the certification as listed hereafter.
    b. 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 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 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 equipment layouts and similar Shop
          Drawings shall be drawn to at least \( \frac{1}{8} \)-inch = 1'-0" scale.

       2) All Shop Drawings shall indicate the equipment actually purchased. The
elevation, location, support points, load imposed on the structure at support
and anchor points, shall be indicated. All beam penetrations and slab
penetrations shall be indicated and sized and shall be coordinated. All
Design Drawing space allocations shall be maintained, such as ceiling
height, chase walls, equipment room size, etc., unless proper written
authorization is required from the Engineer to change them. All associated
equipment shall be coordinated and clearly shown on the Shop Drawings.

11. Submittal data for each section must be complete. Partial submittals, or submittals not
    in the specified format, will be rejected and returned to the Contractor without further
    review.
J. All equipment installed on this project shall have local (within 125 miles) representation, local factory-authorized service, and a local stock of repair parts. This requirement is essential and will be strictly reviewed by the Owner's Representative prior to concurrence with the Contractor's approval for all submittals covered by electrical division sections.

K. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of approved manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.

L. These paragraphs related to electrical divisions submittal data rescind, amend, and supersede any provisions to the contrary contained in the Project Manual.

1.12 CERTIFICATION OF SUBMITTAL DATA

A. The Contractor shall provide the following certification with all submittal data furnished to the Owner's Representative for review and comment.

   Project Title:

   Description of Submittal Data:

   This is to certify that the above-described submittal data has been reviewed and is approved for compliance with the Contract Documents, manufacturer's recommendation, adequacy, clearances, code compliance, safety, and coordination with other trades and/or work except as follows: (list “none” or itemize and explain). In addition, the Contractor shall submit to the Owner's Representative a signed statement from each representative certifying as follows:

   EXCEPTIONS:

   “I certify that the materials and/or equipment listed below have been personally inspected by the undersigned authorized manufacturer's representative and is properly installed and operating in accordance with the manufacturer's recommendations and are asbestos free.”

   Name and Company

1.13 ACCEPTANCE OF MATERIALS AND EQUIPMENT

A. Owner's Manual: After the submittals have been accepted the Contractor is requested to include a minimum of three (3) additional copies for insertion in the project’s Owner's Manuals at the completion of the project.

B. NOTICE: The Contractor is responsible for providing materials and equipment that conform to the requirements of the project manual in every respect unless a deviation has been “accepted” in writing. Removal of any nonconforming materials and equipment and the replacement with conforming materials and equipment shall be at the Contractor's sole expense, regardless of when nonconformance was discovered. If the owner or owners representative elects to keep the equipment it shall be contractors responsibility to provide any additional connections or services required to make the equipment function as specified or required by the manufacturer. The
contractor shall coordinate with other subs for any different material requirements (wire size, breakers, cooling, mounting requirements, etc.).

C. Approval of materials and equipment shall be based on manufacturer's published data and shall be tentatively subject to the submission of complete shop drawings which comply with the contract documents. Approval is also dependent upon the existence of adequate and acceptable clearances for entry, servicing, and maintenance.

D. Approval of materials and equipment under this provision shall not be construed as authorizing any deviations from the specifications, unless the attention of the Owner's Representative has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.

1.14 SHOP DRAWINGS

A. As soon as practicable after the award of contract and approval of materials and equipment, but prior to installation, complete and detailed shop drawings of the following shall be submitted for review and comment:
   1. Equipment arrangements.
   2. Fire alarm system.
   3. Data drops.
   4. Security system.
   5. Equipment foundations.
   7. Anchors.
   8. Control.
   9. Interlock.
   10. Switch gear configuration.
   11. Other details as directed by the Owner's Representative. Composite drawings of areas requiring coordination between trades shall be provided and expedited to eliminate conflicts and to ensure maximum cooperation and work progress.

B. Work performed without benefit of reviewed and approved shop drawings will not be recommended for payment by the Engineer until such time as the shop drawings are submitted, reviewed, and approved. Any work performed without the benefit of reviewed and approved shop drawings may require removal, relocation, and/or replacement at the Contractor's sole expense in order to resolve conflicts between the various systems and provide the performance specified.

C. All installation of equipment, fixtures, terminal devices, etc. shall be made in accordance with approved composite shop drawings. The Contractor shall modify installation and relocate installed work to provide code clearances, service access, and eliminate conflict with other systems.

D. Submit one copy of shop drawings with each submittal. The shop drawing shall be marked with the A/E comments and returned to the Contractor for printing and distribution. Distribution shall include the return of three (3) prints of the approved shop drawings, with the A/E's comments included, to the A/E for the A/E's and Owner's use.

1.15 SITE OBSERVATION

A. Site observation by the Architect, Engineer, and/or Owner's Representative is for the express purpose of verifying compliance by the Contractor with the contract documents, and shall not
be construed as construction supervision nor indication of approval of the manner or location in which the work is being performed as being a safe practice or place.

1.16 SUPERVISION

A. In addition to the Superintendent required under the conditions of the contract, each subcontractor shall keep a competent superintendent or foreman on the job at all times.

B. It shall be the responsibility of each superintendent to study all plans and familiarize himself with the work to be done by other trades. He shall coordinate his work with other trades and, before material is fabricated or installed, make sure that his work will not cause an interference with another trade. Where interferences are encountered, they shall be resolved at the jobsite by the superintendents involved. Where interferences cannot be resolved without major changes to the plans, the matter shall be referred to the Owner’s Representative for comments.

1.17 OPERATION PRIOR TO COMPLETION

A. When any piece of electrical equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation and has the written permission of the Owner’s Representative to do so. The contractor shall energize the power distribution in a timely manner to facilitate completion of other trades work. Electrical lighting shall be energized after ceiling has been completed. New permanent fixtures shall not be used as temporary under any circumstances. The warranty period shall not commence, however, until such time as the equipment is operated for the beneficial use of the Owner or date of substantial completion, whichever occurs first.

B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, properly adjust, and complete all deficiency list items before final acceptance by the Owner. The date of acceptance and the start of the warranty may not be the same date.

1.18 MANUFACTURER’S RECOMMENDATIONS

A. The manufacturer’s published directions shall be followed in the delivery, storage, protection, installation, piping, and wiring of all equipment and material. The Contractor shall promptly notify the Owner’s Representative, in writing, of any conflict between the requirements of the contract documents and the manufacturer’s directions, and shall obtain the Owner’s Representative’s comments before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer’s directions or applicable comments from the Owner’s Representative, he shall bear all costs arising in connection with the correction of such deficiencies.

1.19 CHECKING AND TESTING MATERIALS AND/OR EQUIPMENT

A. Before final acceptance of the work, an authorized representative of the manufacturer of the installed materials and/or equipment shall personally inspect the installation and operation of his materials and/or equipment to determine that it is properly installed and in proper operating order. Testing and checking shall be accomplished during the course of the work where required by work being concealed, and at the completion of the work otherwise. In addition, the Contractor shall submit to the Owner’s Representative a signed statement from each representative certifying as follows:
"I certify that the materials and/or equipment listed below have been personally inspected by the undersigned authorized manufacturer's representative and is properly installed and operating in accordance with the manufacturer's recommendations and are asbestos free."

1.20 OPERATING AND MAINTENANCE INSTRUCTION

A. The Contractor shall prepare for the owner's manual hereinafter specified complete sets of operating and maintenance instruction's, control and interlock diagrams, manuals, parts lists, etc. for each item of equipment. These are to be assembled as hereinafter specified for owner's manual.

B. In addition, the Contractor shall provide the service of a competent engineer or a technician acceptable to the Owner's Representative to instruct a representative of the Owner in the complete and detailed operation of all equipment and systems. These instructions shall be provided for a period of sufficient duration to fully accomplish the desired results. Upon completion of these instructions, a letter of release will be required, acknowledged by the Owner, stating the dates of instruction and personnel to whom instructions were given.

C. Additional diagrams, operating instructions, etc. shall be provided as specified hereinafter in the other sections of these specifications.

1.21 MATERIAL AND EQUIPMENT SCHEDULES

A. Contractor shall refer to both drawings and specification for schedules. Where reference is made to items "scheduled on drawings" or "scheduled in specifications," same shall include schedules contained in both the drawings and the specifications. The Contractor's attention is directed to the various specification sections and drawings for schedules.

1.22 APPLICABLE CODES AND STANDARDS

A. The installation shall meet the minimum standards prescribed in the latest editions of the following listed codes and standards, which are made a part of these specifications, except as may be hereinafter specifically modified in these specifications and associated drawings.

1. National Fire Protection Association Standards (NFPA):
   a. NFPA No. 10, Portable Fire Extinguishers
   b. NFPA No. 54, National Fuel and Gas Code
   c. NFPA No. 70, National Electrical Code
   e. NFPA No. 255, Method of Test of Surface Burning Characteristics of Building Materials

   b. A117.1, Handicapped Code

3. American Society of Mechanical Engineers (ASME): Section IV, V, CSD-1


5. National Electrical Manufacturers’ Association (NEMA): All applicable manuals and standards.


7. Occupational Safety and Health ACT (OSHA): National Sanitation Foundation, Standard No. 2

8. Americans with Disabilities Act, 1990

9. American Gas Association (AGA)
10. Underwriters Laboratories, Inc. (UL)
11. Applicable State Building Codes (Uniform Building Codes, as amended):
12. All County codes related to mechanical, electrical, plumbing, and system equipment; piping; conduit; wiring; etc. furnished and installed under these specifications.
13. All City ordinances related to mechanical, electrical, plumbing, and systems and equipment; piping; conduit; wiring; etc. furnished and installed under these specifications.
14. Refer to specification sections heretofore bound for additional codes and standards.

B. All materials and workmanship shall comply with all applicable city, state, and national codes, specifications, and industry standards. All materials shall be listed by the Underwriters Laboratories, Inc. as conforming to its standards and so labeled in every case where such a standard has been established for the particular type of material in question.

C. 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 Owner’s Representative in writing of said discrepancies and apply for an interpretation. Should the discovery and notification occur after the execution of a contract, any additional work required for compliance with said regulations shall be paid for as covered by Division 1 of these contract documents, providing no work or fabrication of materials has been accomplished in a manner of noncompliance. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules, and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations.

1.23 DEFINITIONS

A. Refer to the condition of the contract for Division 1 for additional requirements regarding definitions.

B. Where “as required” is used in these specifications or on the drawings, it shall mean “that situations exist that are not necessarily described in detail or indicated that may cause the Contractor certain complications in performing the work described or indicated. These complications entail the normal coordination activities expected of the Contractor where multiple trades are involved and new or existing construction causes deviations to otherwise simplistic approaches to the work to be performed. The term shall not be interpreted to permit an option on the part of the Contractor to achieve the end result.”

C. Where “and/or” is used in these specifications or on the drawings, it shall mean “that situations exist where either one or both conditions occur or are required and shall not be interpreted to permit an option on the part of the Contractor.

D. Unless specifically indicated otherwise elsewhere in these specifications or on the drawings the word “furnish” or any of its derivatives shall be understood to indicate the purchase, delivery, storage and protection of an item at the job site in a location and manner suitable for use by the recipient who will be responsible for installation of this item. The word “install” or any of its derivatives shall be understood to indicate taking receipt of an item, properly mounting it, and providing the related utilities (electrical, communication, etc.) for proper and complete operation of the item. Installation shall also include calibration, programming and operational testing of said item. The word “provide” or any of its derivatives shall be understood to indicate both furnishing and installing an item.
1.24  SUBSTANTIAL COMPLETION

A.  Refer to Division 1 for additional requirements for substantial completion.

B.  Substantial completion shall be defined as the level of project completion where the owner is ready to occupy the building. The contractor shall have ensured that all mechanical, electrical, plumbing, and building systems (elevators, automatic doors, hardware, security, etc.) are complete and in fully functional working order. This level of completion does not absolve the contractor from the requirements of final inspection or final acceptance. The contractor shall ensure there are no life safety issues unresolved with the project at the time of substantial completion.

C.  All “punch” list items shall have been resolved or shall be identified as pending resolution. Items listed as unresolved shall be either pending information or direction from the owner or owners representative or shall be awaiting parts or supplies that are “on order”. The contractor at the owners discretion shall produce documentation of the part or supply on order status.

1.25  FINAL INSPECTION

A.  Refer to Division 1 for additional requirements for final inspection.

B.  It shall be the responsibility of the Contractor to personally conduct a careful inspection, assuring himself that the work on the project is ready for final acceptance and developing his own “punchlists,” before calling upon the Owner's Representative to make a final inspection. Failure of the Contractor to conduct such inspections and provide the Owner's Representative with a copy of his “punchlists” prior to the final inspection shall be adequate cause for the Owner's Representative to cancel any Contractor-requested final inspection.

C.  In order not to delay final acceptance of the work, the Contractor shall conduct his own “final inspections” prior to requesting the Owner's Representative to “final” the project; will have all necessary bonds, guarantees, receipts, affidavits, etc. called for in the various articles of this specification prepared and signed in advance; and together with a letter of transmittal listing each paper included, shall deliver the same to the Owner's Representative at or before the time of said final inspection. The Contractor is cautioned to check over each bond, receipt, etc. before preparing same for submission to see that the terms check with the requirements of the specifications.

D.  The final inspection will be made jointly by the Owner's Representative and the Owner.

1.26  REQUIREMENTS FOR FINAL ACCEPTANCE

A.  Requirements for final acceptance shall include but not be limited to the Contractor accomplishing the following:
   1.  Construction: Complete all construction.
   2.  Deficiency Lists: Correct all deficiencies listed at time of Substantial Completion.
   3.  Owner’s Manual: Submit at least 30 days prior to final acceptance one (1) copy of the owner's manual for the Owner's Representative's review and comments. Following acceptance, prepare three (3) copies of bound and indexed owner's manual, to be delivered at the time of final acceptance, which shall include but not be limited to the following:
      a.  System operating instructions.
      b.  System control drawings.
      c.  System interlock drawings.
d. System maintenance instructions.
e. Manufacturers’, suppliers’, and subcontractors’ names, addresses, and telephone numbers, both local representatives and manufacturers’ service headquarters.
f. Equipment operating and maintenance instructions and parts lists.
g. Manufacturers’ certifications (see Checking and Testing Materials and/or Equipment, this section).
h. Contractor’s warranty.
i. Acceptance certificates of authorities having jurisdiction.
j. Log of all tests made during course of work.
k. Owner’s acknowledgment of receipt of instruction, enumerating items in owner’s manual.
l. List of manufacturers’ guarantees executed by the Contractor.
m. Owner’s acknowledgment of items of equipment or accessories indicated or specified to be turned over to Owner.

4. Instructions:
a. Verbal, as herein specified.
b. Posted, framed under glass or plastic laminated:
   1) System operating instructions.
   2) System control drawings.
   3) System interlock drawings.

5. Record Drawings: Deliver the specified record drawings to the Owner’s Representative.

1.27 RECORD DRAWINGS

A. The Contractor shall maintain a set of contract drawings at the job site on which he shall indicate the installed locations of all equipment, electrical lighting, data drops, fire alarm devices, PA system devices, security devices, outlets, and electrical feeders. These drawings shall be used for reference or construction and shall not leave the field office. Upon completion of the work, the Contractor shall obtain and pay for Mylar’s and/or disks (if available as CAD files) of the contract drawings from the Owner’s Representative and transfer the above information to these Mylar’s to provide “Record Drawings.” The above-mentioned prints and “Record Drawings” shall then be delivered to the Owner’s Representative. Refer to paragraph entitled “Record Drawings” of the Supplemental General Conditions.

1.28 ALLOWANCES

A. Refer to Division 1 for allowances.

1.29 ALTERNATE PROPOSALS

A. Alternate proposals are summarized in Division 1 and on the bid proposal form. Refer to all sections of the specifications and the drawings to determine the exact extent and scope of the various alternate proposals as each pertains to the work of the various trades.

1.30 WARRANTY

A. General: All work performed (including equipment and materials furnished) under the various sections of these specifications shall be 100% warranted, for a period of one (1) year from the date of substantial completion thereof, against defective materials, design, and unauthorized substitution. Upon receipt of note of failure of any part of the guaranteed
equipment and/or facilities during the guaranty period, the affected part(s) or facilities shall be replaced promptly with new parts, etc. by and at the expense of the Contractor. Further, the Contractor shall properly obtain, execute, and forward any and all manufacturer's warranties on equipment furnished under the Contract. Refer to Division 1 for additional requirements.

B. Extended Period: The Contractor shall provide all extended time warranties available from the manufacturer of the equipment provided as standard at no additional cost. This includes all extended warranties where specified with certain equipment as directed in other sections of this Specification.

1.31 SPARE PARTS

A. Spare Parts Data: As soon as practicable after approval of materials and equipment and, if possible, not later than four months prior to the date of beneficial occupancy, the Contractor shall furnish spare parts data for each different item of equipment listed. The data shall include a complete list of parts and supplies with current unit prices and sources of supply, a list of parts and supplies that are either normally furnished at no extra cost with the purchase of the equipment or specified hereinafter to be furnished as part of the Contract, and a list of additional items recommended by the manufacturer to assure efficient operation for a period of 120 days at the particular installation. The foregoing shall not relieve the Contractor of any responsibilities under the warranty specified.

PART 2 - PRODUCTS

2.1 MATERIALS AND WORKMANSHIP

A. All materials, unless otherwise specified, shall be current United States manufacture, new, free from all defects, and of the best quality. Foreign goods specifically approved for use by the Owner's Representative prior to bidding may be furnished.

B. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by electricians skilled in their respective trades, and the installations shall present a neat, precise appearance.

C. The responsibility for the furnishing and intended installation of the proper electrical equipment and/or material as intended rests entirely upon the Contractor. The Contractor shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

2.2 MATERIAL AND EQUIPMENT REQUIREMENTS

A. Manufacturer's Instructions: The manufacturer's published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufacturer materials or equipment, unless otherwise indicated. The Contractor shall promptly notify the Owner's Representative in writing of any conflict between the requirements of the Contract Documents and the manufacturer's direction and shall obtain the clarification of the Owner's Representative before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer's directions or such clarification by the Owner's Representative, he shall bear all costs arising in connection with the correction of the deficiencies.
B. Storage at Site: The Contractor shall not receive material or equipment at the jobsite until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage from surrounding work. All new or relocated equipment shall be stored inside or protected from the environment. Equipment that is not properly stored shall be replaced by the contractor at no cost to the owner.

C. Capacities shall be not less than those indicated and shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

D. Conformance to Agency Requirements: Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriters Laboratories, Inc., or constructed and/or tested in accordance with the standards as listed in the NEC, the Contractor shall submit proof that the items furnished under this section of the specifications conform to such requirements. The label of the Underwriters Laboratories, Inc. applied to the item will be acceptable as sufficient evidence that the items conform to such requirements.

E. Nameplates: Each major component of equipment shall have the manufacturer’s name, address, and model-identification number embossed on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection. All equipment starters and disconnects shall be tagged with the equipment designated mark and circuit.

F. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number otherwise surfaces of ferrous metal shall be given a rust-inhibiting coating. The treatment shall withstand 200 hours in salt-spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen shall show no signs of wrinkling or cracking and no signs of rust creepage beyond 1/8 inch on either side of the scratch mark. Where rust inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified, except that coal tar or asphalt-type coatings will not be acceptable unless so stated for a specific item. Where steel is specified to be hot-dip galvanized, mill-galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-26915.

G. Protection of Connections: Switches, breaker handles, keys setscrews, handles and other parts not listed for normal occupied operation (light switches, etc.) shall be located accessible to but out of paths to prevent their accidental shutoff.

H. Verifications of Dimensions: The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. The Contractor shall visit the premises and thoroughly familiarize himself with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Owner’s Representative of any discrepancy before performing any work. Adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner, Architect, or Engineer.

I. Standard Products: Materials and equipment to be provided 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.

2.3 SUBSTITUTION OF MATERIALS AND EQUIPMENT
A. No substitution of materials or equipment herein specified or called for on the drawings will be permitted, except by written permission of the Owner's Representative. Where several makes of equipment or material are mentioned, any item named may be bid upon provided it meets space, capacity specifications, finish, usage (switching, ballasts, similar operation), and looks and functions as what was specified.

B. Do not submit substitutions that do not match in whole what was specified or scheduled. Deviations from scheduled or specified items are installed at the contractors risk and are subject to replacement if the owner/engineer deems the product different from the specified item.

C. If the specified item is no longer available, it is the contractor's responsibility to contact the architect/engineer and notify that the item is not available and suggest a suitable substitution that matches in whole the form, function, and appearance of the scheduled or specified item.

D. Refer to Conditions of the Contract and Division 1 for additional requirements regarding substitutions.

2.4 FLAME SPREAD AND SMOKE DEVELOPED PROPERTIES OF MATERIALS

A. Plenum cable, conduit, insulation, equipment support and mounting hardware, tapes, adhesives, core materials, jackets, and other materials in concealed locations, including any above-ceiling area, shall have a flame spread rating not over 25 without evidence of continued progressive combustion and a smoke developed rating no higher than 50. Flame spread and smoke developed ratings shall be in accordance with NFPA Standard No. 255.

2.5 MOTORS

A. The Contractor shall provide all motors required for equipment supplied under each portion of the work. Motors shall be built in accordance with the latest ANSI, IEE, and NEMA standards, shall be fully coordinated with the equipment served, shall be of sizes and electrical characteristics scheduled.

2.6 STARTING EQUIPMENT

A. Each motor shall be provided with proper starting equipment. This equipment, unless hereinafter specified or scheduled to the contrary, shall be provided by the trade furnishing the motor. All motor starting equipment provided by any one trade shall be of the same manufacture unless such starting equipment is an integral part of the equipment on which the motor is mounted.

2.7 SLEEVES, INSERTS, AND FASTENINGS

A. General: Proper openings through floors, masonry walls, roofs, etc. for the passage of conduits shall be provided. All conduit through floors and walls must pass through sleeves, except conduit that is cast-in-place. Sleeves shall be set in new construction before concrete is poured, as cutting holes through any part of the concrete will not be permitted unless acceptable to the Owner's Representative.

B. Materials: Sleeves shall be of standard weight galvanized iron pipe, except heavy-gauge galvanized iron sleeves may be utilized in concrete pours where acceptable to the Owner's Representative for size and metal gauge. Sleeves in fittings, grade beams, and where pipes enter or leave the building or pass through concrete or masonry shall be Schedule 40 PVC.
along the pipe route from the underground installation to the insulating coupling installed above ground.

2.8 FOUNDATIONS

A. General: All special foundations and supports required for the proper installation of equipment and pipe shall be provided as hereinafter specified and under the section of the specifications covering the equipment, unless otherwise indicated on the drawings.

B. Concrete foundations for the support of equipment such as floor-mounted transformers, switchgear, equipment, etc. shall be not less than 5 inches high and 4 inches beyond the equipment, unless otherwise noted, and shall be poured in forms built of new dressed lumber. All corners of the foundations shall be neatly chamfered by means of sheet metal or triangular wood strips nailed to the form. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Allow 1 inch below the equipment bases for alignment and grouting. Foundations for equipment located on the exterior of the building shall be provided as indicated. Foundations shall be constructed in accordance with approved shop drawings and shall be reinforced with #4 bars at 12 inches on center both ways (minimum). Refer to Division 3: Concrete Work for materials, placement, etc. Coordinate with the equipment manufacturer for heavy (greater than 1000 pounds) pieces of equipment.

2.9 ACCESS DOORS

A. General: Provide wall, ceiling, or duct access doors for unrestricted access to all concealed items of electrical equipment.

B. Manufacturers shall be Inland-Milcor, Bilco, Miami Carey, or approved equal.

C. UL labeled when in fire-rated construction, one and one-half hour rating.

D. Equipment access doors shall be of sufficient size to remove/replace equipment and provide routine maintenance as necessary, unless otherwise noted. All doors shall have wedge-type latches except where cylinder locks are otherwise indicated or specified. Doors shall be set flush with adjacent finish surfaces. Exterior doors shall be provided with cylinder locks.

E. Access doors into ductwork shall be 14-gauge insulated galvanized steel with 16-gauge galvanized gasketed steel frame and cam-type locks. Access door shall be a minimum of 12" H12" in size.

2.10 CONDITION OF MATERIALS

A. All materials required for the installation of the electrical systems shall be new and unused. Any material or equipment damaged in transit from the factory, during delivery to premises, while in storage on premises, while being erected and installed, or while being tested, until time of final acceptance, shall be replaced by this Contractor without extra cost to Owner.

PART 3 - EXECUTION

3.1 SPACE AND EQUIPMENT ARRANGEMENTS
A. The size of electrical equipment indicated on the drawings is based on the dimensions of a particular manufacturer. While other manufacturers will be acceptable, it is the responsibility of the Contractor to determine whether the equipment he proposes to furnish will fit in the space. Shop drawings shall be prepared when required by the Owner's Representative to indicate a suitable arrangement.

B. All equipment shall be installed in a manner to permit access to all surfaces.

3.2 LARGE APPARATUS

A. 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 and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly, completely protected from damage as hereinafter specified.

3.3 HOISTING, SCAFFOLDING, AND TRANSPORTATION

A. Provide hoisting and scaffolding facilities as required to set materials and equipment in place.

3.4 PROTECTION

A. The Contractor shall take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of work. This shall include the erection of all required temporary shelters and supports to adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the uncompleted building with tarpaulins or other protective covering. Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.

B. The Contractor shall protect existing facilities, the work of others, and the premises from any and all damages that may be made possible by the execution of work.

C. Equipment and materials shall be protected from rust both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these specifications.

3.5 COOPERATION BETWEEN TRADES AND WITH OTHER CONTRACTORS

A. Each trade, subcontractor, and/or Contractor must work in harmony with the various trades, subcontractors, and/or Contractors on the job as may be required to facilitate the progress to the best advantage of the job as a whole. Each trade, subcontractor, and/or Contractor must pursue its work promptly and carefully so as not to delay the general progress of the job. This Contractor shall work in harmony with Contractors working under other contracts on the premises.

B. It shall be the responsibility of each trade to cooperate fully with the other trades on the job to help keep the jobsite in a clean and safe condition. At the end of each day's work, each trade shall properly store all of its tools, equipment, and materials and shall clean its debris from the job. Upon the completion of the job, each trade shall immediately remove all of its tools, equipment, any surplus materials, and all debris caused by its portion of the work.
3.6 PRECEDENCE OF MATERIALS

A. These specifications and the accompanying drawings are intended to cover systems which will not interfere with the structural design of the building, which will fit into the several available spaces, and which will ensure complete and satisfactory systems. Each subcontractor and/or trade shall be responsible for the proper fitting of his material and apparatus into the building.

B. The work of the various trades shall be performed in the most direct and workmanlike manner without hindering or handicapping the work of other trades. Piping interferences shall be handled by giving precedence to pipe lines which require a stated grade for proper operation. Where space requirements conflict, the following order or precedence shall, in general, be observed:
1. Building lines.
2. Structural members.
3. Soil and drain piping.
5. Vent piping.
6. Supply, return, and outside air ductwork.
7. Exhaust ductwork.
8. HVAC water and steam piping.
9. Steam condensate piping.
10. Fire protection piping.
11. Natural gas piping.
12. Domestic water (cold and hot).
13. Refrigerant piping.

3.7 CONNECTIONS FOR OTHERS

A. This Contractor shall rough-in for and make all electrical connections to all fixtures, equipment, machinery, etc. provided by others in accordance with detailed roughing-in drawings provided by the equipment suppliers, by actual measurements of the equipment connections, or as detailed.

B. After the equipment is set in place, this Contractor shall make all final connections and shall provide all required conduit, fittings, whips, connectors, etc.

C. The Mechanical Contractors will set in place, ready for connection, all motors to be provided under their Contracts. The Mechanical Contractors will furnish and deliver all starter and control equipment not shown in motor control centers for any motors which they furnish. The Mechanical Contractor shall be responsible for the complete installation of all automatic temperature control systems, including wire, conduit, and interlocking connections.

D. The Electrical Contractor shall connect all motors and shall set in place all control devices, furnishing supports if and as necessary, and shall furnish and install all interconnecting line voltage wiring and make all connections ready for operation between motors, starters, and disconnect switches, as required. The Electrical Contractor shall furnish and install all motor control centers, including breakers, starters, etc. The Contractor shall refer to the Mechanical drawings and specifications for his scope of the connections to equipment furnished under these Contracts.

3.8 INSTALLATION METHODS
A. Where to Conceal: All conduits shall be concealed in chases, walls, furred spaces, below suspended floors, or above the ceilings of the building unless otherwise indicated. All concealed conduit shall be run in a professional manner, and parallel or perpendicular to the building lines.

B. Where to Expose: In mechanical rooms, only where necessary, conduit may be run exposed. All exposed conduit shall be run in the neatest, most inconspicuous manner, and parallel or perpendicular to the building lines. Conduit shall be bent in a manner as to run parallel to other conduits and not cross at angles.

C. Support: All conduit shall be adequately and properly supported from the building structure by means of hangers or clamps to walls as herein specified.

D. Maintaining Clearance: Where limited space is available above the ceilings and below concrete beams or other deep projections, conduit shall be sleeved through the projection where it crosses, rather than hung below them, in a manner to provide maximum above-floor clearance. Sleeves shall be as herein specified. Approval shall be obtained from the Owner's Representative for each penetration.

E. All conduits, etc. shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines. Conduits in furred ceilings and in other concealed spaces may be run at angles to the construction but shall be neatly grouped and racked indicating good workmanship. All conduit openings shall be kept closed until the systems are closed with final connections.

F. Special Requirements:
   1. The Contractor shall study all construction documents and carefully lay out all work in advance of fabrication and erection in order to meet the requirements of the extremely limited spaces. Where conflicts occur the Contractor shall meet with all involved trades and the Owner's Representative and resolve the conflict prior to erection of any work in the area involved.
   2. All conduit not directly buried in the ground or installed outside shall be considered as "interior."
   3. Prior to the installation of any ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the Owner's Representative so that arrangements can be made for an inspection of the above-ceiling area about to be "sealed off." The Contractor shall give as much advance notice as possible up to ten (10) working days, but in no case less than five (5) working days.
   4. The purpose of this inspection is to verify the completeness and quality of the installation of the electrical systems and any other special above-ceiling systems, such as data, fire alarm, security. The ceiling supports (tee bar or lath) should be in place so that access panel and light fixture locations are identifiable and so that clearances and access provisions may be evaluated.
   5. No ceiling material shall be installed until the deficiencies listed from this inspection have been corrected to the satisfaction of the Owner's Representative.

3.9 CUTTING AND PATCHING

A. General: Cut and patch walls, floors, etc. resulting from work in existing construction or where made necessary by failure to provide proper openings or recesses in new construction.
B. Methods of Cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Owner's Representative. Impact-type equipment will not be used except where specifically acceptable to the Owner's Representative. Openings in concrete for pipes, conduits, outlet boxes, etc. shall be core drilled to exact size. **Determine location of embedded conduit and reinforcing bars prior to cutting.**

C. Restoration: All openings shall be restored to “as-new” condition under the appropriate specification section for the materials involved, and shall match remaining surrounding materials and/or finishes.

D. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc. shall be of the proper size and shape, and shall be installed in a manner acceptable to the Owner's Representative.

E. Plaster: All mechanical work in area containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.

F. Weakening: No cutting, boring, or excavating which will weaken the structure shall be undertaken.

### 3.10 SLEEVES, INSERTS, AND FASTENINGS

A. Sleeves: The minimum clearance between horizontal conduit and sleeve shall be ¼ inch, except that the minimum clearance shall be ⅓ inch where piping contacts the ground. Sleeves through floors shall extend ¾ inch above the floor; sleeves through walls and partitions shall be installed flush with exposed surfaces. Sleeves are not required for piping indicated to the cast-in-concrete slabs-on-fill.

B. Inserts: Suitable concrete inserts for conduit and equipment hangers shall be set and properly located for all conduit and equipment to be suspended from concrete construction.

C. Fasteners: Fastening of pipes, conduits, etc. in the building shall be as follows:
   1. **To wood members:** by wood screws.
   2. **To masonry and concrete:** by threaded metal inserts, metal expansion screws, or toggle bolts, whichever is appropriate for the particular type of masonry or concrete.
   3. **To steel:** machine screws or welding (when specifically permitted or directed), or bolts.

D. Weatherproofing: The annular space between a conduit and its sleeve in exterior walls or through floor to below grade shall be filled with polyurethane foam rods 50% greater in diameter than the space as backing and fill material and made watertight with a permanent elastic polysulfide compound. Seal both surfaces of wall or floor with a fire-resistant sealant.

### 3.11 FLOOR AND CEILING PLATES

A. Except as otherwise noted, provide one-piece chrome-plated brass floor and ceiling plates (or escutcheons) around all pipes, conduits, etc. passing through walls, floors, or ceilings in any spaces, except underfloor and attic spaces. Plates shall be sized to fit snugly against the outside of the conduit. Plates will not be required for piping where sleeves extend ¾ of an inch above finish floor and are concealed. Plates shall be one piece.
3.12 FIRE AND SMOKE PARTITION, WALL, AND/OR FLOOR PENETRATIONS

A. Conduit passing through fire- or smoke-rated floors, partitions, walls, or other barriers within a UL-listed assembly which shall maintain the rating of the applicable wall, floor, partition, or barrier. Flexible conduit shall not be used in rated walls. Provide connections between “hard” pipe and flexible whips on either side of wall. Fireproof around conduits.

B. The Contractor shall review the architectural and structural drawings and determine the location of the fire-rated building elements. Where these elements are penetrated, UL-listed fire-rated penetration assemblies approved by the local authority shall be provided in accordance with the manufacturer’s instructions to obtain the required rating.

3.13 METAL BUILDING SYSTEMS/ELECTRICAL SUPPORTS

A. Metal building systems are required to be designed by the manufacturer to accommodate and support the electrical systems indicated on the electrical drawings and specifications.

B. The metal building systems manufacturer is required to provide the following:
   1. Framed openings through the roofs with supports, roof curbs, and flashings for roof-mounted equipment, fans, vents, and air intakes.
   2. Structural support for piping, conduits, and suspended equipment consisting of beam, joists, purlins, and/or blocking above and perpendicular to conduit routes and equipment hangers at intervals not to exceed 8 feet.
   3. Structural support for suspended ceilings and light fixtures, including associated raceways.

C. The electrical trade shall:
   1. Provide all routes, weights, installation heights, opening locations, etc. for all equipment, conduits, sleeves, etc. to the metal building system manufacturer and coordinate requirements for structural supports, hangers, attachments, etc. with the metal building systems manufacturer.
   2. Provide all supporting devices (hangers, attachments, brackets, cross beams, etc.) to attach to the metal building structural system.

3.14 CONDUIT SUPPORT

A. Conduit Support: All conduits throughout the building, both horizontal and vertical, shall be adequately supported from the construction to line of grade, with proper provision for expansion, contraction, vibration elimination, and anchorage. Vertical conduits shall be supported from floor lines with riser clamps sized to fit the lines and to adequately support their weight. At the bases of lines, where required for proper support, provide anchor base fittings or other approved supports.

B. Conduit shall not be supported from any other system.

3.15 HANGERS

A. General: Each hanger shall be properly sized to fit the supported pipe or to fit the outside of the insulation on lines where specified.

B. Attachment:
1. The load on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete which holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required.
2. Where pipes are supported under steel beams, approved-type beam clamps shall be used.
3. Where conduit is supported under wood joists, hanger rods shall be attached to joists with side beam brackets or angle clips.

C. Spacing: All hangers shall be so located as to properly support horizontal lines without appreciable sagging of these lines. All PVC shall be supported at intervals recommended by the manufacturer, or as otherwise specified or indicated.

D. Trapezes: Where multiple lines are run horizontally at the same elevation and grade, they may be supported on trapezes of Kindorf, Elcen, or approved equal, channel-suspended on rods or pipes. Trapeze members including suspension rods shall each be properly sized for the number, size, and loaded weight of the lines they are to support.

E. Ceiling-Mounted Devices: All lighting and devices or assemblies mounted in lay-in-type ceilings and which are supported by the ceiling grid, directly or indirectly, and which weigh in excess of 2 lbs., shall be provided with at least two 12-gauge minimum wire supports connected securely between the device or assembly and the structure, to serve as a safety support in the event of the collapse of or a disturbance in the support of the ceiling system that might cause the device or assembly to fall through the ceiling. This includes, but is not limited to, light fixtures, J-boxes, and heavy speakers. Provide additional support as required where the weight of the device or assembly will exceed the safe limits of the wire supports.

F. Perforated strap iron or wire will not be acceptable as hanger material.

G. Miscellaneous: Provide any other special foundations, hangers, and supports indicated on the drawings, specified elsewhere herein, or required by conditions at the site. Hangers and supporting structures for suspended equipment shall be provided as required to support the load from the building structure in a manner acceptable to the Owner's Representative.

3.16 ACCESS DOORS

A. Provide in walls, floors, and ceilings to permit access to all equipment and piping requiring service or adjustment. Examples of such equipment needing access are disconnects, actuators, contacts, and equipment needing periodic or replacement maintenance.

B. Use panels equal to Milcor Style M for masonry and drywall construction, equal to Milcor Style K for plastered masonry walls and ceilings. Stainless steel panels shall be used in ceramic tile or glazed structural tile.

C. Access doors located outside or in a moisture-laden environment (e.g., toilet room, dressing area, shower area, etc.) shall be stainless steel.

3.17 ROOF PENETRATIONS AND FLASHING

A. The contractor shall obtain from the Owner all warranty requirements for new or existing roofing systems and shall have all work on roof penetrations, curbs or equipment supports performed by a subcontractor acceptable to the Owner and the new or existing roofing system installer and manufacturer in order that all roofing system and materials warranties are preserved.
B. Pipe and conduit ducts, pitch pockets, curb bases, and flashing compatible with the roofing installation shall be provided for roof penetrations. Provide framing or other support around all openings through roof as required to preserve the structural integrity of the roof system and make the penetration weathertight.

C. Roof curbs for all roofs except standing seam metal roofs shall be provided by the equipment supplier supplying the roof-mounted equipment, etc., and such curbs shall be installed by the roofing trades. Contractor shall coordinate all roof curb requirements with all trades and the roofing trades at the earliest possible stage of the project.

D. Roof curbs for standing seam metal roofs shall be provided by the roofing trades. Curb base size, height, and type shall be coordinated with the roofing trades at the earliest possible stage of the project.

E. Flashing for pipe and conduit penetrations of standing seam metal roofs shall be provided and installed by the roofing trades.

F. See Division 7: Thermal and Moisture Protection for metal roof curbs, flashing, etc.

3.18 ROOFTOP EQUIPMENT

A. Install all starters and disconnects within 5 feet of equipment being served.

B. Mount starters and disconnects on the equipment only if allowed or recommended by the manufacturer. Otherwise, mount disconnects on unistrut-style framing in an “L” configuration. Secure unistrut to roof with a flashed wood nailer. Provide cross bracing.

C. Run “hard” conduit (IMC) through conduit curb to starter or disconnect. Install IMC from starter or disconnect to equipment. Flexible watertight conduit is acceptable only for equipment on a vibration-type (spring) curb or that has movement. This does not include AHU, chillers, fans on factory non-spring curbs, package units, or other internally isolated rooftop equipment.

3.19 TESTS AND INSPECTIONS

A. Refer to conditions of the contract and Division 1 for additional requirements regarding tests and inspections.

B. General: The Contractor shall make all tests deemed necessary by the inspection departments of the authority having jurisdiction, Board of Underwriters, etc. He shall provide all equipment, materials, and labor for making such tests. Fuel and electrical energy for system operational tests following beneficial occupancy by the Owner will be paid for by the Owner.

C. Other: Additional tests specified hereinafter under the various specifications sections shall be made.

D. Notification: The Owner's Representative shall be notified at his office 36 hours prior to each test and other specifications requirements requiring action on the part of the Owner, Architect, Engineer, and/or Owner's Representative.

E. Test Logs: All tests which the Contractor conducts shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel, description and extent of system tested, test conditions, test results, specified results, and any other pertinent
data. Data shall be delivered to the Owner’s Representative as specified under “Requirements for Final Acceptance.

F. Inspections: In general, an inspection by the Owner’s Representative shall be required prior to closing up any work and prior to beneficial occupancy or final project completion. The closing up of work includes, but is not limited to, conduit installations prior to backfilling; electrical and fire protection work prior to placement of concrete; or closing up walls and overhead electrical and fire protection work prior to installation of the ceiling.

3.20 CLEANING AND PAINTING

A. The contractor shall at all times keep the premises free from accumulations of waste material or rubbish. Debris shall be removed from the site and from any street or alley adjacent to the site.

B. Thoroughly clean and touch up the finish on all parts of the materials and equipment. Exposed parts in equipment rooms, and all other spaces except sealed chases and attics shall be thoroughly cleaned of cement, plaster, and other materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out.

C. Exposed metal work which is not galvanized shall be carefully brushed down with steel brushes to remove rust and other spots and left smooth and clean and then painted with a suitable rust resistant primer. Exposed metal work includes work exterior to the building; exposed in mechanical or electrical equipment rooms and storage rooms; and other areas where occupants could see the work, whether normally occupied or not.

D. All other painting shall be accomplished under the Painting Section of Division 9 of the specifications.

E. At completion of the project, the Contractor shall remove all tools, scaffolding, and surplus materials. Contractor shall leave the area “broom clean”. Before final acceptance, vacuum all panels, switchboards, starters, and other electrical devices. Wipe clean all fixture lenses and reflectors, all panelboard and switchboard interior and exterior surfaces, being careful to remove all stray paint, construction materials, dust, and particles. Touch-up all marred surfaces to restore existing conditions to those provided by the manufacturer.

3.21 IDENTIFICATION AND LABELING

A. General: The Contractor shall make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, disconnects, panels, etc. by marking them. All disconnects/starters/panels shall be labeled for the equipment they serve. Marks shall be the same as the drawings.

3.22 COORDINATION OF WORK

A. The light fixture grid layout as indicated on the drawings must be maintained. This Contractor shall refer to all light fixture plans and details indicated on the drawings.

B. The electrical trades shall locate all junction boxes, pull boxes, conduits, etc. to avoid interference with the diffusers, dampers, grilles, etc. The mechanical trades shall furnish to all other trades copies of approved ductwork shop drawings to assist in the coordination of the rough-in and installation of all items of work.
C. The order of space allocation priority in plan and in elevation shall be as follows.
1. 1st Light Fixtures, at Ceiling Soffit + 6"
2. 2nd Grade Plumbing Waste and Vent Systems
3. 3rd Ductwork
4. 4th Pressurized Piping Systems
5. 5th Electrical Conduit
6. 6th Ceiling Support System, where required

3.23 DISCHARGE OF WASTES FROM CONSTRUCTION SITE

A. The Contractor shall comply with all applicable provisions of local, state, and federal laws regarding the discharge of wastes into sewer and waterways. Special caution shall be exercised to prevent the discharge of wastes which contain oil, tar, asphalt, roofing compound, kerosene, gasoline, paint, mud, cement, lime, or other materials which would degrade the water quality of the receiving water course.

B. Disposal of Lamps and Ballasts: The proper disposal of all ballasts and lamps from the demolition of lighting fixtures as part of this project will be the responsibility of the Electrical Contractor. All lamps and ballasts found to contain hazardous contaminants will be removed from the site and transported to a licensed disposal facility by a contractor licensed in this field. All work shall be performed in accordance with current state and Federal rules and regulations pertaining to the processing of contaminated waste materials. A certificate of proper disposal from the licensed waste contractor shall be provided to the Engineer.

3.24 OPERATING AND MAINTENANCE MANUAL

A. The Contractor shall furnish indexed operating and maintenance manuals with complete technical data for each electrical system, piece of equipment, and material installed under this Contract.

B. The manuals shall be identified on the cover as “Operating and Maintenance Manual” and shall list the name and location of project, the Owner, the Engineers, the General Contractor, and the Subcontractors installing equipment represented in the brochure.

C. Two (2) copies of the manual, bound in three-ring hardback binders shall be provided. One copy shall be completed and delivered to the Engineer prior to the time that system and equipment tests are performed. The second copy shall be delivered prior to final acceptance. The manual shall have a Table of Contents and shall be grouped in tabbed sections according to the specification sections. Each section shall be organized as follows:
1. Approved engineering submittals with complete performance and technical data.
2. Manufacturer's local representative and/or distributor's name and address.
3. Manufacturer's installation instructions and brochures.
4. Manufacturer's operating and maintenance brochures.
5. Manufacturer's installation wiring diagram.
6. Contractor's field wiring diagram, if different.
7. Manufacturer's brochure listing recommended spare parts.
8. Manufacturer's brochure listing replacement part numbers and descriptions.

D. Provide a final section entitled, “Warranties and Guarantees”, for all equipment as well as Contractor's warranty.

3.25 CONDITIONS OF EQUIPMENT AT FINAL ACCEPTANCE
A. At the time of acceptance, the Contractor shall have inspected all installed systems to assure the following has been completed:
   1. Fixtures are operating, and lenses and reflectors are free of dust, debris, and fingerprints.
   2. Panelboards have all conductors neatly formed, bundled, and made-up tight. Cans shall be vacuum cleaned and surfaces cleaned of stray paint, dust, grease, and fingerprints. All circuit directories to be neatly typed and in place.
   3. Wall plates and exposed switch and receptacle parts to be clean, free of paint, plaster, etc.
   4. Safety and disconnect switches and motor starters to be vacuum cleaned of debris and dust, and all surfaces free of stray paint, grease, and fingerprints.
   5. Switchgear, transformers, and system devices shall be cleaned internally and externally and have all surfaces restored to original surface conditions.
   6. Touch-up all scratched surfaces using paint matching the existing equipment paint. Where paint cannot be matched, the entire surface shall be repainted in a color and manner approved by the Engineer.

END OF SECTION
SECTION 26 0050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Raceways.
   2. Building wire and connectors.
   4. Electricity-metering components.
   5. Concrete equipment bases.
   6. Electrical demolition.
   7. Cutting and patching for electrical construction.
   8. Touchup painting.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. FMC: Flexible metal conduit.
C. IMC: Intermediate metal conduit.
D. LFMC: Liquidtight flexible metal conduit.
E. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For electricity-metering equipment.
B. Shop Drawings: Dimensioned plans and sections or elevation layouts of electricity-metering equipment.
C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 QUALITY ASSURANCE

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

1.6 COORDINATION

A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow:
   1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

C. Coordinate electrical service connections to components furnished by utility companies.
   1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
   2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section “Access Doors.”

E. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

F. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

PART 2 - PRODUCTS

2.1 RACEWAYS

A. See Section “Raceways and Boxes.”

2.2 CONDUCTORS

A. See Section “Conductors and Cables.”

2.3 SUPPORTING DEVICES

A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.

B. Metal items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.

C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch- diameter slotted holes at a maximum of 2 inches o.c., in webs.
D. Nonmetallic Channel and Angle Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch diameter holes at a maximum of 8 inches o.c., in at least one surface.
   1. Fittings and Accessories: Products of the same manufacturer as channels and angles.
   2. Fittings and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.

E. Raceways and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

F. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

G. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.

H. Expansion Anchors: Carbon-steel wedge or sleeve type.

I. Toggle Bolts: All-steel springhead type.


2.4 EQUIPMENT FOR UTILITY COMPANY’S ELECTRICITY METERING

A. Current-Transforming Cabinets: Comply with requirements of electrical power utility company.

B. Meter Sockets: Comply with requirements of electrical power utility company.

C. Modular Meter Centers: Factory-coordinated assembly of a main meter center circuit-breaker unit with wireways, tenant meter socket modules, and tenant branch circuit breakers arranged in adjacent vertical sections complete with interconnecting buses.
   1. Housing: NEMA 250, Type 3R enclosure
   2. Tenant Branch Circuit Breakers: Series combination rated to protect circuit breakers in downstream panelboards that have 10,000-A interrupting capacity, minimum.

D. Provide power utility company communication conduit to meter.

E. Relocate communication conduit with meter as required to maintain minimum utility company clearances.

2.5 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

A. Meter: Electronic kilowatt-hour/demand measuring to record electricity used and highest peak demand over a time period according to electric utility. Meter is designed for used on the type and rating of circuit indicated for its application.
   2. Kilowatt-Demand Display: Digital, liquid-crystal type to register highest peak demand.
   3. Enclosure: NEMA 250, Type 1, Minimum, with hasp for padlocking or sealing.
   4. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
5. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for the ratings of the circuits indicated for this application.
   a. Type: Solid core.
6. Accuracy: Nationally recognized testing laboratory certified to meet ANSI C12.16 specifications.
7. Demand Signal Communication Interface: Match signal to building automation system input that conveys data on instantaneous/integrated demand level measured by meter used for load switching to control demand.

B. Current-Transformer Cabinets: Listed or recommended by metering equipment manufacturer for use with sensors indicated.

C. Available Metering Equipment Manufacturers: Subject to compliance with requirement, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. E-MON Corporation.
   3. Osaki Meter Sales, Inc.

2.6 CONCRETE BASES

A. Concrete: 3000-psi, 28-day compressive strength as specified in Division 3 Section “Cast-in-Place Concrete.”

2.7 TOUCHUP PAINT

A. For Equipment: Equipment manufacturer’s paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

D. Right of Way: Give to raceways and piping systems installed at a required slope.

E. Mount all non-wall mounted equipment minimum of:
   1. Two (2) inches off the wall for switchboards, free standing distribution boards, disconnects, panels and all other non-vibrating equipment.
   2. Minimum of four (4) inches for vibrating equipment to include transformers.
3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Dry Locations: Steel materials.

C. Support Clamps for PVC Raceways: Click-type clamp system.

D. Selection of Supports: Comply with manufacturer’s written instructions.

E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.3 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

F. Install ¼-inch-diameter or larger threaded steel hanger rods, unless otherwise indicated.

G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1½ inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Simultaneously install vertical conductor supports with conductors.

J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.

K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and
fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
1. Wood: Fasten with wood screws or screw-type nails.
2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
3. New Concrete: Concrete inserts with machine screws and bolts.
4. Existing Concrete: Expansion bolts.
5. Steel: Welded threaded studs or spring-tension clamps on steel.
a. Field Welding: Comply with AWS D1.1.
6. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
7. Light Steel: Sheet-metal screws.
8. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.4 UTILITY COMPANY ELECTRICITY-METERING EQUIPMENT
A. Install equipment according to utility company’s written requirements. Provide grounding and empty conduits as required by utility company.

3.5 FIRESTOPPING
A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 7 Section “Firestopping.”

3.6 CONCRETE BASES
A. Construct concrete bases of dimensions indicated, but not less than 6 inches larger, in both directions, than supported unit and bollards.

B. Follow supported equipment manufacturer’s anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Sections “Cast-in-Place Concrete,” “Concrete Reinforcement,” and “Concrete Formwork.”

C. Bollards: Provide bollards around utility provider pad mount transformer. Protect equipment on road or driveway sides.

D. Provide bollards around owner genset if within 10 feet of roadway.

E. Provide 36 inch concrete pads in front of exterior switchboards full length of switchboard.

F. Provide 30 inch concrete pads in front of ground mounted disconnect racks.

3.7 DEMOLITION
A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

D. Remove demolished material from Project site.

E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.8 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.9 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:
   1. Raceways.
   2. Building wire and connectors.
   4. Electrical identification.
   5. Electricity-metering components.
   6. Concrete bases.
   7. Electrical demolition.
   8. Cutting and patching for electrical construction.

B. Test Owner’s electricity-metering installation for proper operation, accuracy, and usability of output data.
   1. Connect a load of known kW rating, 1.5 kW minimum, to a circuit supplied by the metered feeder.
   2. Turn off circuits supplied by the metered feeder and secure them in the “off” condition.
   3. Run the test load continuously for eight hours, minimum, or longer to obtain a measurable meter indication. Use a test load placement and setting that ensure continuous, safe operation.
   4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at the test load connection. Record test results.
   5. Repair or replace malfunctioning metering equipment or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.

3.10 REFINISHING AND TOUCHUP PAINTING
A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section “Painting.”
   1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
   2. Follow paint manufacturer’s written instructions for surface preparation and for timing and application of successive coats.
   3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.11 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION
SECTION 26 0433
CONTROL PANEL

PART 1 - GENERAL

1.1 SUMMARY

A. This specification is confidentially issued for this specific project only
B. Contractor shall be responsible for reading all specifications from all disciplines prior to bid
C. This section describes the requirements for a quality construction and fabrication of SCADA/Control Panels including power, control, and instrumentation related equipment
D. This section will also describe desired operation of facility
E. All equipment described herein shall be submitted, and factory installed, as an integral part of equipment specified in overall construction documents
F. Insert half-size blackline prints of wiring diagrams applicable to each control panel in a clear plastic envelope and store in a suitable print pocket or holder inside each control panel.

1.2 PRICE AND PAYMENT PROCEDURES

A. No separate payment for work performed under this section. Include cost for SCADA/Control Panels in overall electrical equipment

1.3 REFERENCES

A. NEMA 250 - Enclosures for Electrical Equipment (1000 volts maximum)
B. ANSI/NFPA 70 - National Electrical Code (NEC)
C. Underwriters Laboratories, Inc. (UL)
D. Factory Mutual (FM)
E. Occupational Safety and Health Administration (OSHA)
F. American National Standards Institute (ANSI)
G. NEMA ICS 1 - General Standards for Industrial Control and Systems
H. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies
I. NEMA ICS 3 - Industrial Systems
J. NEMA ICS 6 - Enclosures for Industrial Controls and Systems
K. NEMA ST 1 - Standard for Specialty Transformers (Except General Purpose Type).
L. ISA - Instrument Society of America
M. FM - Factory Mutual
N. IEEE - Institute of Electrical and Electronic Engineers
O. NFPA - National Fire Protection Association
P. JIC - Joint Industrial Council
1.4 SUBMITTALS

A. Refer to specification for Basic Submittal and O&M Requirements 16051

B. Panels, Consoles, and Cabinets Information:
   1. Layout Drawings include the following:
      a. Front, rear, end, and plan views to scale.
      b. Dimensional information.
      c. Tag number and functional name of components mounted in and on panel, console, or cabinet.
      d. Product information on all panel components.
      e. Nameplate location and legend including text, letter size, and colors to be used.
      f. Location of anchoring connections and holes.
      g. Location of external wiring and/or piping connections.
      h. Mounting and installation details.
      i. Proposed layouts and sizes of graphic display panels.

2. Wiring and/or piping diagrams include the following:
   a. Name of panel, console, or cabinet.
   b. Wiring sizes and types.
   c. Piping and tubing sizes and types.
   d. Terminal strip numbers.
   e. Color coding.
   f. Functional name and manufacturer's designation for components to which wiring, and piping are connected.

3. Electrical control schematics in accordance with JIC standards.
4. Plan showing equipment layout in each area.

C. Field wiring and piping/tubing diagrams, include the following:
   1. Wiring and piping/tubing sizes and types.
   2. Terminal strip numbers.
   3. Color coding.
   4. Conduits in which wiring is to be located.
   5. Location, functional name and manufacturer’s designation of items to which wiring and/or piping are connected.
   6. Point-to-point wiring diagrams

1.5 RECORD DRAWINGS

A. Refer to specification for Basic Submittal and O&M Requirements 16051

1.6 OPERATIONS & MAINTENANCE MANUALS

A. Refer to specification for Basic Submittal and O&M Requirements 16051

B. Accurately record actual locations of control cabinets and input and output devices connected to system. Include interconnection wiring and cabling information and terminal block layouts in control cabinets, inserted in an aluminum drawing pocket on inside of door.

C. During drawing submittal phase, submit detailed information consisting of ladder logic and line code, complete input, output, relay and controls identification labels and written description of program operation. Ladder logic diagrams submitted shall contain a written descriptive note for each line, describing the function and logic of that line. Submit all documents in hard copy and on CD.
D. Submit factory-testing procedures proposed to verify all input, output, loop operation, and system logic verification. Testing procedures submitted shall detail, as a minimum, verification of the following required minimum functions:
1. Verify motor start, motor stop, and level or pressure alarm outputs by simulating signals representing levels or pressures.
2. Verification of each discrete input via external manually operated connection.
3. The system shall be tested and verified with all external devices required to simulate field connections connected simultaneously for a full system test.

1.7 QUALITY ASSURANCE

A. Any manufacturer that cannot meet the requirements of this specification will not be considered

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Rittal
B. Hoffman Enclosures
C. NEMA Enclosure Manufacturing Co.
D. Approved equal quality

2.2 WIRING METHOD

A. Install wiring in open-slot plastic wiring duct or Panduit wireways
B. Where wireways are used, they shall be properly sized for wiring contained within and shall not be oversized. Wireway fill shall not exceed 75 percent of wireway capacity and shall not be less than 25 percent of wireway capacity. Wireway width to depth ratio shall not be less than 2 to 1
C. Do not use adhesive type cable ties. Attached with stainless steel bolts or welded studs
D. Provide thermostat-controlled strip-type space heater (150 watts maximum), convenience outlets and internal fluorescent lighting (where shown on drawings)
E. Nameplates: On the outside of each cabinet's inner door, provide motor data nameplate information for each pump motor; copy all information exactly as shown on each motor nameplate. Provide engraved laminated plastic nameplates; white letters with black background; fasten to outside of cabinet door of each motor starter section with stainless steel screws
F. All equipment and devices shall be NEMA rated. IEC rated equipment and devices are not acceptable
G. A divider of same material and thickness as the cabinet shall be added to divide electrical components and wiring from instrumentation and pneumatic components and wiring
H. All interconnect wiring inside panel to be stranded copper conductors intended for panel wire use. Thermoplastic covered wire is not to be used.
I. Cable ties shall be spaced at intervals not to exceed 4 inches. All wiring between device terminals and wireways shall be orderly and tied. Wire markers shall be visible without removing wiring from a wireway
J. All cable ties shall be trimmed, and loose ends shall not exceed 1/8 inch in length after trimming

K. Wiring bundles shall be secured in place with nylon cable clamps that are attached to the mounting plate with stainless steel bolts. Cable bundles attached to the back side of a front plate or cover plate shall be via steel studs welded to the plate before painting. Counter sunk head steel bolts may be used in which case the head finish shall match the panel finish in color so as to provide a neat appearance of the front panel

L. Wire splices inside panels are prohibited. Wire nuts and similar devices are prohibited. Split, bridged, or extended circuits shall be done via use of terminal strips only except where looped grounds or power circuits may be used where wire is not cut and is attached at each device with proper terminal devices. All circuits shall be continuous and unbroken

M. Use wire strippers of proper size to avoid wire nicks or cut strands. Trimming strands to make wire fit a terminal is prohibited. Provide proper sized wire and/or terminal device

2.3 DEVICE MOUNTING

A. All devices mounted on plates or doors shall be installed in holes that are punched with dies that specifically match the device requirements. Holes may be formed with machine tools. No mounting holes are to be cut with saws, nibblers, or similar tools not made for professional panel fabrication. All edges to be smooth and free of burrs

B. Panels that have scratches or are otherwise damaged when mounting devices may be touched up with the same identical paint where dried under the same conditions of heat or drying as the original panel finish. Repairs shall not be detectable

C. All panels to be constructed of 316 stainless steel, 16 gauge painted steel, or 16-gauge aluminum, as noted on plans. All doors to be constructed so as to prevent flexing or twisting movement when opened. This is especially of concern when devices are mounted on door. Lightweight doors are not acceptable. Inner panel is to be aluminum or steel. Plexiglas panel is not acceptable

D. Where panel is provided by an Equipment Manufacturer as part of the specified equipment package, the Equipment Manufacturer shall be held to these same standards and requirements. Providing panels of less quality than these standards will not be acceptable regardless of Equipment Manufacturer’s standard panel specification described in equipment data sheets. Other specification sections of lesser quality do not supersede the requirements of this specification section

E. No devices shall be mounted in outer door of panels except where specifically noted on plans. Where instruments are mounted in panel doors or plates, the mounting devices, clips, and brackets shall be type provided by the Instrument Manufacturer or shall be specifically fabricated for the purpose. All panel mounted instruments shall have enclosures that cover any exposed circuit boards or components on the back side of the instrument

F. Components are to be attached with bolts, washers, and nuts properly sized and made for the purpose applied. Screws or self-tapping screws are not acceptable for mounting components, except self-tapping stainless screws shall be used for mounting nameplates

G. Do not mount temperature sensitive devices near heat producing components such as resistors or transformers

H. Arrange all devices for easy identification, removal, and repair. Removal of any device shall not require removal or disturbing other components

I. Wet devices shall be located in lower part of panel or cabinet with metallic spray shield installed above, separating other electrical devices
J. DIN rail mounted devices shall be made for purpose and shall be standard sized components. Micro and miniature type components are not acceptable. Provide additional 8-inch DIN rail for future devices

K. All devices shall be of type that is readily available and not special-order type components that are not standard manufactured units

L. All components, parts, and devices are to be identified at their locations with approved labels or nameplates. Provide 8 ½ x 11-inch laminated parts list in steel or hard plastic door pocket along with the control diagrams

M. All over current devices shall be fast acting circuit breakers. Fuses are not allowed except where specifically called for. Where fuses are specified, provide ten (10) each spare fuses in addition to requirements of other specification sections

N. Fused circuits are not acceptable for power or control devices. Circuit breakers shall be used for all overcurrent protection purposes. Any use of fuses shall be acceptable where specifically approved by Engineer in writing for each specified panel

O. All display screens or readouts shall be mounted in panel at height of 60 inches above level where operator stands. This must be accounted for where panels are installed on concrete pads or other elevated structures

2.4 TERMINALS

A. All terminations for interfacing with external wiring shall be via screw type terminal strips that have numbered markings to identify termination points. All terminals to have compression plates made specifically for the purpose, in addition to the screws. Round washers are not acceptable substitute for the compression plates

B. All terminals or exposed wiring with more than 120 volts to ground or 300 volts between legs are to be shielded with non-metallic, non-conducting insulating material made for the purpose of avoiding accidental contact. Label all shields and devices in a recognizable manner with warning nameplate or sign

C. Locate terminal strips in accessible location in panel to allow easy access when making terminations. Provide nameplate for each terminal strip

2.5 MISCELLANEOUS

A. Door fasteners shall be of highest quality, designed to withstand repeated engagement and disengagement without damage to retaining parts, which shall be firmly attached to the panel frame members. Fasteners shall be properly aligned with retainer parts. Lightweight fasteners are not acceptable. Any fasteners failing before warranty period expires shall be replaced with different type fastener that is acceptable to Owner and Engineer

B. All attachments and studs that are welded to stainless steel panel, enclosure, or plate shall be properly welded in such a manner that does not discolor finish. All welds shall be properly cleaned, buffed, and treated to provide a neat appearing finish. Any discolored plates or enclosures shall be replaced

C. Panel Manufacturer shall send Engineer color photographs or e-mail color photo files of finished panel where shop inspection has not been conducted before shipping. Photos shall be of quality and clarity so as to allow evaluation of finished panel quality. No panels shall be delivered to job site without this review and approval in writing by Engineer and, where delivered without this approval may be rejected by Engineer. Any delay in construction due to failure to satisfy this requirement will be at fault of contractor
D. Relocation of panels up to 40-fet from where shown may be required and shall be included in bid cost

2.6 CONTROL PANEL

A. Enclosure Type: NEMA 1

PART 3 - EXECUTION

3.1 TESTING

A. All elements of each electrical control system shall be set up, calibrated, and tested by Manufacturer’s Technician to demonstrate that the total system satisfies all of the requirements of this Specification. All special testing of materials and equipment shall be provided by the Contractor. The Contractor shall coordinate and schedule all of his testing and startup work with the Owner and Systems Integration Engineer. As a minimum, the testing shall include both a factory test and a field test. Testing requirements are as follows:

1. Factory Tests: The electrical controls and all other associated hardware shall be tested via a full simulation at the factory, prior to shipment, to demonstrate that each component is operational and meets the requirements of these specifications. Manufacturer shall provide test routine program for shop testing of I/O wiring. Where solid-state controller programs are furnished by a specified Systems Integration Programmer, a copy of the program will be provided for Manufacturer’s use in factory testing. Test results shall be certified, with written documentation provided to the Engineer upon test completion. Factory testing may be witnessed by the Engineer and/or Programmer.

2. Field Tests: All electrical control system components shall be checked to verify that they have been installed properly and that all terminations have been made correctly. Witnessed field tests shall be performed on the complete system. Prior to witnessed test, Contractor shall perform a complete test of each and every function, device operation and overall operations of electrical power, control, instrumentation and SCADA system. Prior to loading PLC or SCADA programming and prior to any PLC or SCADA set up by programmer, an inspection shall be conducted by Engineer’s Inspector to assure electrical controls are functioning properly. Any discrepancies or problems shall be corrected and then Contractor shall send a written notice that complete electrical control system is installed and operating per the Plans and Specifications. This notice shall be signed by an Officer of the General Contractor’s company. Contractor shall provide a checklist for all electrical, control and instrumentation functions and send to Engineer for approval. Each function shall be demonstrated to the satisfaction of the Owner and Engineer on a paragraph-by-paragraph basis. Any equipment, devices or functions that are found not performing properly will be reason for termination of test until repairs are made. Additional testing by Engineer and Owner may be at Contractor’s expense for time and travel of Engineer and Owner’s staff.

B. A state licensed Electrician shall be present at all scheduled inspections.

C. Controller Program: Remote testing by Engineer will require a minimum of 30 working days after programs are downloaded to the controller. Provide six (6) weeks’ notice for program downloading by Programmer. This shall be accounted for in project schedule. Any delay of project completion due to lack of notice is at Contractor’s risk and expense.
D. Prior to testing system, PLC programs or HMI programs provided by other than the Systems Integration Engineer, programs shall be furnished on CD for review by Engineer. Provide any special software necessary to run and test complete program.

E. Modem and/or radio system setup shall be conducted by Manufacturer’s Technician before any field-testing by Engineer is performed. Set up per Manufacturer’s written instructions. Provide Engineer with checklist and values of all settings and adjustments before requesting field test by Engineer. Indicate impedance of terminal load resistor at each end of modem line.

3.2 PREPARATION

A. Verify that surface and job conditions are ready for construction; report unsatisfactory conditions to the Engineer. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Deliver products to site in acceptable condition and in protective wrappings.

C. Store and protect products from damage.

D. Accept products on site in factory containers and verify damage.

E. Store products in clean, dry area; maintain temperature to NEMA ICS 1.

F. Maintain temperature above 32°F and below 104°F during and after installation of products.

G. Maintain area free of dirt and dust during and after installation of products.

H. Provide temporary heating and air conditioning units and equipment required to maintain environmental conditions specified for control panel’s.

3.3 INSTALLATION

A. Install in accordance with manufacturer’s instructions and intent of Contract Drawings. Provide sufficient clearance for calibration and maintenance access.

B. Install control panels, instruments, and motor control centers, to allow a minimum of four (4) feet clearance for access to control devices.

C. Transport, handle, and install products in accordance with manufacturer’s instructions.

D. Install on prepared pads at minimum height of 12 inches above grade or floor and not less than 18 inches above flood plain elevation. Anchor securely at each corner. Shim and grout as required to form a watertight seal.

E. Install cabinet fronts plumb.

F. Shop-cut bottom conduit entrance openings for outdoor cabinets. Seal removable plates with silicone sealant. Seal around and beneath perimeter of cabinet with silicone sealant.

G. Install ground rod and equipment ground conductor.

H. Install separate instrument ground lug and ground conductor; connect to common station ground grid.

I. Mount devices to allow removal and reinstallation without backboard removal. Use stainless steel mounting hardware.

J. Except for nameplate fasteners, mounting or other hardware shall not penetrate panel exterior.
K. Exterior Panels: Mount with stainless steel anchor bolts and ground to the station ground field. Install and test ground field to provide maximum 5-ohm resistance to ground in accordance with Section 16452 – “Grounding.”

L. Provide door restraints for outer and inner doors to positive lock and hold doors open at 115 degrees minimum.

M. Minimum headroom around control cabinet shall be 78 inches.

N. Label all wires with heat shrink markers per Section 16052 – “Electrical Identification.”

3.4 CONTROL LOGIC

A. Pump start/stop operation shall be controlled by remote pressure switches in NO and NC configurations as detailed in drawings. Acceptable pressure switch manufacturers are Ashcroft, Schneider and Omega.

B. Provide a start delay timer for each pump.

C. Each motor controller shall be as follows:
   1. A 10 hp minimum variable frequency drive as manufactured by ABB, Eaton/Cutler Hammer, Yaskawa or Danfoss type in a NEMA 1 enclosure with integral MCP, substitutions are not allowed. Drives must be able to accommodate 1 phase, 240VAC input and convert to 240VAC, 3 phase output to power a 7.5 hp booster pump.
   2. Each pump control panel shall be equipped with pull-apart terminal blocks
   3. Control wiring and associate control devices in each pump control panel shall be furnished intrinsically safe for operation in its intended environment
   4. Each motor controller shall be equipped with a copper ground bus
   5. All control relays shall be 4-pole ice cube type each with 10-amp, 120V rated contacts. Each contact shall be field convertible. Each relay shall have open-close position indication. Relay coils shall be rated 120V A.C. continuous duty, including the latch type relay coils. Relay to accept #14 AWG conductors
   6. Controls shall be as indicated on the drawings
   7. Remote pilot operators, "RPD" devices, shall be furnished for remote control of indicated motor and other remote-control functions
   8. RPD Devices, such as start, stop pushbuttons, pilot lights, and selector switches shall consist of heavy-duty oil-tight operators. Pushbuttons, selector switches, and pilot lights are to be multi-light industrial type. Pilot lights shall be transformer type LED, push to test, complete with LED. Pilot lights shall be equipped with the indicated colored lenses:
      a. Red: Run
      b. Green: Stop
      c. Amber: Fault
      d. White: Power On
   9. Each RPD device shall be equipped with engraved plastic surround to identify functions. Legend plates shall be provided for devices mounted on the door. The plates shall be manufacturer’s standard with lettering indicated on the plans and of the same manufacture as the respective pushbutton, selected switch, or pilot light.
      Provide all legend and name plates as per the plans
   10. Remote pilot operators shall be Eaton or Schneider
   11. Elapsed time meters shall be installed for each motor and shall measure in increments of hours and be non-resettable. Furnish Eagle Signal Controls H Series time totalizer or approved equal
   12. Each pump control panel shall be equipped with a lightning arrester complete with an overcurrent protection device. Furnish Schneider or approved equal
13. Each pump control panel shall be furnished with one main disconnect circuit breaker that de-energizes all power and controls when the handle is turned to the off position. Main disconnect shall be able to be padlocked in the off position.

3.5 SYSTEM STARTUP

A. Provide the services of factory trained personnel to assist in the installation and start-up of the control system

3.6 TRAINING

A. Provide minimum four (4) hours of “hands-on” instruction each for Owner’s staff. To be conducted at project site by control systems manufacturer’s representative, at no additional cost to Owner. Training is to be conducted after all control systems are fully operational.

B. Provide minimum two (2) weeks’ notice to Engineer and Owner before conducting training

3.7 MAINTENANCE/WARRANTY

A. Provide manufacturer’s maintenance services of control systems for one year from date of substantial completion.

B. Contractor shall provide full 1-year service warranty on the overall installation and shall include all labor and materials required to repair or replace equipment and/or components that are defective or malfunctioning. Included under this warranty shall be all equipment, devices, hardware, and software. This warranty shall begin on date of written “Final Acceptance” of the electrical systems to be executed as required at no additional cost to the Owner.

C. Contractor’s warranty shall also guarantee 24-hour service response time and shall provide labor, work, or materials as necessary to maintain plant operation when replacement parts are on order. In no case shall plant electrical systems be out of service for more than 24 hours from time Owner calls for warranty service. This shall be provided at no additional cost to the Owner. All equipment and materials installed shall have full warranty from Manufacturer that guarantees equipment is rated for harsh industrial electrical/mechanical environment in which it is installed. Where Manufacturer’s products fail prematurely, Manufacturer shall be fully responsible for new replacement and shall not have the option of declaring that failures were caused by environmental conditions and its effect on the product. Contractor is fully responsible for assuring that Product Manufacturers are aware of this condition and that warranty statement is included in shop drawing submittals. Failure to do so will be at the Contractor’s expense and at no additional cost to the Owner.

D. All critical warranted repairs shall be made within 24 hours of receipt of required parts from Manufacturer with reasonable delivery time of overnight shipping. Any repairs not completed within 5 working days from date of notice are subject to Owner making other arrangements for repair and back charging contractor. This requirement is a condition of this contract.

E. Where equipment or instrument problems remain unresolved by contractor beyond a reasonable time, a factory technician shall be provided on-site to take any corrective actions necessary to put equipment or instruments in operating order. Owner and engineer reserve the right to determine a reasonable time for corrective action by contractor.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. This specification is confidentially issued for this specific project only
B. Contractor shall be responsible for reading all specifications from all disciplines prior to bid
C. This section includes pilot and control devices for instrumentation and control system
D. Products listed are applicable where shown on plans or required by other specifications or manufacturer's

1.2 SUBMITTALS

A. Refer to specification for Basic Submittal and O&M Requirements 16051

PART 2 - PRODUCTS

2.1 TAGGING

A. Provide Type 316 stainless steel tag on field-mounted units and permanently affix tag to unit
B. Include Engineer's tag number where listed in Control Diagrams

2.2 PUSHBUTTONS/SELECTOR SWITCH/PILOT LIGHTS

A. Manufacturers:
1. Square D Class 9001, Type K
2. Eaton
3. Allen Bradley 800T
4. Or, pre-approved equal

B. Construction:
1. Heavy duty
2. Liquid tight
3. Oil tight
4. Base mounting
5. Flush panel mounting
6. Size to mount in 30.5 mm diameter opening without adapter. Smaller units are not acceptable
7. Padlock attachments, where required, constructed of metal. Plastic material is not acceptable
8. Legend plates, as required, for type of operation or as specified elsewhere

C. Pushbuttons:
1. Flush head unless specified elsewhere.
2. Contact Blocks:
   a. Double break silver contacts
   b. AC Ratings: 7,200 VA make, 720 VA break
c. Single pole, double throw or double pole, single throw
d. Up to six (6) tandem blocks

3. Maintained contact unless specified elsewhere
4. Non-illuminated.
5. Legend plates, as required, for type of operation or as specified elsewhere

D. Selector Switches:
1. Maintained position unless specified elsewhere
2. Contact Blocks:
   a. Double break silver contacts
   b. AC Rating: 7,200 VA make, 720 VA break
   c. Single pole, double throw or double pole, single throw
   d. Up to six (6) tandem blocks
3. Operators:
   a. Number of positions as specified elsewhere
   b. Standard knob type unless specified elsewhere

E. Pilot Lights:
1. LED, high visibility type
2. Colored lenses as specified elsewhere
3. Interchangeable lenses
4. Push to test
5. Legend plates as specified elsewhere

F. Enclosures:
1. Mounted in control or instrument panel as specified elsewhere
2. Control Station:
   a. Environment:
      i. NEMA 12 in general areas
      ii. NEMA 4X 316 stainless steel in wet locations or outdoors
   b. Flush or surface mounted as specified elsewhere.
      i. Provide flush mounted pull box.

G. Nameplates:
1. Control Stations:
   a. Engraved laminated plastic
   b. Letters 3/16 in. high
   c. White letters on black background
   d. Identify per equipment controlled

2.3 CONTROL RELAYS

A. Manufacturers:
1. Potter and Brumfield
2. Struthers Dunn
3. Or pre-approved equal

B. B. Operating Data:
1. Pickup Time: 13 ms maximum
2. Dropout Time: 10 ms maximum.
3. Operating Temperature: -45 o C to 70 o C

C. AC Coil:
1. 120 or 240 Va
2. Continuous rated
3. 3.5 VA inrush
4. 1.2 VA sealed
5. 50 to 60 Hz
6. Minimum Dropout Voltage: 10% of coil rated voltage

D. DC Coil:
1. 24 or 120 Vdc
2. Continuous rated
3. Minimum Coil Resistance
   a. 24 Vdc: 450 ohm
   b. 120 Vdc: 9,000 ohm

E. Contacts:
1. Silver cadmium oxide for 1 amp or less resistive load
2. Gold flashed fine silver; gold diffused
3. 4 Form C
4. 120 VAC
5. 20 amp make, 1.5-amp break (inductive)

F. Rated at 10 million operations

G. Plug-in sockets

H. Enclosed and protected by polycarbonate cover

I. Provide relay retaining clips

J. All relays to be 4PDT type

2.4 TIME DELAY RELAY

A. ATC # 319D-016, with 2 SPDT switches rated 5 amps at 120 Volt, contacts and coil, plug in base and socket, 5 ranges, .02 seconds to 30 minutes.

B. AGASTAT #7022AC, Instantaneous open on energization, time delay close on de-energization. Time range 1.5 seconds to 15 seconds, 120-volt, 60 Hz

C. ATC Model #319D-134, with 2 S.P.D.T. switches rated 5 Amps at 120 Volt, contacts and coil, plug in base and socket, 3 ranges, .1 to 100 seconds.

D. Macromatic Industrial Controls, Model #TAA1U, with two (2) S.P.D.P. switches rated 3 amps at 250-volt contacts, 24-240VAC/DC coil, plug-in base, six (6) functions, sixteen (16) ranges, 0.5 seconds to 10 hours.

E. Or approved equal

2.5 ELAPSED TIME METER

A. Manufacturers:
   1. Cramer #635G/HRS.
   3. Power: 120 VAC, 60 Hz.

B. Manufacturers:
   1. Cramer #635S surface mounted.
   2. Digits: Five (5), non-resettable
   3. Power: 120 VAC, 60 Hz

2.6 TIMERS

A. 24 Hour Clock Timer (Repeat Cycle):
1. Manufacturers:
   a. Tork Time Controls
   b. Intermatic
   c. Or pre-approved equal
2. Mounting: Surface
3. Display: 24-hr LCD
4. Contacts: One (1) SPDT rated 20A
5. Set Points: 288 per 24 hr.
6. Skip Feature: 1 to 7-day adjustable
7. Minimum On-Off Time: 5 min.
8. Time cycle programmable by keypad
9. Power: 120 VAC, 60 Hz

B. Interval/Duration Timer:
1. Manufacturers: ATC or equal.
2. Mounting: Plug-in with dust tight cover
3. Type: Integrated circuit
4. Range: As indicated on drawings
5. Contacts: Two (2) DPDT contacts rated 10 amp
6. Power: 120 VAC, 60 Hz

2.7 ALTERNATOR

A. Manufacturers:
1. Diversified Electronics:
   a. Two (2) Pump Duplexor:
      i. 24 VAC/DC, ARA-24-ABA.
      ii. 48 VDC, ARA-48-ABA
      iii. 120 VAC/DC, ARA-120-ABA
      iv. 208 VAC, ARA-208-ABA
      v. 240 VAC, ARA-240-ABA
   b. Three (3) Pump Triplexor:
      i. 24 V, ARA-24-AFE
      ii. 120 V, ARA-120-AFE
   c. Four (4) Pump Quadruplexor:
      i. 24 V, ARA-24-AGE
      ii. 120 V, ARA-120-AGE
   d. Two (2)/Three (3) Pump Duplexor/Triplexor: 120 V, ARA-120-AME
   e. Three (3)/Four (4) Pump Triplexor/Quadruplexor: 120 V, ARA-120-ANE
   f. Five (5)-Pump Pentaplexor: 120 V, ARP-100
   g. Six (6)-Pump Hexaplexor: 120 V, ARA-100
2. Time Mark Corporation: 120 V, B 471
3. Macromatic Industrial Controls: Two (2) pump Duplexor, 120 volt, ARP120A6, 240 volts, ARP240A6
4. Or approved equal

B. Provide automatic alternation of energizing motor starters
C. Permit operation of units singly or together as called by pilot devices
D. N.O. auxiliary contacts from motor starters required to operate alternator
E. Alternator shall provide for operation of standby or lag unit through second pilot device in event of failure of lead unit or first pilot device or alternator coil
F. With pump selector switch for operation of two (2), three (3), four (4) and five (5) pump systems

2.8 EXTERIOR MOUNTED ALARM HORN

A. Manufacturers:
   1. Edwards
   2. Or, pre-approved equal

B. 120 VAC

C. Suitable for use in wet location, gasketed.

D. Cabinet mounted, provide mounting lugs. Body to include outlet box.

E. Aluminum mounting hood.

F. ¾ inch conduit hubs

2.9 PRESSURE SWITCH

A. Potable Water Application:
   1. Manufacturer: Ashcroft, Schneider, Omega or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's written instructions, applicable requirements of NEC, NECA "Standard of Installation," and recognized industry practices.

B. Control Relay:
   1. Install panel control relays in I&C panel.
   2. Install motor starter control relays in MCC and wherever more rugged type relay required

END OF SECTION
SECTION 26 0519
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 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.
B. Related Sections include “Control/Signal Transmission Media” for transmission media used for control and signal circuits.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Qualification Data: For testing agency.
C. Field Quality-Control Test Reports: From Contractor.

1.4 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Available Manufacturers: Subject to compliance with requirements, all conductors shall be listed for the application, temperature, and insulation rating to which they are intended.

2.2 CONDUCTORS AND CABLES
A. Refer to Part 3 “Conductor and Insulation Applications” Article for insulation type, cable construction, and ratings.
B. Conductor Material:
   1. Copper complying with NEMA WC 5 or 7.
   2. Solid conductors, sizes 10 and 12, uncoated copper per ASTM B3.
3. Stranded conductor, all other sizes, uncoated copper per ASTM B3, ASTM B787, and ASTM B8.

C. Conductor Insulation Types: Type THHN-THWN and complying with NEMA WC 5 or 7.
   1. Rated for sunlight resistance all colors.
   2. Conductors shall be color coded for voltage and phase as per NEC and any local amendments.
   3. Larger conductors shall have taped color coding.
   4. Size, rating, temperature, and type shall be permanently marked on conductor jacket.
   5. Insulation shall be PVC, heat and moisture resistant, flame retardant compound as per UL-83 and UL-1063.
   6. Jacket shall be polyamide outer nylon covering per UL-83 and UL-1063.

D. Rated for sunlight resistance all colors.

2.3 CONNECTORS

A. Wire Connectors:
   1. Description: Factory-fabricated UL listed connected and of size, ampacity rating, material, type, and class for application and service indicated.
   2. Provide self-locking square wire spring grab screw on wire connectors sized as per NEC and the number of conductors to be connected.
   3. Thermoplastic deep shell design, with wings on smaller connectors, rated for application temperature, Minimum 105 degrees C.
   4. Copper to copper connection, 600V.
   5. Provide high temp wire connectors for all high temperature equipment applications.

B. Push-in wire connectors are Not Approved and shall not be used for any power or lighting circuits above 50V.

2.4 ALTERNATES

A. Blue Jacketed steel MC Cable is only permitted for 6 foot (maximum) lighting whips. It shall be used for no other purpose.

B. AC cable is not permitted at all.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, suitable for use in air return plenums.

C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlsspaces: Type THHN-THWN, single conductors in raceway.
E. Exposed Branch Circuits, including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.

H. Underground Feeders and Branch Circuits: Type THHN-THWN, single conductors in raceway.

I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.


K. Class 1 Control Circuits: Type THHN-THWN, in raceway.

L. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.2 INSTALLATION

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Minimum line voltage conductor size is #12.

C. Neutrals shall not be shared on any single pole circuit.

D. 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.

E. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

F. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

G. Support cables according to Section “Basic Electrical Materials and Methods.”

H. Seal around cables penetrating fire-rated elements according to Section “Through-Penetration Firestop Systems.”

I. Identify and color-code conductors and cables according to Section “Electrical Identification” and adhere to local color code requirements.

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturers published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.4 FIELD QUALITY CONTROL

A. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
   1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
   2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

B. Test Reports: Prepare a written report to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION
SECTION 26 0526
GROUNDING AND BONDING

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 grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.
B. Related Sections include Section "Lightning Protection" for additional grounding and bonding materials.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Qualification Data: For firms and persons specified in “Quality Assurance” Article.
C. Field Test Reports: Submit written test reports to include the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.4 QUALITY ASSURANCE
A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.
   1. Testing Agency’s Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   1. Comply with UL 467.
C. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Grounding Conductors, Cables, Connectors, and Rods:
      a. Apache Grounding/Erico Inc.
      b. Boggs, Inc.
      c. Chance/Hubbell.
      d. Copperweld Corp.
      e. Dossert Corp.
      g. Framatome Connectors/Burndy Electrical.
      h. Galvan Industries, Inc.
      i. Harger Lightning Protection, Inc.
      j. Hastings Fiber Glass Products, Inc.
      k. Heary Brothers Lightning Protection, Co.
      l. Ideal Industries, Inc.
      m. ILSCO.
      o. Korns: C.C. Korns Co.; Division of Robroy Industries.
      p. Lightning Master Corp.
      q. Lyncole XIT Grounding.
      r. O-Z/Gedney Co.; a business of the EGS Electrical Group.
      s. Raco, Inc.; Division of Hubbell.
      t. Robbins Lightning, Inc.
      v. Superior Grounding Systems, Inc.
      w. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Section “Conductors and Cables.”

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

E. Grounding Electrode Conductors: Stranded cable.

F. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

G. Bare Copper Conductors: Comply with the following:

H. Copper Bonding Conductors: As follows:
   1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, ¼ inch in diameter.
   2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1 inches wide and 1/16 inches thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1 inches wide and 1/16 inches thick.

I. Ground Conductor and Conductor Protector for Wood Poles: As follows:
   1. No. 4 AWG minimum, soft-drawn copper conductor.
   2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir, or cypress or cedar.

J. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS
A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.
C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer’s written instructions.

2.4 GROUNDING ELECTRODES
A. Ground Rods: Copper-clad steel.
B. Ground Rods: Sectional type; copper-clad steel.
   1. Size: ¾ by 120 inches.
C. Test Wells: Provide handholes for test wells.

PART 3 - EXECUTION
3.1 APPLICATION
A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
B. In raceways, use insulated equipment grounding conductors.
C. Exothermic-Welded Connections: Use for connections to structural steel, ground rods, and for underground connections, except those at test wells.
D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
E. Ground Rod Clamps at Test Wells: Use bolted pressure clamps with at least two bolts.
F. Grounding bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Use insulated spacer; space 1 inch from wall and support from wall 6 inches above finished floor, unless otherwise indicated.
2. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the specified height above the floor.

G. Underground Grounding Conductors: Use tinned-copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install equipment grounding conductors in all feeders and circuits.

C. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

D. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.

E. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

F. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding 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 raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment grounding conductor. Isolate equipment grounding 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. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

I. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.

J. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

K. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a ¼-x2x12-inch grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

L. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

M. Common Ground Bonding 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.

3.3 COUNTERPOISE

A. Ground the steel framework of the building with a driven ground rod at the base of every corner column and at intermediate exterior columns at distances not more than 60 feet apart. Provide a grounding conductor (counterpoise), electrically connected to each ground rod and to each steel column, extending around the perimeter of the building. Use tinned-copper conductor not less than No. 2/0 AWG for counterpoise and for tap to building steel. Bury counterpoise not less than 18 inches below grade and 24 inches from building foundation.

3.4 INSTALLATION

A. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building’s main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

E. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

F. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
G. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

H. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade or floor.

I. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, Paragraph 250-81(c), using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG. If concrete foundation is less than 20 feet long, coil excess conductor within the base of the foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.

3.5 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.

F. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturers published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by
connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.6 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Duct Banks: Install a grounding conductor with at least 50 percent ampacity of the largest phase conductor in the duct bank.

B. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a 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 tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Connections to Manhole Components: Connect 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 conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade and 6 inches from the foundation.

3.7 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.

3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

   a. Equipment Rated 500 kVA and Less: 10 ohms.
   b. Equipment Rated 500 to 1000 kVA: 5 ohms.
   c. Equipment Rated More Than 1000 kVA: 3 ohms.
e. Manhole Grounds: 10 ohms.

4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify
Architect promptly and include recommendations to reduce ground resistance.

3.8 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section.
Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it
as soon as possible after backfilling is completed. Restore areas disturbed by trenching,
storing of dirt, cable laying, and other activities to their original condition. Include application
of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 2 Section
“Landscaping.” Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION
SECTION 26 0533

RACEWAYS AND BOXES

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 raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
   1. Division 7 Section “Firestopping” for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
   2. Section “Basic Electrical Materials and Methods” for supports, anchors, and identification products.
   3. Section “Wiring Devices” for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. ENT: Electrical nonmetallic tubing.
C. FMC: Flexible metal conduit.
D. IMC: Intermediate metal conduit.
E. LFMC: Liquidtight flexible metal conduit.
F. LFNC: Liquidtight flexible nonmetallic conduit.
G. RNC: Rigid nonmetallic conduit.
H. PVC-GRS: PVC-Coated galvanized rigid steel.

1.4 SUBMITTALS

A. Product Data:
   1. For surface raceways, wireways and fittings.
   2. Floor boxes.
   3. Hinged-cover enclosures and cabinets.
   5. Conduit rack supports.

B. Shop Drawings: Show fabrication and installation details of components for raceways, fittings, boxes, enclosures, and cabinets.
1.5 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
   2. Refer to 3.1, RACEWAY APPLICATION, for materials to be used.

2.2 METAL CONDUIT AND TUBING

A. Available Manufacturers:
   1. AFC Cable Systems, Inc.
   2. Alflex, Inc.
   3. Anamet Electrical, Inc.; Anaconda Metal Hose.
   4. Electri-Flex Co.
   5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
   6. Republic Conduit.
   7. Manhattan/CDT/Cole-Flex.
   8. O-Z Gedney; Unit of General Signal.
   9. Wheatland Tube Co.
   10. Perma-Cote
   11. Plasti Bond
   12. KorKap

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. PVC--Coated Steel Conduit and Fittings: UL514b NEMA RN 1.

E. PVC- Coated IMC and Fittings: ETL PVC-001 NEMA RN 1 UL6.

F. EMT: ANSI C80.3.

G. FMC: Zinc-coated steel.
H. LFMC: Flexible steel conduit with PVC jacket.

I. Fittings: NEMA FB 1; compatible with conduit and tubing materials. Provide fittings factory matched with conduit types.
   1. Indoor Fittings: Steel Set Screw or Steel Compression
   2. Outdoor Fittings: Threaded fittings on IMC or Rigid Conduit
   3. Outdoor Fittings: Compression fittings with gaskets on all transitions to flexible conduit.
   4. Die cast fittings are not acceptable anywhere.
   5. Provide factory fittings with MC cable where allowed.
   6. EMT crimp type fittings are not acceptable.

2.3 NONMETALLIC CONDUIT AND TUBING

A. Available Manufacturers:
   2. Anamet Electrical, Inc.; Anaconda Metal Hose.
   3. Amco Corp.
   4. Cantex, Inc.
   7. ElecSYS, Inc.
   8. Electri-Flex Co.
   9. Lamson & Sessions; Carlon Electrical Products.
  10. Manhattan/CDT/Cole-Flex.
  11. RACO; Division of Hubbell, Inc.
  12. Thomas & Betts Corporation.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

D. LFNC: UL 1660.

E. Fittings: NEMA TC 3; match to conduit or tubing type and material. Provide fittings factory matched with conduit types.
   1. Indoor/Outdoor Fittings: Compression.
   2. Outdoor Fittings: Compression fittings with gaskets on all transitions to flexible conduit.

2.4 METAL WIREWAYS

A. Available Manufacturers:
   1. Hoffman.
   2. Square D.

B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
E. Wireway Covers: Hinged type, or as indicated.

F. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS

A. Available Manufacturers:
   1. Hoffman.
   2. Lamson & Sessions; Carlon Electrical Products.

B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

E. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

2.6 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer’s standard prime coating.
   1. Available Manufacturers:
      a. Airey-Thompson Sentinel Lighting; Wiremold Company (The).
      b. Thomas & Betts Corporation.
      d. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC compound with matte texture and manufacturer's standard color.
   1. Available Manufacturers:
      b. Enduro Composite Systems.
      c. Hubbell, Inc.; Wiring Device Division.
      d. Lamson & Sessions; Carlon Electrical Products.
      e. Panduit Corp.
      g. Wiremold Company (The); Electrical Sales Division.

C. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

D. Provide raceway base, cover, base coupling, coupling covers, angle fittings, end caps at ends, and entrance end fittings. Provide divider wall throughout raceway. Provide device brackets and snap-on bezels at all devices shown on drawings. Provide blank covers at all non-used bezels.
E. Provide raceway full length, mounted as per drawings or 6" above counters if height is not indicated, as shown on drawings. Provide elbows and raceway to 6 inches above ceiling if risers are indicated on the drawings.

2.7 BOXES, ENCLOSURES, AND CABINETS

A. Available Manufacturers:
   1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
   2. Emerson/General Signal; Appleton Electric Company.
   3. Erickson Electrical Equipment Co.
   6. O-Z/ Gedney; Unit of General Signal.
   7. RACO; Division of Hubbell, Inc.
   8. Stahlin
   10. Spring City Electrical Manufacturing Co.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

H. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.8 FACTORY FINISHES

A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.

B. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION
3.1 RACEWAY APPLICATION

A. Outdoors:
   1. Exposed: Rigid steel or IMC.
   2. Concealed: Rigid steel or IMC.
   5. Underground Primary: PVC Schedule 80 with long radius elbows.
   7. Underground Data: PVC Schedule 40 with long radius elbows.
   8. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFNC.
   9. Boxes and Enclosures: NEMA 250, Type 3R.
   11. Penetrations though exterior walls: RMC or IMC.
   12. Embedded in Concrete: Only in Approved locations – wrapped RMC or IMC.
   13. Coastal or Corrosive Locations or where specifically indicated on drawings: ETL PVC-001 PVC-GRS

B. Indoors:
   1. Exposed in Mechanical/Electrical/Unfinished Spaces: EMT.
   2. Exposed in Finished Spaces: Metal Surface Raceway painted/finished to match space finishes.
   3. Concealed: EMT.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFNC in damp or wet locations or with water equipment.
   5. Damp or Wet Locations: Sealed EMT with sealed fittings.
   6. Underfloor: Sealed EMT with sealed fittings or IMC.
   7. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
      a. Damp or Wet Locations: NEMA 250, Type 4, nonmetallic.

C. Minimum Raceway Size: 1/2-inch for single 20A or less circuits; otherwise, 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating using the manufacturer’s PVC touch up compound after installing conduits.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz.

F. Aluminum conduit will not be accepted on this project.

3.2 INSTALLATION

A. Conduit Routing:
   1. All branch circuit conduit shall be run overhead unless specifically directed by the engineer.
      a. Exceptions:
         1) Conduit to floor boxes.
         2) Conduit to locations otherwise inaccessible overhead (exposed or not).
3) Conduit to exterior slab locations without overhead cover.
4) Conduit to column mounted lighting, devices, or equipment inaccessible from above.

2. Panel feeder conduits may be run in the floor or underfloor ONLY IF indicated on the drawings or directed by the engineer.
3. Service secondary conduits may be run underfloor or in-ground.
4. Conduit for exterior equipment or lighting may be run underfloor or in-ground.
5. All conduit serving any equipment or devices (to include panels, transformers, and switchboards, or any other electrical distribution equipment) within the perimeter of the building shall be run within the perimeter of the building. Conduit shall not run across courtyards or underground from one section of the building to another section of the contiguous building.
   a. Exception: Service entrance conduit.
6. All conduit shall be run at right angles or parallel to the building lines to the limits that the structure will allow. Raceways shall not be run diagonal or curved.

B. Installation of the PVC Coated Conduit System shall be performed in accordance with the Manufacturer’s Installation Manual. To assure correct installation, the installer shall be certified by Manufacturer to install coated conduit.

C. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

D. Install raceways as high as possible and coordinate installation with other equipment.

E. Install raceways to equipment mounted on the floor away from walls from overhead down to the equipment or disconnects. Do not run across the floor creating a tripping hazard. Rack support conduit at the disconnect.

F. Provide clear access to all pull and j-boxes. Provide access doors over hard (non-lay-in ceilings) to all pull boxes. Minimum access required 1.5 x box cover size or 18 inches.

G. Label all j-box and pull box covers with circuits contained within box.

H. Under no circumstances shall power and data be shared in the same raceway, tray, channel, or sleeve.

I. Install raceways for power conductors (any conductor over 50V) 12 inches from any signal/communications conductor (data, fiber optics, telephone, fire alarm, PA, community antenna and radio distribution (CATV), low power or network powered broadband communications, systems controls, and any other system operating under 50V) not in conduit on J-hooks.

J. Install raceways for power conductors (any conductor over 50V) 12 inches from communications raceways. Communications raceways include; data, fiber optics, telephone, fire alarm, PA, community antenna and radio distribution (CATV), low power or network powered broadband communications, systems controls, and any other system operating under 50V.
   1. Exception: Data and power raceways shall be permitted to be 2 inches apart only at the wall drop to the devices. Above the ceiling or overhead the minimum 12 inch spacing shall be maintained.
   2. Exception: Within the surface raceways. When not within the surface raceway, the power and communications raceways shall be 12 inches apart.
   3. Underground: Data and power conduit/raceway shall be allowed in the same trench only if specifically allowed by the engineer and then there shall be a minimum of 12
inches of fill between the power and communications raceways. Magnetic marking tape shall be placed above the level of the highest (closest to grade) raceway.

K. Exterior Exposed Raceways:
1. See application schedule for raceway types.
2. Provide non-flexible raceways through roofs to disconnects, panels, or receptacles as per application schedule.
3. Provide transitions from non-flexible raceways to flexible raceways within 3 feet of the equipment.
   a. Exception: Flexible raceways may exceed 3 feet only to accommodate the drip legs.
4. Penetrate roofing membranes with approved methods only for the type of roof used. See roofing or architectural details.
5. Provide chem-curbs on built-up roofs unless otherwise directed from roofing or architectural details.
6. Support all exposed raceway on roofs with manufactured neoprene blocks with integral galvanized channel, conduit hangers as part of a manufactured assembly with galvanized channel (portable pipe hangers or equal), or approved method as per architectural.
7. Exposed raceways on roofs shall not be unsupported in any areas nor attached directly to the roof.
8. Provide roof hoods for multiple conduits through roofs as indicated.
9. Provide drip legs for all exterior exposed raceways from disconnects to equipment.

L. Buried Raceways:
1. See application schedule for raceway types.
2. Label all buried conduits.
3. Provide spacers between all buried conduits for a neat and uniform installation. Conduit shall not be “stacked” on top of each other without manufactured spacers.
4. IF telecommunications conduits and power conduits (only under 600V) are allowed in the same trench by owner or engineer, provide a minimum of 12 inches of compacted earth between the conduit racks. Provide magnetic marking tape between the communications conduits and the power conduits.
5. Under NO circumstances shall power conduits over 600V be in the same trench as the communications conduits.
6. All communications conduits shall have long radius elbows 10x the conduit diameter, but no less than 30”, rising up into the building or communications equipment.
7. Provide concrete encasement for all primary building feeders unless directed by utility company.
8. Provide concrete encasement for all secondary building feeders unless otherwise noted.
9. Provide pull strings/tape (per size and distance) for all empty conduits.
10. Minimum depth of primary or medium voltage conduits 42 inches. (600V and above).
11. Minimum depth of secondary or low voltage conduits 30 inches. (0 to 600V).
12. All 90 degree changes in direction shall be long radius.
13. Provide metal backed marking tape at 12 inches below grade and 6 inches above all buried raceways.
14. Clean and swab out all conduits prior to installing conductors.
15. Any metallic conduit coming in contact with earth, insulate with approved tape or asphalt paint.

M. All underfloor conduits shall be supported as per NEC.
1. See application schedule for conduit types.
2. All conduit supports shall be anchored to structure.
3. Provide support for multiple conduits with galvanized kindorf rack, conduit straps, all thread rod to angles, and mount angles to structure.

4. ONLY IF specifically directed by owner or engineer to use RNC underfloor;
   a. Provide support for 2” and below conduit every 48 inches.
   b. Provide support for 2-1/2” and above every 60 inches.

N. Complete raceway installation before starting conductor installation.

O. Support raceways as specified in Section “Basic Electrical Materials and Methods.”

P. Install temporary closures to prevent foreign matter from entering raceways during construction. Remove prior to completion of conduit.

Q. Sleeves: Provide metallic raceway sleeves through walls or floors for all conductors/cabling not in raceways. Provide bushings at both ends of sleeves prior to installing any conductors or wiring. Firestop as per requirements.

R. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

S. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

T. Firestop: Firestop all raceway penetrations in rated walls. Provide intumescent fill in all sleeve openings. Contractor shall be responsible for all wall repair and damage. Excessive firestop for holes too large (½ inch beyond the edge of the raceway) is unacceptable. Holes shall be repaired with suitable wall materials to maintain the integrity of the wall construction.

U. Cut openings in walls as per the outer edges of the raceway. Openings made with hammers or other wall damaging tools are not acceptable. Holes too large (½ inch beyond the edge of the raceway) are unacceptable and shall be repaired with suitable wall materials to maintain the integrity of the wall construction. Contractor shall be responsible for repair to match existing.

V. Provide manufactured elbows of conduit type specified for PVC raceways. Field constructed elbows are not allowed. Rigid Non-metallic tubing shall not have any field fabricated 90 degree bends. Provide manufactured elbows at all 90 degree changes in direction.

W. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
   1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

X. Raceways Embedded in Slabs are allowed ONLY where specifically called out or ALLOWED by structural and electrical engineer: Install in middle one-third of slab thickness where practical and leave at least 2 inches of concrete cover on the top and bottom.
   1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
   2. Space raceways laterally to prevent voids in concrete.
   3. Run raceways parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.

Y. Expansion Joints: Provide flexible connections suitable for use with conduit type for all conduit in structural expansion joints or independent slabs that are within another structural assembly.
Z. Raceways Through Slabs to Interior Spaces: Install where practical and leave at least 2 inches from any walls unless required to come up in the wall. Coordinate with grade or perimeter beams prior to installation.
   1. Secure raceways to concrete with conduit clamps.
   2. Change from nonmetallic raceways to rigid steel conduit or IMC before rising above the floor.
      a. Exception: Raceways from below grade into transformers and switchgear enclosures shall be RNC with bushings.
      b. Exception: Raceways from below grade for telephone boards and data/signal equipment shall be RNC with bushings.
   3. Tape conduit from minimum 3 inches below transition to 3 inches above the floor so that no portion of the rigid steel conduit or IMC is in contact with the concrete.

AA. Raceways Through Floors: Install where practical and leave at least 2 inches from any walls. Coordinate with grade or perimeter beams prior to installation.
   1. Secure raceways to concrete with conduit clamps.
   2. Provide sleeve seals for conduit penetrations through floors. Provide firestopping at all floor penetrations.

BB. Install ALL exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
   1. Run parallel or banked raceways together on common supports.
   2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
   3. Install conduit as high as possible.
   4. Flexible cable or raceway for general circuiting is allowed exposed in mechanical or electrical spaces only. Not allowed in finished spaces.
      a. Exception: As equipment connection only.

CC. Join raceways with fittings designed and approved for that purpose and make joints tight.
   1. Use insulating bushings to protect conductors.

DD. Tighten set screws of threadless fittings with suitable tools.

EE. Terminations:
   1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
   2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

FF. Install pull tape/wires in empty raceways.
   1. For raceways under 2 inches and under less than 100 feet, 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.
   2. Raceways under 2 inches and over 100 feet without intermediate pull boxes, provide mule tape. With intermediate pull boxes use pull wire.
   3. For raceways over 2 inches and use mule tape.
   4. Sleeves under 36 inches do not require pull tape/wire.

GG. Telephone and Signal System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of
two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

HH. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-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. Label boxes “seal-off”. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

II. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

JJ. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures if not using MC cable for lighting whips; for equipment subject to vibration, noise transmission, or movement, and for all motors indoors of non-water operating equipment. Use LFNC in damp or wet locations or to any water operating equipment. Install separate ground conductor across flexible connections.

KK. Prime and Paint exposed conduit in finished spaces, unless pre-painted surface raceways is provided, as per owner/architect. Provide with paintable surface.

LL. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.

MM. Floor Boxes:
1. Set floor boxes level. Grout around floor box to fill in area around box opening.
2. Trim after installation to fit flush with finished floor surface.
3. Ground floor box with circuit grounding conductor.
4. Coordinate covers with floor finishes. Provide covers with inserts for tile or carpet.
5. Floor boxes shall be flush with finish floor.

NN. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

OO. Cap all un-used/spare conduits. Does not include sleeves.

3.3 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.
3. Provide cover over conduits during storage to prevent dirt and debris from entering conduits during storage.

3.4 CLEANING
A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

B. Remove debris from conduits prior to capping any spare conduits.

C. Blow-out empty conduits that are future spares in any exterior or underground installation prior to capping.

3.5 RECORD

A. Record the location of all spare conduits buried for future use by the owner.

END OF SECTION
SECTION 26 0553

ELECTRICAL IDENTIFICATION

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 electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

1.3 SUBMITTALS
A. Product Data: For each electrical identification product indicated.
B. Schedule of Nomenclature: An index of electrical equipment and system components used in identification signs and labels.
C. Samples: For each type of label and sign to illustrate color, lettering style, and graphic features of identification products.

1.4 QUALITY ASSURANCE
A. Comply with ANSI C2.
B. Comply with NFPA 70.
C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 - PRODUCTS

2.1 RACEWAYS AND CABLE LABELS
A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
   1. Color: Black letters on orange field.
   2. Legend: Indicates voltage and service.
B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend overlaminated with a clear, weather- and chemical-resistant coating.
C. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.
D. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

   1. Not less than 6 inches wide by 4 mils thick.
   2. Compound for permanent direct-burial service.
   3. Embedded continuous metallic strip or core.
   4. Printed legend indicating type of underground line.

F. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

G. Aluminum, Wraparound Marker Bands: Bands cut from 0.014-inch-thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.

H. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.

I. Aluminum-Faced, Card-Stock Tags: Weather-resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inch thick, laminated with moisture-resistant acrylic adhesive, punched for fasteners, and preprinted with legends to suit each application.

J. Brass or Aluminum Tags: 2×2×0.05-inch metal tags with stamped legend, punched for fastener.

2.2 NAMEPLATES AND SIGNS


B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
   1. Engraved legend with black letters on white face.
   2. Punched or drilled for mechanical fasteners.

C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. ¼-inch grommets in corners for mounting.

D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for the application. ¼-inch grommets in corners for mounting.

E. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
   2. Tensile Strength: 50 lb minimum.
   3. Temperature Range: Minus 40 to plus 185 deg F.

B. Paint: Formulated for the type of surface and intended use.
   1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
   2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
   3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
   4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.

C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before applying.

E. Install painted identification according to manufacturer’s written instructions and as follows:
   1. Clean surfaces of dust, loose material, and oily films before painting.
   2. Prime surfaces using type of primer specified for surface.
   3. Apply one intermediate and one finish coat of enamel.

F. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below:
   1. Bands: Pretensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
   2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
   3. Apply the following colors to the systems listed below:
      e. Mechanical and Electrical Supervisory System: Green and blue.
      f. Telecommunication System: Green and yellow.

G. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.

H. Circuit Identification Labels on Boxes: Install labels externally.
   1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.
4. Normal Power Circuits: Black lettering and numbers
5. Emergency Power Circuits: Red lettering and numbers

I. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

J. Color-Coding of Secondary Branch Circuit Conductors: Use the following colors for service, feeder, and branch-circuit branch circuit conductors:
1. 120/208V 3 Phase Conductors:
   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.
   e. Ground: Green.
2. 120/240V 3 Phase Conductors:
   a. Phase A: Black.
   b. Phase B: Orange (High Leg Only).
   c. Phase C: Blue.
   e. Ground: Green.
3. 120/240V Single Phase Conductors:
   a. Phase A: Black.
   b. Phase B: Red or Blue.
   d. Ground: Green.
4. 277/480V 3 Phase Conductors:
   a. Phase A: Purple.
   b. Phase B: Brown.
   c. Phase C: Yellow.
   d. Neutral: Gray.
   e. Ground: Green.
5. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:
   a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
   b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.

K. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, manholes, and switchboard rooms.
1. Legend: ¼-inch-steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
2. Tag Fasteners: Nylon cable ties.

L. Apply identification to conductors as follows:
1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

M. Apply warning, caution, and instruction signs as follows:
1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

N. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with ½-inch-high lettering on 1½-inch-high label; where two lines of text are required, use labels 2 inches high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:
1. Panelboards, electrical cabinets, and enclosures.
2. Access doors and panels for concealed electrical items.
3. Electrical switchgear and switchboards.
4. Electrical substations.
5. Emergency system boxes and enclosures.
7. Disconnect switches.
8. Enclosed circuit breakers.
11. Power transfer equipment.
12. Contactors.
15. Control devices.
16. Transformers.
17. Inverters.
18. Rectifiers.
19. Frequency converters.
20. Battery racks.
22. Telephone switching equipment.
23. Clock/program master equipment.
24. Call system master station.
25. TV/audio-monitoring master station.
26. Fire alarm master station or control panel.
27. Security-monitoring master station or control panel.

END OF SECTION
SECTION 26 0923
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.
   4. Indoor occupancy sensors.
   5. Outdoor motion sensors.
   7. Emergency shunt relays.

B. Related Requirements:

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Specification Compliance Review:
   1. Manufacturers and bidders must provide the consulting engineer with a Compliance Review of the Specifications and Addenda’s. The Compliance Review shall be a paragraph-by-paragraph review of the Specifications and schedule with the following information “C”, “D”, or “E” marked in the margin of the original Specifications and any subsequent Addenda’s. If the manufacturer or bidder does not provide the Compliance Review to the engineer for review, with the submittal, the submittal will be subject to rejection as non-compliant.
      a. “C” Comply with no exceptions.
      b. “D” Comply with deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.
      c. “E” Exception do not comply. For each and every exception, provide a numbered footnote with reasons and possible alternatives. Non-compliance with the specifications is grounds for rejection as unacceptable. A bid from any alternative or listed equipment manufacturer with any number of exceptions will be reason for rejection for non-compliance without further review.
      d. Unless a deviation or exception is specifically noted in the Compliance Review, the manufacturer shall provide full compliance with entire specification. Deviations or exceptions taken in letters or cover letters in a bid document, subsidiary documents, by omission or by contradiction do not release the manufacturer or bidder from being in complete compliance, unless the exception or deviation has...
been specifically noted in the Compliance Review and approved by the consulting engineer.
e. Equipment manufacturers or bidders that do not meet the specifications thru the above process will be subject to rejection without further review.

C. Shop Drawings: Contractor to submit entire lighting control system shop drawings showing locations of devices, coverage areas delineated with contour style lines, power pack or controller locations, connections, photocells and locations, and control wiring required.
   1. Show installation details for occupancy and light-level sensors.
   2. Interconnection diagrams showing field-installed wiring.
   3. Include diagrams for power, signal, and control wiring.
   4. Sensors shall overlap in coverage areas requiring multiple sensors.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Manufacturers: subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Cooper Industries, Inc.
   2. Intermatic, Inc.
   3. Invensys Controls.
   4. Leviton Manufacturing Co., Inc.
   5. NSi Industries, LLC: TORK Products
   6. Lithonia

B. Electronic Time Switches: Solid state, 7-day programmable, with alphanumeric display; complying with UL 917.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Contact Configuration: SPST.
   3. Contact Rating: 30-A inductive or resistive.
   4. Programs: See drawings for number of channels, minimum one channel per circuit plus one spare; each channel is individually programmable with 40 on-off operations per week and an annual holiday schedule that overrides the weekly operation on holidays.
   5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
   6. Astronomic Time: All channels.
   7. Automatic daylight savings time changeover.
   8. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.
2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work includes, but are not limited to, the following:
   1. Cooper Industries, Inc.
   2. Intermatic, Inc.
   3. NSi Industries, LLC; TORK Products.

B. Description: Solid state, with SPST dry contacts rated for 1800 VA to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Light-Level Monitoring Range: 1.5 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.
   3. Time Delay: Fifteen second minimum, to prevent false operation.
   5. 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. Manufacturers: Subject to compliance with requirements. Products that may be incorporated into the Work include, but are not limited to, the following:
   1. Cooper Industries, Inc.
   2. Eaton Corporation.
   3. Hubbell Building Automation, Inc.
   4. Leviton Manufacturing Co., Inc.
   5. Lithonia Lighting; Acuity Brands Lighting, Inc.
   6. NSi Industries, LLC; TORK Products.
   7. Sensor Switch, Inc.
   8. Tyco Electronics; ALR Brand.

B. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack, to detect changes in indoor lighting levels that are perceived by the eye.

C. Electrical Components, Devices, and Accessories:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
   3. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor is powered by the power pack.
   4. Power Pack: Dry contacts rated for 20-A load at 120- and 277-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
   5. 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.
   6. Atrium Space Sensors Light-Level Monitoring Range: 50 to 500 fc (1080 to 10 800 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.
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. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work includes, but are not limited to, the following:
   1. Cooper Industries, Inc.
   2. Hubbell Building Automation, Inc.
   4. Lithonia Lighting; Acuity Lighting Group, Inc.
   5. Watt Stopper.

B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
   1. Lighting control set point is based on two lighting conditions:
      a. When no daylight is present (target level).
      b. When significant daylight is present.
   2. System programming is done with two hand-held, remote-control tools.
      a. Initial setup tool.
      b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with 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 ROOM CONTROLLER: Manufacturers standard complete assembly in one enclosure rated for location. Unit shall contain controls, connections, relays, and wiring.

A. The following features:
   1. Individual control of each switch leg (zone). See floor plan for number of zones. Provide minimum 1 zones with one spare.
   2. Zone control relay fails closed.
   3. Occupancy sensor input.
   5. Capable of network (Owner) controllable.
   6. Zones capable of either vacancy occupancy operation.

B. Provide factory matched to room controller switching of each zone with either pushbutton backlit touch screen or digital wall switching of each zone. See floor plan for type.

2.6 CEILING MOUNTED OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Cooper Industries, Inc.
   2. Hubbell Building Automation, Inc.
3. Leviton Manufacturing Co., Inc.
4. Lithonia Lighting; Acuity Brands Lighting, Inc.
5. Lutron Electronics Co., Inc.
6. NSi Industries LLC; TORK Products.
7. Sensor Switch, Inc.
8. Square D.

B. General Requirements for Sensors: Ceiling-mounted, 360 degree, solid-state indoor occupancy sensors with a separate power pack.
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 or enable wall manual switch 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 20 minutes.
3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
4. Power Pack: Dry contacts rated for 20-A load at 120- and 277-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.
5. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Internal dry contact closure for SPDT.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
7. Bypass Switch: Override the "on" function in case of sensor failure.
8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.
9. Dimming output to control 0-10 VDC.
10. Provides second occupancy time out period enabling lighting to go dim prior to off.
11. Adjustable maximum minimum.
12. Can be series or parallel connected.
13. Photo Cell:
   a. Auto set point
   b. On/Off mode during occupancy
   c. Dimming control

C. Standard 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 15 ft. radius when mounted on a 108-inch high ceiling.

D. Extended Range Dual-Technology Type: Ceiling Mounted
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 28 ft. radius when mounted on a 108-inch high ceiling.

2.7 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

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:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Bryant Electric.
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
4. Leviton Manufacturing Co., Inc.
5. Lightolier Controls.
6. Lithonia Lighting; Acuity Brands Lighting, Inc.
7. Lutron Electronics Co., Inc.
8. NSI Industries LLC; TORK Products.
9. RAB Lighting.
10. Sensor Switch, Inc.
11. Square D.
12. Watt Stopper.

C. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

D. Wall-Switch Sensor:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 2100 sq. ft (196 sq. m).
2. Sensing Technology: Dual technology - PIR and ultrasonic.
3. Switch Type: SP. SP, field selectable automatic "on," or manual "on" automatic "off."
4. Voltage: Dual voltage, 120 and 277 V.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
9. Programmable for occupancy or vacancy mode.

2.8 HIGH-BAY OCCUPANCY SENSORS

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:
B. 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.

C. 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.

D. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet (3.7 to 15.2 m).

E. Accessories: Obtain manufacturer’s installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.9 EXTREME-TEMPERATURE OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements. Products that may be incorporated into the Work include, but are not limited to, the following:
   1. Cooper Industries, Inc.
   2. Sensor Switch, Inc.

B. Description: Ceiling-mounted, solid-state, extreme-temperature occupancy sensors with a separate power pack.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended application in damp locations.
   2. Operation: 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 30 minutes.
   3. Operating Ambient Conditions: From minus 40 to plus 125 deg F (minus 40 to plus 52 deg C).
   4. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
   5. 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.
   6. 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 cover.
   7. Bypass Switch: Override the "on" function in case of sensor failure.
8. Automatic Light-Level Sensor: Adjustable from 2 to 10 fc (21.5 to 108 lux); keep lighting off when selected lighting level is present.

C. Detector Technology: PIR. 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 1500 sq. ft. (139 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
   3. Detection Coverage (High Bay): Detect occupancy within 25 feet (7.6 m) when mounted on a 25-foot- (7.6-m-) high ceiling.

2.10 OUTDOOR MOTION SENSORS

A. Manufacturers: Subject to compliance with requirements. Products that may be incorporated into the Work include, but are not limited to, the following:
   1. Bryant Electric.
   2. Cooper Industries, Inc.
   3. Hubbell Building Automation, Inc.
   4. Leviton Manufacturing Co., Inc.
   5. Lithonia Lighting; Acuity Brands Lighting, Inc.
   6. NSi Industries, LLC: TORK Products.
   7. RAB Lighting.
   8. Sensor Switch, Inc.

   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Dual-technology (PIR and infrared) type, weatherproof. Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm). Comply with UL 773A.
   3. Switch Rating:
      a. Separately Mounted Sensor: Dry contacts rated for 20-A load at 120- and 277-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
   4. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off." With bypass switch to override the "on" function in case of sensor failure.
   5. Voltage: Match the circuit voltage.
   6. Detector Coverage:
      a. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
      b. Long Range: 180-degree field of view and 110-foot (34-m) detection range.
   7. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
   8. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
   10. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F (minus 40 to plus 54 deg C), rated as "raintight" according to UL 773A.
2.11 LIGHTING CONTACTORS

A. Manufacturers: Subject to compliance with requirements. Products that may be incorporated into the Work include, but are not limited to, the following:
   2. ASCO Power Technologies, LP.
   5. Square D.

B. Description: Electrically operated and electrically 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.
   4. Provide with integral H-O-A switch unless one switch operates multiple contactor cabinets.

C. Interface with DDC System for HVAC: Provide hardware interface to enable the DDC system for HVAC to monitor and control lighting contactors.
   2. Control: On-off operation, relay.
   3. See drawings for operation.

2.12 EMERGENCY SHUNT RELAY

A. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

2.13 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 "Conductors and Cables."

B. Classes 2 and 3 Control Cable: Plenum rated, multiconductor cable with stranded-copper conductors.

C. Class 1 Control Cable: Plenum rated, multiconductor cable with stranded-copper conductors.

D. All exterior or underground cabling shall be rated for location.
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. Coordinate location of wall mounted devices with millwork and other wall mounted devices to optimize sensor field of view. Do NOT mount sensors directly behind doors.

C. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

D. Provide factory representative to locate and calibrate daylight sensors (both stand-alone and integral to fixture) for daylight harvesting (dimming). Verify operation and document settings.

E. Contractor to verify all sensors intended operation and calibrate sensor field of view and sensitivity. Adjust to capture major movement through space openings.

F. Coordinate with owner for occupancy/vacancy sensor delay times.

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.

B. Mount cabinet to wall or unistrut frame.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Section “Control/Signal Transmission Media.” 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.

E. Support ceiling mounted backboxes from structural elements or supports that are directly attached to structure. Do not support directly from ceiling grid.

3.4 ROOM CONTROLLER INSTALLATION

A. Room Controller:
   1. Coordinate switch/touch pad location in room.
   2. Locate room controller above ceiling in accessible location.
3. Provide plenum rated control cable to each device(s).
4. Provide above ceiling switch.

3.5 IDENTIFICATION

A. Identify components and power and control wiring according to "Electrical Identification."
   1. Identify controlled circuits in lighting contactors.
   2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections on ALL the sensors 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.
   3. Verify emergency lighting automatic switchover to generator power at all UL 924 rated light fixture locations.
   4. Verification of sensor operation
      a. Sensor turns lighting on/off at programmed times
      b. Sensor automatically dims lighting
      c. Sensor enables additional switching
      d. Sensor works during emergency lighting generator operation with automatic changeover
      e. Sensors coverage meets operational intent. Rotate ceiling sensors or adjust wall mounted sensor windows to maximize coverage.

C. Lighting control devices will be considered defective and replaced with new if they do not pass tests and inspections.

D. Prepare a written report to be sent to the engineer for review indicating the following:
   1. Room Number
   2. Sensor Type (wall, ceiling, occupancy vacancy, daylighting)
   3. Delay time
   4. Operation Verification (Yes/No)

3.7 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. Rotate sensors to capture occupant entrance into spaces.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors.

3.8 DEMONSTRATION

A. Coordinate demonstration of products with Owner prior to substantial completion.

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION
SECTION 26 1210
CONTROL/SIGNAL TRANSMISSION MEDIA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of control and signal transmission media: Twisted-pair cable used for security, access control, building management systems, sound, intercom, or any Non-IT/Voice/Data Control.

B. Related Sections include the following:
   1. Section "Basic Electrical Materials and Methods" for building wire used for control or signal circuits.
   2. Section "Conductors and Cables" for building wire.
   3. Section "Raceways and Boxes."

1.3 DEFINITIONS

A. PTFE: Polytetrafluoroethylene.

1.4 SUBMITTALS

A. Product Data: For control/signal transmission media.

B. Product Certificates: Signed by manufacturers of transmission media certifying that the products furnished comply with requirements and that they have been coordinated with and accepted by manufacturer of connected equipment.

C. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Maintenance Data: For transmission media to include in the maintenance manuals specified in Division 1.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain all cable of each type through one source from a single manufacturer.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
   1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
C. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
1. Notify Architect at least two (2) days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

1.7 COORDINATION

A. Coordinate with and obtain review of cable characteristics and certification for use with the connected system equipment by the connected equipment manufacturers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Electronic Cables:
   a. American Insulated Wire Corp.
   b. AT&T Technology, Inc.; Cable and Wire Division.
   c. Berk-Tek, Inc.
   d. BICC Brand-Rex Company.
   e. Cooper Industries; Belden Division.
   f. Guardian Products; General Cable.
   g. Mohawk Wire and Cable Corp.
   h. Pirelli Cable Corp.; Power Cable Division.
2. Optical Fiber Cables:
   a. AT&T Technology, Inc.; Cable and Wire Division.
   b. BICC Brand-Rex Company.
   c. Cooper Industries; Belden Division.
   d. Mohawk Wire and Cable Corp.
   e. Optical Cable Corp.
   f. Pirelli Cable Corp.; Power Cable Division.
   g. Siecor Corp.

2.2 ELECTRONIC CABLE

A. Provide cabling as indicated per manufacturer's installation instructions and as indicated below.

B. Twisted-Pair Plenum:
   1. Quantity of twisted pairs indicated;
   2. No. 24 AWG, 7-strand, tinned-copper conductors; PTFE insulation; overall aluminum/polyester shield; No. 22 AWG tinned-copper drain wire; PTFE jacket; suitable for use in air-handling spaces.

C. Control cabling. Provide cabling as indicated by manufacturer. Minimum Cat 5e. Cabling shall be:
1. Plenum rated.
2. Color coded per drawings or specifications. Cabling shall not be the same color as data or telephone cabling.
3. Copper Cable:
   a. Conductors are twisted in pairs with four pairs contained in a flame retardant PVC jacket separated by a spline.
   b. Superior performance exceeds all TIA/EIA-568-B Category 5 and ISO 11801 Edition 2.0 for Class E cable requirements. ETL tested and verified for Category 5E component performance.
   c. Performance tested to 500 MHz.
   d. Plenum (CMP) flame rated.
4. Fiber Optics:
   a. Optical Fiber Cable: Indoor Outdoor All Dielectric Cable or warranty approved Equal:
      1) All dielectric construction with no metallic elements.
      2) UV resistant cable sheathing.
      3) Indoor/Outdoor air handling space plenum rated.
      4) Sheath markings for positive identification and length verification.
      5) Flexible Buffer tube. Does not require innerduct.
      6) Multi-mode 62.5 micron. 10 Gb/s rated. Provide number of strands per application. Minimum 2.
   b. Building Connector Optical Fiber Cable: Indoor/Outdoor Interlocking Armor Clad Cable or warranty approved Equal.
      1) Aluminum Interlocking Armor.
      2) Indoor/Outdoor air handling space plenum rated.
      3) UV resistant cable sheath.
      4) Dry Water block. No gel.
      5) Multi-mode 62.5 micron. 10 Gb/s rated. Provide number of strands per application, minimum 6.
      6) Sheath markings for positive identification and length verification.

D. Cable shall be rated for indoor and outdoor use if located outside the building conditioned space. (Underfloor or buried is outside conditioned space)

E. Control cabinet data cabling. Provide cabling as indicated by manufacturer or minimum cat 5e between control cabinets and devices within cabinet.
   1. Plenum rated.
   2. Color-coded per drawings or specifications.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine raceways and other elements to receive cables for compliance with requirements for installation tolerances and other conditions affecting performance of transmission media. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install cable as indicated, according to manufacturer’s written instructions.

B. Install transmission media without damaging conductors, shield, or jacket.
1. Do not bend cable, in handling or installation, to smaller radii than minimum recommended by manufacturer.
2. All new installation cabling shall be one piece without breaks or splices except at device connections.
3. Existing cabling extended or relocated from an existing point shall be spliced per manufacturer installation instructions. If there are no manufacturer's splicing instructions, provide compression butt splices and plenum rated sleeves suitable for use with the cabling jacket.
   a. Use splice and tap connectors compatible with cable material.
   b. Make no splices except at indicated splice points.

C. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
   1. Pull cables simultaneously if more than one is being installed in same raceway.
   2. Use pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation.
   3. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage media or raceway.
   4. Provide pull boxes as per NEC.
   5. Provide junction or pull boxes at all splice points.

D. Install exposed cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.

E. Support cables according to Section "Basic Electrical Materials and Methods."

F. Seal around cables penetrating fire-rated elements according to Section "Firestopping."

G. Bond shields and drain conductors to ground at only one point in each circuit.

H. Connect components to wiring system and to ground as indicated and instructed by manufacturer.

I. 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.

J. Identify cables according to Section "Electrical Identification."

K. Provide 24" service loops coiled every 100'. Velcro strap cabling together. Do not damage cabling by overtightening ties. If the cabling is deformed, replace the cable.

L. Mount on J-hooks when not in conduit independent of other systems. Secure to J-hooks with zip ties. Provide conduit or J-hooks separate from tele/data or security cabling. Do not tie to ceiling supports or any other non-structural support above ceiling.

M. Install in conduit in all exposed or non-continuous ceilings or any finished space where cabling is visible and all unfinished areas below 10' AFF. See Raceways and Boxes application schedule for conduit types.

N. Coordinate with owner for connector equipment type.

3.3 FIELD QUALITY CONTROL
A. Copper Cable Testing Procedures: Inspect for physical damage and test cable for continuity and shorts. Use time-domain reflectometer with strip-chart recording capability and anomaly resolution to within 12 inches in runs up to 1000 feet in length. Test cable segments for faulty connectors, splices, terminations, and the integrity of the cable and its component parts.

B. Replace malfunctioning cables at Project site, where possible, and retest to demonstrate compliance.

C. Provide written documentation to the owner’s representative of cabling performance.

END OF SECTION
SECTION 26 1310
PULL AND JUNCTION BOXES

PART 1 - GENERAL

1.1 DESCRIPTION
A. Work covered by this Section includes furnishing of and paying for all materials, labor, services, equipment, licenses, taxes, other items, and appliances necessary for the execution, installation and completion of all work specified herein and/or shown on the drawings.
B. Pull and junction boxes of appropriate size and depth as indicated on the drawings and as specified hereinafter.

1.2 SUBMITTALS
A. Submittals for products furnished under this section are not required.

PART 2 - PRODUCTS

2.1 MATERIALS
A. For interior work, provide galvanized sheet metal boxes of code thickness with lapped and welded joints, ¾-inch flanges, screw covers, etc.
B. For exterior work, provide galvanized sheet metal boxes of code thickness with lapped and welded joints, ¾-inch flanges, bolted covers with full gaskets forming a completely rain tight assembly for above ground installations. Provide concrete boxes with screw fittings and drains for in ground pull boxes. Boxes shall be sized as per NEC or as indicated on the drawings.
C. See drawings for pull boxes requiring racks.
D. Boxes with concentric knockouts are not acceptable.
E. Provide ground terminal strip and ground pull box and circuits.
F. As shown on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Provide junction boxes as shown on drawings and otherwise where required, sized according to number of conductors in box or type of service to be provided. Minimum junction box size 4 inches square and 2½ inches deep. Provide screw covers for junction boxes.
B. Use minimum 16-gauge steel for pull boxes and provide with screw cover.

C. Install boxes in conduit runs wherever necessary to avoid too long runs or too many bends. Do not exceed 100-foot runs without pull boxes.

D. Rigidly secure boxes to walls or ceilings. Conduit runs will not be considered adequate support.

E. Install boxes with covers in accessible locations.

F. Observe maximum conductor fill as required by the National Electrical Code.

END OF SECTION
SECTION 26 2200
DRY-TYPE TRANSFORMERS

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 dry-type distribution and specialty transformers rated 1000 V and less.

1.3 SUBMITTALS
A. Product Data: Include data on features, components, ratings, and performance for each type of transformer specified. Include dimensioned plans, sections, and elevation views. Show minimum clearances and installed devices and features.

B. Wiring Diagrams: Detail wiring and identify terminals for tap changing and connecting field-installed wiring.

C. Specification Compliance Review:
   1. Manufacturers and bidders must provide the consulting engineer with a Compliance Review of the Specifications and Addenda’s. The Compliance Review shall be a paragraph-by-paragraph review of the Specifications and schedule with the following information “C”, “D”, or “E” marked in the margin of the original Specifications and any subsequent Addenda’s. If the manufacturer or bidder does not provide the Compliance Review to the engineer for review, with the submittal, the submittal will be subject to rejection as non-compliant.
      a. “C” Comply with no exceptions.
      b. “D” Comply with deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.
      c. “E” Exception do not comply. For each and every exception, provide a numbered footnote with reasons and possible alternatives. Non-compliance with the specifications is grounds for rejection as unacceptable. A bid from any alternative or listed equipment manufacturer with any number of exceptions will be reason for rejection for non-compliance without further review.
      d. Unless a deviation or exception is specifically noted in the Compliance Review, the manufacturer shall provide full compliance with entire specification. Deviations or exceptions taken in letters or cover letters in a bid document, subsidiary documents, by omission or by contradiction do not release the manufacturer or bidder from being in complete compliance, unless the exception or deviation has been specifically noted in the Compliance Review and approved by the consulting engineer.
      e. Equipment manufacturers or bidders that do not meet the specifications thru the above process will be subject to rejection without further review.
D. Product Certificates: Signed by manufacturers of transformers certifying that the products furnished comply with requirements.

E. Qualification Data: For firms and persons specified in “Quality Assurance” Article.

F. Factory Test Reports: Certified copies of manufacturer's design and routine factory tests required by referenced standards.

G. Sound-Level Test Reports: Certified copies of manufacturer's sound-level tests applicable to equipment for this Project.

H. Field Test Reports: Indicate and interpret test results for tests specified in Part 3.

I. Maintenance Data: For transformers to include in the maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide transformers specified in this Section that are listed and labeled.
   1. The Terms “Listed” and “Labeled”: As defined in NFPA 70, Article 100.

B. Comply with IEEE C2.

C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering transformers that may be incorporated into the Work include, the following:
   1. Siemens.
   2. Powersmith.
   3. Square D.
   4. Eaton

2.2 TRANSFORMERS, GENERAL

A. Description: Factory-assembled and -tested, air-cooled units of types specified, designed for 60-Hz service.

B. Cores: Grain-oriented, nonaging silicon steel.
C. Coils: Copper. Continuous windings without splices, except for taps.

D. Internal Coil Connections: Brazed or pressure type.

E. Enclosure: Class complies with NEMA 250 for the environment in which installed.

F. Sound-Level: Unless indicated otherwise, dry-type transformers shall have a minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.3 GENERAL-PURPOSE DISTRIBUTION AND POWER TRANSFORMERS

A. Comply with NEMA ST 20 and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Windings: One coil per phase in primary and secondary. Copper windings.

D. Enclosure: Indoor, ventilated.

E. Insulation Class: 185 or 220 deg C class for transformers 15 kVA or smaller; 220 deg C class for transformers larger than 15 kVA.
   1. Rated Temperature Rise: 115 deg C maximum rise above 40 deg C.

F. Taps: For transformers 3 kVA and larger, full-capacity taps in high-voltage windings are as follows:
   1. Taps, 3 through 10 kVA: Two 5-percent taps below rated high voltage.
   2. Taps, 15 through 500 kVA: Six 2.5-percent taps, 2 above and 4 below rated high voltage.
   3. Taps, 750 kVA and Above: Four 2.5-percent taps, 2 above and 2 below rated high voltage.

G. K-Factor Rating: Transformers indicated to be K-factor rated are listed to comply with UL 1561 requirements for nonsinusoidal load current handling capability to the degree defined by the designated K-factor.
   1. Transformer design prevents overheating when carrying full load with harmonic content corresponding to the designated K-factor.
   2. Nameplate states the designated K-factor of the transformer.

H. Electrostatic Shielding: Each winding is independently single shielded with a full-width copper electrostatic shield arranged to minimize interwinding capacitance.
   1. Coil leads and terminal strips are arranged to minimize capacitive coupling between input and output connections.
   2. Shield Terminal: Separate; marked “Shield” for grounding connection.
   3. Capacitance: Shield limits capacitance between primary and secondary to a maximum of 33 picofarads over a frequency range of 20 Hz to 1 MHz.
   4. Common-Mode Noise Attenuation: Minus 120 dB minimum, 0.5 to 1.5 kHz; minus 65 dB minimum, 1.5 to 100 kHz.
   5. Normal-Mode Noise Attenuation: Minus 52 dB minimum, 1.5 to 10 kHz.

I. Wall-Mounting Brackets: Manufacturer’s standard brackets for transformers up to 75 kVA.

J. Fungus Proofing: Permanent fungicidal treatment for coil and core.
2.4 CONTROL AND SIGNAL TRANSFORMERS

A. Units comply with NEMA ST 1 and are listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If rating is not indicated, provide capacity exceeding peak load by 50 percent minimum.

C. Description: Self-cooled, two (2) windings.

2.5 FINISHES

A. Indoor Units: Manufacturer's standard paint over corrosion-resistant pretreatment and primer.

B. Outdoor Units: Comply with ANSI C57.12.28.

2.6 SOURCE QUALITY CONTROL

A. Factory Tests: Design and routine tests comply with referenced standards.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project if specified sound levels are below standard ratings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with safety requirements of IEEE C2.

B. Mount transformers on 4 inch chamfered concrete housekeeping pad with Korfund isolation pads underneath mounting feet. Arrange equipment to provide adequate spacing for access and for circulation of cooling air. Provide minimum 4 inches between rear of transformer and back wall. Coordinate location of transformers with all other gear prior to rough-in.

C. Identify transformers and install warning signs according to Section “Electrical Identification.”

D. Tighten electrical connectors and terminals according to manufacturers published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. Labeling: provide permanent engraved label with transformer; name, voltage and kVA rating.

3.2 GROUNDING

A. Separately Derived Systems: Comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near the transformer.

B. Comply with Section “Grounding” for materials and installation requirements.

C. Provide case mounted lug and connect to circuit ground and electrode ground.

D. Provide 1/0 stranded ground to ground rod or building ground bars tied into service.
3.3 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to supervise the field assembly and connection of components, and the testing and adjusting of transformer components and accessories.

B. Test Objectives: To ensure transformer is operational within industry and manufacturer's tolerances, is installed according to the Contract Documents, and is suitable for energizing.

C. Test Labeling: On satisfactory completion of tests for each transformer, attach a dated and signed “Satisfactory Test” label to tested component.

D. Schedule tests and provide notification at least seven (7) days in advance of test commencement.


F. Tests: Include the following minimum inspections and tests according to manufacturer's written instructions. Comply with IEEE C57.12.91 for test methods and data correction factors.
   1. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.
   2. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those specified in UL 486A and UL 486B.
   3. Insulation Resistance: Perform megohmmeter tests of primary and secondary winding to winding and winding to ground.
      b. Minimum Insulation Resistance: 500 megohms.
      c. Duration of Each Test: 10 minutes.
      d. Temperature Correction: Correct results for test temperature deviation from 20 deg C standard.

G. Test Failures: Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

3.4 CLEANING

A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.5 ADJUSTING

A. After installing and cleaning, touch up scratches and mars on finish to match original finish.

B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings and submit with test results. Adjust taps to be as close to 480V, 208V, or 240V (per transformer) as possible with actual building loads running. Simulate as much building load as possible during transformer voltage testing (turn on and run all AC units, water
heaters, elevator, lighting, and any other permanent equipment possible) to adjust the transformer output voltage.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site readjustment of transformer tap settings to suit actual occupied conditions. Provide up to two (2) visits to Project site for this purpose without additional cost.

1. Voltage Recordings: Contractor performed. Provide up to 48 hours of recording on the low-voltage system of each medium-voltage transformer.

2. Point of Measurement: Make voltage recordings at load outlets selected by Owner.
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 load centers and panel boards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:
      1. Lighting and appliance branch-circuit panel boards.
      2. Distribution panel boards.
      3. Transient voltage surge suppressor panel boards.

1.3 DEFINITIONS
   A. EMI: Electromagnetic interference.
   B. GFCI: Ground-fault circuit interrupter (GFI).
   C. RFI: Radio-frequency interference.
   D. RMS: Root mean square.
   E. SPDT: Single pole, double throw.
   F. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS
   A. Product Data: For each type of panel board, overcurrent protective device, TVSS device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
   B. Specification Compliance Review:
      1. Manufacturers and bidders must provide the consulting engineer with a Compliance Review of the Specifications and Addenda’s. The Compliance Review shall be a paragraph-by-paragraph review of the Specifications and schedule with the following information “C,” “D,” or “E” marked in the margin of the original Specifications and any subsequent Addenda’s. If the manufacturer or bidder does not provide the Compliance Review to the engineer for review, with the submittal, the submittal will be subject to rejection as non-compliant.
         a. “C” Comply with no exceptions.
         b. “D” Comply with deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.
c. “E” Exception do not comply. For each and every exception, provide a numbered footnote with reasons and possible alternatives. Non-compliance with the specifications is grounds for rejection as unacceptable. A bid from any alternative or listed equipment manufacturer with any number of exceptions will be reason for rejection for non-compliance without further review.

d. Unless a deviation or exception is specifically noted in the Compliance Review, the manufacturer shall provide full compliance with entire specification. Deviations or exceptions taken in letters or cover letters in a bid document, subsidiary documents, by omission or by contradiction do not release the manufacturer or bidder from being in complete compliance, unless the exception or deviation has been specifically noted in the Compliance Review and approved by the consulting engineer.

e. Equipment manufacturers or bidders that do not meet the specifications thru the above process will be subject to rejection without further review.

C. Shop Drawings: For each panelboard and related equipment.
1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
   a. Enclosure types and details for types other than NEMA 250, Type 1.
   b. Bus configuration, current, and voltage ratings.
   c. Short-circuit current rating of panelboards and overcurrent protective devices.
   d. UL listing for series rating of installed devices.
   e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.

D. Field Tests Reports: Submit written test reports and include the following:
1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panel board Schedules: For installation in panel boards. Submit final versions after load balancing.

F. Maintenance Data: For panel boards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section “Closeout Procedures,” include the following:
1. Manufacturer’s written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency that is a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency’s Field Supervisor: Person currently certified by the International Electrical Testing Association or National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of panel boards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

1.7 EXTRA MATERIALS

A. Keys: Six (6) spares of each type of panel board cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the following:

1. Panel boards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
   a. Siemens
   b. Square D Co.
   c. Eaton

2. Electronic Grade Panel boards:
   a. Liebert Corporation.
   b. Square D Co.
   c. Eaton
   d. Siemens

2.2 FABRICATION AND FEATURES

A. Enclosures: Flush- and surface-mounted cabinets as indicated on drawings. NEMA PB 1, Type 1, to meet environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

B. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

C. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

D. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
E. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.

F. Bus: Hard-drawn copper, 98 percent conductivity. Aluminum is **NOT** acceptable.

G. Main and Neutral Lugs:
   1. Compression type suitable for use with conductor material on MLO panels.
   2. Mechanical type suitable for use with conductor material on MCB panels.

H. Equipment Ground Bus: Copper, Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

I. Service Equipment Label: UL labeled for use as service equipment for panel boards with main service disconnect switches.

J. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

K. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box, where indicated on drawings.

L. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads, where indicated on drawings.

M. Split Bus: Vertical buses divided into individual vertical sections.

N. Skirt for Surface-Mounted Panel boards: Same gage and finish as panel board front with flanges for attachment to panel board, wall, and ceiling or floor.

O. Gutter Barrier: Arrange to isolate individual panel sections.

P. Feed-through Lugs: Compression type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

Q. Provide power meters (peak KW, phase amperage, and kWh) with digital displays in the panels where indicated on the drawings. Provide single enclosure large enough for all panel components. Remote mounted meters are not acceptable. Mount meters in the upper portion of the enclosure. Provide correct trim kit for panel and meter. Meter shall have:
   1. Phase Amperage
   2. Peak Phase Amperage or KW
   3. KWh
   4. Phase Voltage
   5. Data Output connection to building management system for monitoring
   6. Digital Display

### 2.3 PANEL BOARD SHORT-CIRCUIT RATING

A. UL label indicating series-connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.

B. Fully rated to interrupt symmetrical short-circuit current available at terminals.

C. See panel schedules for minimum rating.
2.4 LOAD CENTERS


B. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANEL BOARDS

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

B. Doors: Front mounted with concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.6 DISTRIBUTION PANEL BOARDS

A. Doors: Front mounted, except omit in fused-switch panelboards; secured with vault-type latch with tumbler lock; keyed alike. Square D I-Line or approved equal.

B. Main Overcurrent Protective Devices: Thermal magnetic circuit breaker.

C. Branch Overcurrent protective devices shall be one of the following:
   1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
   2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.7 ELECTRONIC GRADE PANEL BOARDS

A. Doors: Front mounted; secured with vault-type latch with tumbler lock; keyed alike. Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

B. Main Overcurrent Devices: Thermal-magnetic circuit breaker.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers.

D. Bus: Copper phase and neutral buses; 200 percent capacity neutral bus.

   1. Minimum single-impulse current rating shall be as follows:
      a. Line to Neutral: 100,000 A.
      b. Line to Ground: 100,000 A.
      c. Neutral to Ground: 50,000 A.
   2. Protection modes shall be as follows:
      a. Line to neutral.
      b. Line to ground.
      c. Neutral to ground.
   3. EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55 dB at 100 kHz.
   4. Category C combination wave clamping voltage shall not exceed 600 V, line to neutral and line to ground on 120/208 V systems or 1000 V, line to neutral and line to ground on 277/480 V systems.
5. UL 1449 clamping levels shall not exceed 400 V, line to neutral and line to ground on 120/208 V systems or 800 V, line to neutral and line to ground on 277/480 V systems.
6. Withstand Capabilities: 3000 Category C surges with less than 5 percent change in clamping voltage.
7. Accessories shall include the following:
   a. Form-C contacts, one normally open and one normally closed, for remote monitoring of system operation. Contacts to reverse position on failure of any surge diversion module.
   b. Audible contacts, one normally open and one normally closed, for remote monitoring of system operation. Contacts to reverse position on failure of any surge diversion module.
   c. Six-digit transient-counter set to total transient surges that deviate from the sine-wave envelope by more than 125 V.

2.8 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents. Breakers shall be fully rated for panel AIC rating.
   2. GFCI Circuit Breakers: Single- and two-pole configurations with 30-mA trip sensitivity.

B. Molded-Case Circuit-Breaker Features and Accessories. Standard frame sizes, trip ratings, and number of poles.
   1. Lugs: Compression style, suitable for number, size, trip ratings, and material of conductors.
   2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
   4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system.
   5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
   6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
   7. Auxiliary Switch: Two SPDT switches with “a” and “b” contacts; “a” contacts mimic circuit-breaker contacts, “b” contacts operate in reverse of circuit-breaker contacts.
   8. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

2.9 CONTROLLERS

A. Motor Controllers: NEMA ICS 2, Class A combination controller equipped for panelboard mounting and including the following accessories:
   1. Individual control-power transformers.
   2. Fuses for control-power transformers.
5. Indicating lights.
6. Seal-in contact.
7. Two convertible auxiliary contacts.

B. Contactors: NEMA ICS 2, Class A combination controller equipped for panelboard mounting and including the following accessories:
   1. Individual control-power transformers.
   2. Fuses for control-power transformers.
   3. Indicating lights.
   4. Seal-in contact.
   5. Two convertible auxiliary contacts.
   7. Selector switches.

C. Controller Disconnect Switches: Fused switch mounted adjacent to and interlocked with controller.
   1. Auxiliary Contacts: Integral with disconnect switches to de-energize external control-power source.

D. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held general-purpose controller.
   1. Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

2.10 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: To test functions of solid-state trip devices without removal from panel board.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panel boards and accessories according to NEMA PB 1.1 and the NEC.

B. Provide minimum 3-foot clearance in front of panel board.

C. Space panels 4 inches apart and provide spacing for future panels.

D. Locate Surge suppression above and adjacent to panelboard serving. Provide additional spacing between panelboards. Surge suppression to be no greater than 7 feet above finished floor.

E. Locate contactors adjacent to panelboards and provide additional spacing. Small contactor enclosures can be above and to the right or left of the panelboard. Contactor mounting height to be no greater than 7 feet above finished floor.
F. Coordinate with other equipment in the room.

G. Coordinate location of panelboards with transformers and conduit feeders.

H. Mounting Heights: Top of trim 74 inches above finished floor, unless otherwise indicated. Mount with at least 6 inches of clearance below panel board.

I. Mounting: Plumb and rigid without distortion of box. Mount recessed panel boards with fronts uniformly flush with wall finish.

J. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panel board loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Use manufacturers supplied card and permanent slot location.

K. Install filler plates in unused spaces.

L. Provision for Future Circuits at Flush Panel boards: Stub four 1-inch empty conduits from panel board into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

M. Provision for Future Circuits at Recessed panel boards: Stub four ¾'' inch empty conduits from panel board into accessible ceiling space or space designated to be ceiling space in the future. Stub four ¾'' inch empty conduits into raised floor space or below slab not on grade.

N. Wiring in Panel board Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

O. Where panelboard meters are indicated, provide power to the meter from the panel being served. Provide CT’s in the panel enclosure. Connect CT’s to the meter and verify operation of demand and voltage.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section “Electrical Identification.”

B. Panel board Nameplates: Label all panel boards with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws. Provide red nameplates for emergency or stand-by power branch fed panels. Nameplate shall include:
   1. Normal Power
      a. Panel Name
      b. Voltage “277/480”, “120/208”, or “120/240”
      c. Panel fed from “panel name or transformer name”
   2. Generator Powered Panels
      a. Panel Name
      b. Voltage “277/480”, “120/208”, or “120/240”
      c. Panel fed from “panel name or transformer name”
      d. Non-Hospital
         1) Non-emergency, “Stand-By Branch”
         2) Life Safety Non-Hospital, “Life Safety Branch”
      e. Hospital Essential Branches:
1) “Life Safety”  
2) “Critical Branch”  
3) “Equipment Branch”

3.3 CONNECTIONS

A. Install equipment grounding connections for panel boards with ground continuity to main electrical ground bus.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each panel board bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Testing: After installing panel boards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
   1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Balance Loads: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes as follows:
   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 panel board, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 ADJUSTING

A. Provide factory technician to set field-adjustable switches and circuit-breaker trip ranges.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of panel boards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION
SECTION 26 2726
WIRING DEVICES

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes receptacles, connectors, switches, and finish plates.

1.3 DEFINITIONS
A. GFCI/GFI: Ground-fault circuit interrupter.
B. SPD: Surge protective device.

1.4 SUBMITTALS
A. Product Data: For each product specified.
B. Shop Drawings: Legends for receptacles and switch plates.
C. Samples: For devices and device plates for color selection and evaluation of technical features.
D. Maintenance Data: For materials and products to include in maintenance manuals specified in Division 1.

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.
B. Comply with NEMA WD 1.
C. Comply with NFPA 70.

1.6 COORDINATION
A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
   1. Cord and Plug Sets: Match equipment requirements.

1.7 EXTRA MATERIALS
A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
1. Telephone/Power Service Poles: One for each 10, but not less than one.
2. Floor Service-Outlet Assemblies: One for each 10, but not less than one.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Wiring Devices:
   a. Bryant Electric, Inc.
   b. Eaton.
   d. Killark Electric Manufacturing Co.
   e. Leviton Manufacturing Co., Inc.
   f. Pass & Seymour/Legrand; Wiring Devices Div.
2. Multi-outlet Assemblies:
   a. Airey-Thompson Co.
   b. Wiremold.
3. Floor Service Outlets and Telephone/Power Poles:
   c. Pass & Seymour/Legrand; Wiring Devices Div.
   d. Square D Co.
   e. Wiremold.

2.2 RECEPTACLES

A. Straight-Blade and Locking Receptacles: Commercial spec grade Configuration NEMA 5-20R. Color by Architect/Owner.

B. GFCI Receptacles: Feed-through type, with integral NEMA WD 6, Configuration 5-20R duplex receptacle arranged to protect connected downstream receptacles on same circuit. Design units for installation in a 2¾-inch-deep outlet box without an adapter. Provide with test light as per NEC.

C. Isolated-Ground Receptacles: Equipment grounding contacts connected only to the green grounding screw terminal of the device with inherent electrical isolation from mounting strap.  
   1. Devices: Orange in color and listed and labeled as isolated-ground receptacles.
   2. Isolation Method: Integral to receptacle construction and not dependent on removable parts.

D. TVSS Receptacles: Duplex type, NEMA WD 6, Configuration 5-20R, with integral TVSS in line to ground, line to neutral, and neutral to ground.

E. USB Receptacles:
   1. USB Charger Tamper-Resistant Receptacle, Two USB Type 2.0 ports 3.5 Amp, 5 Volt DC, 20 Amp, 125 Volt AC Decorator Duplex.
      a. Green LED indicator to show USB power available.
      b. Impact and chemical resistant.
c. Flush fit design.
d. Meets UL94 for 5V flammability rating.
e. Complies with battery charging specification USB BC1.2.
f. Compatible with USB 1.1/2.0/3.0 devices.
g. Listed to UL498 and UL1310.

F. Industrial Heavy-Duty Receptacle: Comply with IEC 309-1.

G. All receptacles on emergency/stand-by power shall be red hospital grade. Faceplate color by Architect. All emergency/stand-by power receptacles shall have circuit numbers on faceplate. Refer to panel schedules and one-line for emergency/stand-by power branches.

H. Fifteen amp (15A) receptacles are not acceptable and shall not be installed unless specifically directed by the engineer.

2.3 PENDANT CORD/CONNECTOR DEVICES

A. Description: Matching, locking type, plug and receptacle body connector, NEMA WD 6, Configurations L5-20P and L5-20R, Heavy-Duty grade.
   2. 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. (Kellum or equal)

2.4 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   1. Cord: Rubber-insulated, stranded-copper conductors, with type SOW-A jacket. Green-insulated grounding conductor, and equipment-rating ampacity plus a minimum of 30 percent.

2.5 SWITCHES

A. Snap Switches: Commercial spec grade.

B. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.
   2. Receptacle: NEMA WD 6, Configuration 5-20R.

C. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible and electromagnetic noise filters rated for amperage and voltage listed.
   1. Control: Continuously adjustable slide, and push-button on/off. Single-pole or three-way switch to suit connections.
   2. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable slide and toggle or rocker; single pole with soft tap or other quiet switch; electromagnetic filter to eliminate noise, RF, and TV interference; and 5-inch wire connecting leads.
2.6 WALL PLATES

A. Single and combination types match corresponding wiring devices.
   2. Material for Finished Spaces:
      a. Smooth, unbreakable nylon; color by Architect.
   3. Material for Kitchens, Unfinished spaces (Mechanical, Electrical), and surface mounted locations: stainless steel.

2.7 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
B. Compartmentation: Barrier separates power and signal compartments.
C. Housing Material: Die-cast aluminum, satin finished.
D. Power Receptacle: NEMA WD 6, Configuration 5-20R, gray finish, unless otherwise indicated.
E. Signal Outlet: Blank cover with bushed cable opening, unless otherwise indicated.

2.8 MULTI-OUTLET ASSEMBLIES

A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
B. Raceway Material: Metal, with manufacturer's standard finish.
C. Raceway Material: Nonmetal.
D. Wire: No. 12 AWG.

2.9 TELEPHONE/POWER SERVICE POLES

A. Description: Factory-assembled and -wired units to extend power, telephone, and data service from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
   1. Poles: Nominal 2.5-inch-square cross section with height adequate to extend from floor to at least 6 inches above ceiling, and separate channels for power and signal wiring.
   2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports, and pole foot with carpet pad attachment.
   3. Finishes: One of manufacturers standard finish and trim combinations, including painted and satin anodized-aluminum finishes and wood-grain-type trim.
   4. Wiring: Sized for six No. 12 AWG power and ground conductors; one 75-ohm coaxial telephone/data cable; and four four-pair, 75-ohm telephone/data cable.
   5. Power Receptacles: four single; 20-A; heavy-duty; NEMA WD 6, Configuration 5-20R units.

PART 3 - EXECUTION
3.1 INSTALLATION

A. Install devices and assemblies straight, plumb and secure.

B. Install devices as per ADA height requirements.

C. Review Architectural elevations to coordinate locations and mounting heights. If there are any discrepancies request information prior to install. If height is not listed on the drawings refer to the following:

1. General purpose receptacles @ 18" AFF.
2. General purpose receptacles at retirement facilities, nursing homes, hospice, nursing facilities @ 24" AFF.
3. TV receptacles at the TV mounting location (see architectural elevations) or at 96" AFF.
4. Above counter receptacles @ 6" above backsplash.
5. Toilet room receptacles @ 48" AFF.
6. Equipment receptacles at the piece of equipment. Coordinate with architectural elevations and equipment submittals.
7. Receptacles shall not be installed flat on any counter surface.

D. Install wall plates when painting is complete. Remove all paint from any wall plates.

E. Provide GFI receptacles within 6 feet of all sinks, exterior receptacles, undercounter equipment, at exterior HVAC equipment, vending machines, and in kitchens.

F. Install wall dimmers to achieve indicated rating after de-rating for ganging as instructed by manufacturer.

G. Do not share neutral conductor on load side of dimmers.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

I. Protect devices and assemblies during painting.

J. Adjust locations at which floor service outlets and telephone/power service poles are installed to suit arrangement of partitions and furnishings.

K. GFCI or GFI receptacles shall be wired to “trip” individually not the entire circuit. Receptacles shall not be daisy chained together from a GFI and create a GFI “protected” receptacle.

3.2 IDENTIFICATION

A. Comply with Section “Electrical Identification.”

1. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.
2. Receptacles: Identify panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on face of plate and durable wire markers or tags within outlet boxes.

3.3 CONNECTIONS

A. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.
B. Isolated-Ground Receptacles: Connect to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system.

C. Tighten electrical connectors and terminals according to manufacturers published torque-tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Test wiring devices for proper polarity and ground continuity. Operate each device at least six times.

B. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

C. Replace damaged or defective components.

3.5 CLEANING

A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION
SECTION 26 2816
DISCONNECT 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 Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes individually mounted switches and circuit breakers used for the following:
   1. Service disconnect switches.
   2. Feeder and equipment disconnect switches.
   3. Feeder branch-circuit protection.
B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Section “Wiring Devices” for attachment plugs and receptacles, and snap switches used for disconnect switches.

1.3 SUBMITTALS
A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
B. Product Data for disconnect switches, circuit breakers, and accessories specified in this Section.
C. Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.
D. Field test reports.
E. Maintenance data for tripping devices to include in the operation and maintenance manual specified in Division 1.

1.4 QUALITY ASSURANCE
A. Source Limitations: Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.
B. Comply with NFPA 70 for components and installation.
C. Listing and Labeling: Provide disconnect switches and circuit breakers specified in this Section that are listed and labeled.
   1. The Terms “Listed” and “Labeled”: As defined in the National Electrical Code, Article 100.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Molded-Case Circuit Breakers:
      a. Siemens Energy & Automation, Inc.
      b. Square D Co.
      c. Eaton
   2. Combination Circuit Breaker and Ground Fault Trip:
      a. Siemens Energy & Automation, Inc.
      b. Square D Co.
      c. Eaton
   3. Molded-Case, Current-Limiting Circuit Breakers:
      a. Siemens Energy & Automation, Inc.
      b. Square D Co.
      c. Eaton
   4. Integrally Fused, Molded-Case Circuit Breakers:
      a. Siemens Energy & Automation, Inc.
      b. Square D Co.
      c. Eaton

2.2 DISCONNECT SWITCHES

A. General: Heavy Duty safety switch, service entrance rated if indicated, with grounding lug kit, rated for equipment amperage, capable to be locked in the open position, with number of poles matching equipment connections.

B. Enclosed, 600V Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle. Switch shall be rated for equipment amperage.

C. Enclosed, 600V Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position. Switch shall be rated for equipment amperage.

D. Enclosure: NEMA KS 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.
   1. Outdoor Locations: Type 3R.
   2. Wet or Damp Indoor Locations: Type 4.

2.3 ENCLOSED CIRCUIT BREAKERS

A. Enclosed, Molded-Case Circuit Breaker: NEMA AB 1, with lockable handle.

B. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting rating to meet available fault current. Breakers will be fully rated for panel AIC rating.

C. Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air-conditioning, and refrigerating equipment.
D. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.


F. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.


H. Molded-Case Switch: Where indicated, molded-case circuit breaker without trip units.

I. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.

J. Shunt Trip: Where indicated.

K. Accessories: As indicated.

L. Enclosure: NEMA AB 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.
   1. Outdoor Locations: Type 3R.
   2. Wet or Damp Indoor Locations: Type 4.
   3. Hazardous Areas Indicated on Drawings: Type 7C.

M. Transient Voltage Surge Suppressors: IEEE C62.41, to meet requirements for category indicated.
   1. Exposure: High.
   2. Impulse sparkover voltage coordinated with system circuit voltage.
   3. Factory mounted with UL-recognized mounting device.

N. Motor circuit breakers shall be Square D thermal magnetic breakers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer’s written instructions. Provide 2-inch clearance for operation and maintenance.

B. Install disconnect switches and circuit breakers level and plumb.

C. Install wiring between disconnect switches, circuit breakers, control, and indication devices.

D. Provide power to all shunt trip circuit breakers / switches from panel the breakers are mounted in or fed from unless indicated otherwise on drawings. Provide 20A 1P CB and label shunt trip power.

E. Grounding: Ground case and metallic conduit of disconnects.

F. Provide working clearance in front of disconnect switch per NEC, minimum 36 inches.
G. Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer.
   1. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486 A and UL 486 B.

H. Identify each disconnect switch and circuit breaker according to requirements specified in Section “Electrical Identification.”

3.2 FIELD QUALITY CONTROL

A. Testing: After installing disconnect switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
   1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for disconnect switches 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

B. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

C. Infrared Scanning: After Substantial Completion, but not more than two (2) months after Final Acceptance, perform an infrared scan of each disconnect switch and circuit breaker. Remove fronts to make joints and connections accessible to a portable scanner.
   1. Follow-up Infrared Scanning: Perform one (1) additional follow-up infrared scan of each disconnect switch and circuit breaker 11 months after date of Substantial Completion.
   2. Instrument: Use an approved infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide calibration record for device used.
   3. Record of Infrared Scanning: Prepare a certified report identifying disconnect switch and circuit breaker checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.3 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION
SECTION 26 4113
LIGHTNING PROTECTION

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 lightning protection for buildings.

1.3 SUBMITTALS
   A. Product Data: For air terminals and mounting accessories.
   B. Shop Drawings: Detail lightning protection system, including air-terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway and data on how concealment requirements will be met.
   C. Qualification data for firms and persons specified in “Quality Assurance” Article to demonstrate their capabilities and experience. Include data on listing or certification by nationally recognized testing laboratory (NRTL) or trade association.
   D. Field inspection reports indicating compliance with specified requirements.

1.4 QUALITY ASSURANCE
   A. Installer Qualifications: Engage an experienced installer who is NRTL listed or who is certified by LPI as a Master Installer/Designer.
   B. Listing and Labeling: As defined in NFPA 780, Article 2-2, “Definitions.”
   C. Provide ETL Master Label indicating system complies with specified requirements.

1.5 COORDINATION
   A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
   B. Coordinate installation of air terminals attached to single-membrane roof systems with roofing manufacturer and installer.

PART 2 - PRODUCTS
2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   3. Harger Lightning Protection, Inc.
   5. Independent Protection Company, Inc.
   7. Thompson Lightning Protection, Inc.

2.2 LIGHTING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96.

B. Roof-Mounting Air Terminals: NFPA Class II, copper, solid, unless otherwise indicated.

C. Stack-Mounting Air Terminals: Solid copper.

D. Ground Rods, Ground Loop Conductors, and Concrete-Encased Electrodes: Comply with Section “Grounding and Bonding” and standards referenced in this Section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.

C. Conceal the following conductors:
   1. Down conductors.
   2. Interiors conductors.
   3. Conductors within normal view from exterior locations at grade within 200 feet of building.
   4. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

D. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components.

E. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

3.2 CORROSION PROTECTION
A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. ETL Inspection: Engage an ETL inspector to inspect completed system for compliance with specified requirements.

END OF SECTION
SECTION 26 5100
INTERIOR LIGHTING

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 interior lighting fixtures, lighting fixtures mounted on exterior building surfaces, lamps, ballasts, emergency lighting units, and accessories.

1.3 SUBMITTALS

A. Product Data: For each type of lighting fixture indicated, arranged in order of fixture designation. Include data on features, accessories, and the following:
   1. Dimensions of fixtures.
   2. Certified results of independent laboratory tests for fixtures and lamps for electrical ratings and photometric data.
   3. Certified results of laboratory tests for fixtures and lamps for photometric performance.
   4. Fluorescent and high-intensity-discharge ballasts.
   5. Types of lamps.

B. Specification Compliance Review:
   1. Manufacturers and bidders must provide the consulting engineer with a Compliance Review of the Specifications and Addenda’s. The Compliance Review shall be a paragraph-by-paragraph review of the Specifications and schedule with the following information; “C”, “D”, or “E” marked in the margin of the original Specifications and any subsequent Addenda’s. If the manufacturer or bidder does not provide the Compliance Review to the engineer for review, with the submittal, the submittal will be subject to rejection as non-compliant.
      a. “C” Comply with no exceptions.
      b. “D” Comply with deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.
      c. “E” Exception do not comply. For each and every exception, provide a numbered footnote with reasons and possible alternatives. Non-compliance with the specifications is grounds for rejection as unacceptable. A bid from any alternative or listed equipment manufacturer with any number of exceptions will be reason for rejection for non-compliance without further review.
      d. Unless a deviation or exception is specifically noted in the Compliance Review, the manufacturer shall provide full compliance with entire specification. Deviations or exceptions taken in letters or cover letters in a bid document, subsidiary documents, by omission or by contradiction do not release the manufacturer or bidder from being in complete compliance, unless the exception or deviation has been specifically noted in the Compliance Review and approved by the consulting engineer.
e. Equipment manufacturers or bidders that do not meet the specifications thru the above process will be subject to rejection without further review.

C. Shop Drawings: Show details of nonstandard or custom fixtures. Indicate dimensions, weights, method of field assembly, components, features, and accessories.
   1. Wiring Diagrams: Detail wiring for fixtures and differentiate between manufacturer-installed and field-installed wiring.

D. Statement that the services of Lighting System Startup Services Agent (LSSSA) as described in Part 3 have been procured.

E. Dimming Driver Compatibility Certificates: Signed by manufacturer of driver certifying that drivers are compatible with dimming systems and equipment with which they are used.

F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

G. Maintenance Data: For lighting fixtures to include in maintenance manuals specified in Division 1.

H. Photometric Analysis: Submit point-by-point values on 1/8” = 1’-0” plans for all interior rooms. Calculations shall be made using (1) no masking, (2) light loss factor of 0.95, (3) point-by-point spacing of 24” x 24”, and (4) reflectances of 80/50/20. In addition, also provide calculated average, maximum, and minimum footcandle values in a schedule for each room. Illuminance values (in footcandles) shall be for a calculation plane (workplane) at 30” AFF unless stated otherwise. Architectural plans in AutoCAD format shall be provided by Engineer for calculations upon request. Refer to architectural drawings for ceiling heights.

1.4 QUALITY ASSURANCE
   A. Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
   B. Comply with NFPA 70.
   C. FM Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.
   D. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.5 COORDINATION
   A. Fixtures, Mounting Hardware, and Trim: Coordinate layout and installation of lighting fixtures with ceiling system and other construction.

1.6 WARRANTY
   A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
B. Special Warranties for Fluorescent Ballasts: Written warranty, executed by manufacturer agreeing to replace fluorescent ballasts that fail in materials or workmanship within specified warranty period.
   1. Warranties for LED Drivers; Written warranty, executed by manufacturer agreeing to replace LED drivers that fail in materials or workmanship within five years from date of manufacture, but not less than four years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers and Models: As indicated on the drawings and lighting fixture schedule. Additional manufacturers may be considered as equal after review from the design engineer. Submit two copies to the design engineer for review prior to bid. Include a cross reference for each fixture submitted. Equipment submitted for “as-equal” without complete cutsheet cross reference, to include drawing fixture lettering, is subject to immediate rejection.
   1. Additional manufacturers will be considered on a case by case basis prior to bid. Post-bid non-approved manufacturers/models are subject to rejection and any cost difference for approved fixtures will be the contractors’ responsibility.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

A. Metal Parts: Free from burrs, sharp corners, and edges.

B. Sheet Metal Components:
   1. Steel, unless otherwise indicated.
   2. Form and support to prevent warping and sagging.
   3. Housing painted after fabrication.
   4. Smooth hemmed sides and smooth inward formed end flanges.

C. Doors, Frames, and Other Internal Access:
   1. Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.
   2. Standard extruded aluminum door frame has superior structural integrity with premium appearance and mitered corners. Door frame is painted after fabrication, standard. Powder-painted rotary cam latches provide easy, secure door closure. Integral T-bar clips are standard. Acrylic shielding materials is 100% UV stabilized.

D. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.
   4. Laminated Silver Metallized Film: 90 percent.

E. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.
   1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
   2. Lens Thickness: 0.125-inch minimum, unless greater thickness is indicated.
F. Electromagnetic Interference Filters: Integral to fixture assembly. Provide one filter for each ballast where indicated on drawings. Suppress conducted electromagnetic interference filters as required by MIL-STD-461.

G. Housings: Manufacturers standard with integral heat sink.

H. Fixture Type Components:
2. Downlight:
   a. Universal mounting bracket.
   b. Integral junction box with conduit fittings.
   c. Battery backup test button and integral to fixture.
3. Linear Industrial
   a. Housing and heat sink rated to the following:
      1) Class 1, Division 2 Groups A, B, C, and D.
      2) NEMA 4X.
      3) IP 54.
      4) IP 66.
      5) Marine and wet locations.
      6) CSA C22.2 No 137.
4. Recessed Linear: Integral junction box with conduit fittings.
5. Strip Light
   a. Pendant mounted with secondary support provision.
   b. Universal mounting bracket.
   c. Integral junction box with conduit fittings.
   d. Wire guard or lens.
6. Surface Mount, Linear
   a. Universal mounting bracket.
   b. Integral junction box with conduit fittings.
7. Surface Mount, Nonlinear
   a. Universal mounting bracket.
   b. Integral junction box with conduit fittings.
8. Suspended, Linear
   a. Pendant mounted with secondary support provision.
   b. Universal mounting bracket.
   c. Provide with aircraft cable.
   d. Fixtures shall join with factory fittings of length on drawings with factory ends.
   e. Coordinate cord drop.
   f. Power feed thru factory quick connect.
   g. White cord drop to end of fixture.
   h. Minimum two supports per run. Minimum one every 8 feet.
9. Suspended, Nonlinear
   a. Pendant mounted with secondary support provision.
   b. Universal mounting bracket.

2.5 LIGHT EMITTING DIODE (LED) LIGHTING

A. General: Comply with fixture component requirements.

B. All LED products must be UL, ETL and/or CSA listed.

C. All LED products must have LM-79 and LM-80 testing minimum and noted on specification sheet by an independent test lab and in accordance with the following:
   1. Lay-in Troffers: L90 at 60,000 hours at 25 degrees C.
2. Surface Mounted: L80 at 60,000 hours at 25 degrees C.
3. Pendant Mount: L90 at 60,000 hours at 25 degrees C.
4. Recessed Can: L70 at 50,000 hours at 25 degrees C.
5. High Bay: L70 at 90,000 hours at 25 degrees C. or L95 at 60,000 hours at 25 degrees C. *
6. Exterior Surf Mtd: L90 at 100,000 hours at 40 degrees C or L80 at 100,000 hours at 25 degrees C *
7. High Bay and Exterior Fixtures shall be Thermally Protected Drivers

D. All LED products should be identified as L70 and/or L90 ratings based on independent test lab data.

E. Long-life LEDs, coupled with high-efficiency drivers, provide superior level and quality of illumination for extended service life.

F. All outdoor and wet location listed products must clearly state the IP rating carried on the fixture based on independent test lab data.

G. All LED products must be serviceable for accessible for field repair needs. Drivers and internal components are accessible from floor. LED boards include plug-in connectors for easy replacement or servicing. Suitable for direct insulation contact. Suitable for damp location.

H. Standard embedded controls continuously monitor system performance, allow for constant lumen management/compensation function, facilitate simple “plug-and-play’ network and controls upgrading via Cat-5 cable.

I. Minimum CRI 80.

J. All outdoor lighting color rendering should be within a 7 step McAdams Ellipse. All outdoor lighting should be 4100 kelvin unless specifically noted.

K. All indoor lighting color rendering should be within a 3 step McAdams ellipse. All indoor lighting should be 4000 kelvin unless specifically noted.

L. All LED drivers should be capable of 0-10 volt controls and DMX control and shall dim to 1% of total lumen output. Where specifically specified the dimming driver may be required to dim to .1% of lumen output, otherwise known as “dim to dark”.

M. Driver manufacturers must have a 5 year history producing dimmable electronic LED drivers for the North American market.

N. Ambient driver temperatures must be within -20 degrees to 50 degrees C (-4 degrees to 122 degrees F).

O. Driver must limit inrush current.

1. Base specification: meet or exceed NEMA 410 driver inrush standard of 430 amp per 10 amps load with a maximum of 370 amps/2 seconds
2. Preferred specification : Meet or exceed 30ma’s at 277 VAC for up to 50 watts of load and 75A at 240us att 277 VAC for 100 watts of load
3. Withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A
4. No visible change in light output with a variation of plus/minus 10percent line voltage input.
5. Total harmonic distortion less than 20%, and meet ANSI C82.11 maximum allowable THD requirements at full output. THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.

P. Any exceptions are at the engineers discretion based on project needs and applicability.

2.6 EXIT SIGNS

A. General Requirements: Comply with UL 924 and the following:
   1. Sign Colors and Lettering Size: Comply with authorities having jurisdiction.
   2. Die cast brushed metal finish exit signage with manufacturer’s multi-style mounting (wall, surface, and top). Plastic exit signage is not acceptable.

B. Internally Lighted Signs: As follows:
   1. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum rated lamp life.
   2. All exit signs shall have battery back-up.
   3. Provide with self-diagnostics as indicated on the drawings.

2.7 LAMPS

A. Fluorescent Color Temperature and Minimum Color-Rendering Index: 3500 K and 90 CRI, SPX 830, unless otherwise indicated.

B. Noncompact Fluorescent Lamp Life: Rated average is 20,000 hours at 3 hours per start when used on rapid-start circuits.

C. Metal-Halide Color Temperature and Minimum Color-Rendering Index: 3600 K and 70 CRI, unless otherwise indicated.

2.8 FIXTURE SUPPORT COMPONENTS

A. Comply with Section “Basic Electrical Materials and Methods,” for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: ½-inch steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, ½-inch steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

F. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

2.9 FINISHES

A. Fixtures: See fixture schedule for colors and finishes. Otherwise manufacturer’s standard.
   1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Fixtures, General: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.
   1. Coordinate location of fixtures with architectural ceiling plan.
   2. Review architectural elevations prior to rough-in for any wall mounted fixtures. Mount at 84 inches or above, unless otherwise indicated. All wall mounted fixtures shall be ADA compatible if below 84 inches.
   3. Center single fixtures in rooms as much as possible.
   4. Center fixtures in exposed ceilings. Provide equal distance between fixtures and structural elements (walls, columns, furdowns, etc.).
   5. Provide switching mechanisms for all fixtures whether indicated on the drawings or not.
   6. Provide supports without causing deflection of ceiling or wall.
   7. Secure to outlet box.

B. Track Lighting
   1. Install track parallel with structural or grid. Secure track to structural mounted j-boxes.
   2. Conceal transformers above accessible ceiling.
   3. Coordinate with architect for track lighting head locations.
   4. Aim track heads at objects to be illuminated
   5. Adjust pendant track fixtures per architect/owner.

C. Remote Battery or Ballasts:
   1. Mount battery backup over accessible ceiling spaces. Provide appropriate battery backup for mounting distance away from fixture.
   2. Remote mount ballasts for fixtures in stairwells or over hard ceilings where ballast is not directly accessible from below.
   3. Mount all remote ballasts and battery packs together as much as possible over accessible ceiling spaces and mount on unistrut with backboard. Do not mount directly to wall. Bundle cabling together and label ballasts/battery packs corresponding to fixture. Provide diagram as required.

D. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for alignment.
   1. Install a minimum of four (4) ceiling support system rods or wires attached to the fixture structure on EACH fixture secured to the building structure. Locate not more than 6 inches from fixture corners.
   2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner.
   3. Fixtures of Sizes Less Than Ceiling Grid: Arrange as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two (2) ½-inch metal channels spanning and secured to ceiling tees.

E. Suspended Fixture Support: As follows:
   1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging. Provide blocking for heavy fixtures.
   2. Stem- Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
   3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
4. Coordinate mounting heights with Architect/Engineer. Consult prior to hanging. Stems may need to be field cut.
5. Chain hung fixtures are NOT acceptable unless indicated on the drawings.
6. Provide secondary support for all fixtures without canopy support from structure.
   a. All high and low bay fixtures shall have secondary support cables secured to structure.
7. Sized and rated for fixture weight.
8. Do not use ceiling grid as support for pendant luminaires. Connect support wired or rods to building structure.

F. Flush-Mounted Luminaire Support:
   1. Secured to outlet box.
   2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
   3. Trim ring flush with finished surface.

G. Wall-Mounted Luminaire Support:
   1. Attached to structural members in walls.
   2. Do not attach luminaires directly to gypsum board.
   3. Provide blocking to support.

3.2 CONNECTIONS

A. Ground equipment:
   1. Tighten electrical connectors and terminals according to manufacturers’ published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Connect to switch mechanisms (wall switch, contactors, relays) room controllers.

C. Provide dual switching for room mounted dual ballast fixtures. Wire each switch leg to each ballast. Do not connect together unless directed by engineer.
   1. Exception: Step dimming fixtures in corridors may be connected together. Consult engineer prior to connections and installing switch legs.

D. Fixture Connections:
   1. Indoors
     a. With Lay-in ceilings: Provide EMT home runs to structure mounted J-boxes. Provide MC Cable from above ceiling j-boxes to fixtures. Do not daisy chain fixtures together unless specifically indicated on the drawings or allowed by engineer.
     b. With gypboard ceilings: Provide EMT home runs to structure mounted J-boxes. Provide access to j-boxes or locate above fixtures. Provide MC Cable from above ceiling j-boxes to fixtures. Do not wire daisy chain fixtures together, unless indicated on the drawings.
     c. Exposed (no ceiling) in finished spaces: Conceal EMT as much as possible in adjacent walls. Route EMT to fixtures in exposed spaces with steel compression fittings and install parallel along structural members to structural mounted j-boxes. Conceal conduit along structural members. DO NOT route conduit across open spaces suspended from structural members unless directed by architect or engineer. Mount fixtures from j-boxes. Center fixtures in spaces.
d. Exposed unfinished spaces: Provide EMT runs to structural mounted j-boxes. Route parallel to structural members as much as possible. Mount fixtures or fixture support to j-boxes.

2. Outdoor: Provide IMC for exterior fixtures and connect directly to fixtures or j-boxes as required for fixture mounting. Exterior fixtures mounted in ceilings or structure can use EMT to fixture j-box mounts.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Advance Notice: Give dates and times for field tests.

C. Provide instruments to make and record test results.

D. Tests: As follows:
   1. Verify normal operation of each fixture after installation.
   2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.
   3. Verify normal transfer to battery source and retransfer to normal.
   4. Report results in writing.

E. Malfunctioning Fixtures and Components (Except LED Fixtures): Replace or repair, then retest. Repeat procedure until units operate properly.

F. Malfunctioning LED Fixtures: Replace fixture then retest. LED fixtures shall not be repaired.

G. Corrosive Fixtures: Replace during warranty period.

3.4 CLEANING AND ADJUSTING

A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities.

3.5 SPECIAL WORK

A. Pre-construction Jobsite Visit
   1. Contractor shall provide the services of individuals certified by the manufacturers of the proposed lighting fixtures and related lighting controls for startup of their products. This function shall be designated within this specification section as the Lighting System Startup Services Agent (LSSSA).
   2. Contractor shall contact LSSSA to schedule jobsite meeting prior to the installation of the lighting control system. Purpose of the meeting shall be to review submittals and installation documentation provided by the system manufacturer. Discussion shall include wiring conventions and specific wiring requirements. Installation of specific devices shall also be addressed.
   3. Prior to start-up, LSSSA shall visit the jobsite to confirm progress and answer any additional questions. Start-up date shall be confirmed at the time of this visit. Training agenda shall be provided to the contractor. Contractor shall confirm owner representative and specifying engineer attendance at lighting system demonstration and/or for training. Contractor shall provide to field service technician programming
information as required for start-up to include zone assignments, time schedules for operation, presets for all control stations, programming sequences for dynamic LED fixtures, emergency operation, blink-warn, and system override. Programming information is required for system set-up and pre-start-up.

B. Lighting Control System Start-Up And Training

1. Prior to energizing lighting control system the following must be completed:
   a. Lighting control system shall be energized prior to LSSSA onsite programming to ensure system operation and basic function test verification as proposed by manufacturer’s recommendations. The manufacturer of the lighting control equipment and its representatives are relieved of all responsibility relating to damaged parts or warranty due to improper installation.
   b. Lighting Control system is defined as the dimmer/relay panel(s) and all associated control stations and related accessories.
   c. The electrical contractor is responsible to install the entire lighting control system, all power feeders, all load wiring, and control wiring. Equipment shall be installed according to the manufacturer’s instructions, contract documents, and national and local codes and regulations.
   d. Equipment shall be plumb and level to the finished floor. All components of the lighting control system shall be clean, free of dust and paint spatters. Components shall be unmarred or damaged. All cable shall be dressed, neatly routed, and labeled. All conduit shall be securely attached to the dimmer/relay panel.
   e. LSSSA services are not provided in conjunction or in association with any commissioning of lighting or other related control systems.

2. System Start-up
   a. Each dimmer/relay shall be tested by the electrical contractor (with a multi-meter) to confirm what voltage is being passed and to confirm that no voltage is being passed when the circuit is open.
   b. A representative of the owner shall be present to observe the testing/demonstration of the dimmer/relay panels. Each individual dimmer/relay panel shall be load tested with all circuits on while under load for a minimum of 1 hour.
   c. Where external devices are to be attached to the dimmer/relay panel including photocell, occupancy sensor, time clock, and/or control stations, operation of each device shall be verified at the panel and specific circuits that are programmed to be controlled by the external device(s).
   d. Where control signals originate from the dimmer/relay panel for control of lighting fixtures, the control signal shall be tested by the electrical contractor to confirm that it is being delivered to each lighting fixture. Proper operation of the lighting fixtures shall be confirmed as part of the system testing/demonstration.

3. Training
   a. Training shall be provided for the owner’s representative and contractor. Prior to start-up owner’s representative and electrical contractor shall acknowledge receipt of training agenda. Electrical contractor shall confirm that specifying engineer has been contacted and been invited to attend the system demonstration and/or training. All product and lighting control system documentation and operation’s manuals shall be provided by electrical contractor at the time of training.
   b. Training is to include, but not be limited to: basic operation of lighting control system, set-up of system and control panels, operation of control stations, programming of system, basic be-bugging, and overall system testing. At completion of training session, all in attendance shall sign the start-up technician’s field service report to confirm participation in the training session.
c. Completed field service report shall be submitted to the electrical contractor and specifying engineer.

C. Follow-Up Contact
1. Approximately 90 days following the initialization of the lighting control system LSSSA shall contact the electrical contractor to confirm that the system is operating correctly and answer any questions that have come up since system initialization.

D. Extended Follow-Up Contact
1. Approximately 300 days following initialization of the lighting control system LSSSA shall contact the owner's representative in order to schedule a job site visit. The purpose of the visit shall be to confirm that all lighting control equipment that was initialized by LSSSA is fully functioning. Any equipment not functioning as originally specified shall be repaired as required.
2. In addition, if the end user has adjustments that need to be made to programming or to any of the control of the system, these shall be made during the jobsite visit. If further training on the system is required this shall be provided at the time of the visit or scheduled at a time of mutual convenience.
3. A completed field service report shall be submitted to the electrical contractor, specifying engineer, and the owner's representative.

END OF SECTION
PART 1 - GENERAL

This section identifies the technical design and specification requirements for the structured cabling for the South Llano River State Park Headquarters Expansion for Texas Parks & Wildlife ("Owner"). The structured cabling as specified is a High End (400 MHz) Industry Standard Category 6 Structured Cable Plant and will support voice and data systems in the new facility. Category 6A cabling is to be used for all wireless access points.

A. Contractor shall provide all materials, equipment, and labor necessary to provide a complete and functional High End Industry Standard Category 6 Structured Cable Plant regardless of any materials and/or equipment not listed or described in this specification and/or supplementary drawings.

1.1 REQUIREMENTS INCLUDED

A. Contractor Requirements
B. Acceptable Manufacturers
C. Codes, Standards and Regulations
D. General Requirements
E. System Requirements
F. Testing Requirements
G. Project Closeout Documentation
H. Attachments

1.2 RELATED REQUIREMENTS

A. The Drawings, Specifications, General Conditions, Supplementary General Conditions and other requirements of Division 1, apply to the work specified in Division 17, and shall be complied with every respect. The Contractor shall examine all of the documents, which make up the Contract Documents, and shall coordinate them with the work on the Technology Drawings and Division 27 of these Specifications.

1.3 CONTRACTOR EXPERIENCE REQUIREMENTS

A. The Contractor shall be a Certified Installer of the proposed Manufacturer Structured Cabling Solution prior to submitting a proposal for the work.
B. The Contractor shall possess any and all relevant Manufacturer Certifications for the company and all installers prior to submitting a proposal for the work. Contractor shall provide
a list of their installers with their work experience, training history and manufacturer’s certifications for the Company and installers.

C. Installers must be certified, trained and experienced on the specific installation, termination and testing of the systems as specified.

D. The Contractor shall certify and the Manufacturer of the solution shall warrant the solution for a period of no less than twenty (20) years.

E. The Contractor shall be an established business with local support and shall have been in business for a minimum of five (5) years.

F. The Contractor shall have prior experience with projects of a similar size and scope. The Contractor shall provide a minimum of five (5) installed systems comparable to the Owner’s installation, where the systems have been in continuous satisfactory operation for at least one (1) year. The Contractor shall provide the following information for each reference: Project Name, Project Location, Project Start Date, Project Completion Date, Project Start Cost, Project Completion Cost, Brief Description of Project, Client Point of Contact Name and Phone Number.

G. Past performance with the Owner is a selection criterion. Experience related to any past or present project with the Owner should be disclosed with bid response.

H. Qualified Contractors should submit proof of all certifications and experience detail with bid response and product submittals.

1.4 SUBMITTALS

A. Pre-Installation

1. Original Equipment Manufacturer (OEM) documentation for each component proposed must be provided to Owner, which certifies performance characteristics. Contractor shall not purchase or install any equipment until OEM documentation has been received and approved by the Architect/Engineer.

2. Product data sheets for all proposed system components. Product data sheets shall include: an equipment schedule listing of all system components to be installed in the project and the manufacturer’s product reference and specification literature for all products to the utilized and/or installed in the project. Contractor shall not purchase or install any equipment until product data sheets have been received and approved by the Architect/Engineer.

3. Contractor shall provide to owner’s representative shop drawings of the proposed layouts of equipment and cable plant. Shop drawings shall include equipment rack layouts, wall elevations, system schematics and riser diagrams. These include detailed shop drawings submitted on 30” X 42” bond paper. Contractor shall not install any equipment until shop drawings have been received and approved by the Architect/Engineer.

4. Manufacturer Certifications for Company as identified in Contractor Experience Requirements.

5. Manufacturer Training Certifications for Installers as identified in Contractor Experience Requirements.

6. Project Manager/Superintendent RCDD Certification as identified in Contractor Experience Requirements.

7. Manufacturer Certification/Warranty offering as identified in Contractor Experience Requirements.
B. Post Installation
   1. Contractor shall prepare, update and make available to the Architect/Engineer a comprehensive three (3) copy set of drawings accurately depicting the “as-built” condition of the Structured Cabling as it was installed. As-Built drawings must be provided in original hardcopy format and on a CD-ROM in AutoCAD 2014. The Contractor shall prepare, update, and make available to the Consultant a comprehensive set of “as built” drawings using the original scale, indicating exact dimensions and locations of all telecommunication rooms, frames, racks, trays, terminal blocks, patch panels, cable runs, cable pathways, workstation locations, and labeling scheme. These drawings shall be turned over to the Consultant at the time of final systems acceptance of the cable plant installation. Final payment will not be recommended until these drawings are received and approved by the Architect/Engineer.

   2. The Contractor shall provide three (3) sets of test documentation for the Structured Cabling to the Architect/Engineer at the time of final systems acceptance. Test results shall be provided in original hardcopy format and on a CD-ROM. Test documentation shall include Power Meter and Light Source Fiber Optic Tests and Category 6 test results for each cable drop in accordance with Section 3.4 of these specifications. Final payment will not be recommended until these test results are received and approved by the Architect/Engineer. Test documentation shall be bound, sectioned and tabbed in the following order:
   - Intra-Building Fiber Optic Cable
   - Intra-Building Copper Cable
   - Horizontal 4-Pair UTP Data Cable
   - Horizontal 4-Pair UTP Voice Cable

   3. The Contractor shall furnish the original Certificate of Certification/Warranty to the Architect/Engineer at the time of final systems acceptance. Final payment will not be recommended until this Certificate of Warranty is received and approved by the Architect/Engineer.

   4. Contractor shall provide warranty information to include the name, address and phone number contacts for warranty call outs. Final payment will not be recommended until this warranty information is received and approved by the Architect/Engineer.

PART 2 – PRODUCTS

The following sections specifically list the acceptable equipment types and items for this project. Proposed equivalent items must meet or exceed these specifications and the specifications of the listed item. In the event a specified manufacturer’s part number has changed or is no longer valid, Contractor shall substitute the appropriate equivalent manufacturer’s part number. Owner or Owner’s designate will have final determination of acceptability of all proposed equipment and must approve submitted equipment prior to installation. Where quantities are not noted, they may be obtained from the drawings. In the event of a discrepancy between the specifications and the drawings, the greater quantity and/or better quality will be furnished. Any Owner-furnished materials or equipment not installed in the project shall be returned to the Owner. Contractor shall store all materials and equipment in accordance with manufacturers’ instructions in a weather-tight, secure enclosure. Contractor shall be responsible for safety and security of all Owner-furnished materials until project is complete and accepted by Owner.

2.1 ACCEPTABLE MANUFACTURES

A. Fiber optic cable
   1. 9 µm Singlemode
      a. Corning 012C-T4131D20
2. Fiber Optic Innerduct (Orange)
   a. AMP
   b. Carlon
   c. Pyramid

B. Copper Cable
   1. Category 5e – Data (Blue Sheath)
      a. Panduit PUP5504BU-U
      b. Commscope DataPipe 5E55

C. Fiber Optic Termination
   1. Panduit CFAPPBL1
   2. Panduit ST connectors

D. Copper Termination
   1. RJ-45 Patch Panels – Data Termination
      a. Panduit – Part # DP245E88TGY
   2. Telecommunications Faceplates
      a. Panduit
   3. Telecommunications Outlets
      a. Panduit

E. Equipment Rack(s) and Wire Management (Black)
   1. Chatsworth Cube IT wall mount enclosure - Part # 11890-736

F. Plywood
   1. ¾” x 8’ h x 4’ w Sheets of Fire Rated Plywood with Fire Rated Stamp

G. Paint
   1. Fire Retardant Paint

H. Cable Support
   1. Ladder Rack and all Applicable/Required Accessories
      a. Chatsworth Universal Cable Runway - Part # 10250-712
   2. J-Hooks and all Applicable/Required Accessories
      a. Erico Caddy Cat J-Hook System
      b. Panduit

I. Ground Busbars and all Applicable/Required Accessories
   1. Chatsworth 20” BICSI & ANSI/EIA/TIA Grounding Busbar (Part # 40153-020)
   2. Chatsworth 10” BICSI & ANSI/EIA/TIA Grounding Busbar (Part # 13622-010)

J. Fire Stop (Intumescent Putty and Pillows)
   1. STI Spec Seal
   2. 3M Products

PART 3 - EXECUTION

3.1 CODES, STANDARDS AND REGULATIONS

A. American National Standards Institute (ANSI)

B. American Society for Testing and Materials (ASTM)
C. Alliance for Telecommunications Industry Solutions (ATIS)

D. Electronics Industry Alliance (EIA)

E. Federal Communications Commission (FCC)
   1. FCC Part 15, Radiated Emissions Limits, revised 1998
   2. FCC Part 68, Connection of Terminal Equipment to the Telephone Network, revised 1998
   3. FCC Part 76, Cable Television Service, revised 1998

F. International Electrotechnical Commission (IEC)

G. Institute of Electrical and Electronics Engineers, Inc. (IEEE)

H. International Organization for Standardization (ISO)

I. International Organization of Standardization/International Electrotechnical Commission (ISO/IEC)


L. National Cable Television Association (NCTA)

M. National Electrical Code (NEC)

N. National Electrical Manufacturers Association (NEMA)

O. National Fire Protection Association (NFPA)

P. NFPA-70, National Electrical Code


U. National Institute Standards and Technology (NIST)

V. Occupational Safety and Health Administration (OSHA)

W. Rural Utility Services (RUS)
X. Telecommunications Industry Association (TIA)
   1. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises, 2009
   2. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, 2009
   5. ANSI/TIA/EIA–569-B, Commercial Building Standard for Telecommunications Pathways and Spaces, 2005
   6. ANSI/TIA–569-B Amendment 1, Commercial Building Standard for Telecommunications Pathways and Spaces, 2009
   9. ANSI/TIA-758, Customer-Owned Outside Plant Telecommunications Infrastructure Standard, 2004

Y. Underwriters Laboratories, Inc. (UL)

In the event of any conflicts between documents referenced herein and the contents of this specification, the Contractor shall notify in writing to the Architect/Engineer of any such occurrences before the purchasing of any equipment, materials and/or installation by the Contractor. The Architect/Engineer will notify the Contractor of any actions required to resolve these conflicts. Such actions may include but are not limited to: design changes, equipment, materials and/or installation changes. In any event Contractor shall not supersede specifications and standards from the latest NFPA and NEC publications.

3.2 GENERAL REQUIREMENTS

A. In the installation of this work, the Contractor shall comply in every way with the requirements of local and City of San Antonio laws, ordinances, and rules, the laws of the State of Texas, the National Board of Fire Underwriters, and the National Electrical Code. If, in the opinion of the Contractor, there is anything in the plans or specifications that will not strictly comply with the above laws, ordinances, and rules, the matter shall be referred to the attention of the Architect/Engineer for a decision before proceeding with that part of the work.

B. No change in the plans or in the specifications shall be made without full consent in writing of the Architect/Engineer.

C. The Contractor shall obtain written permission from the Architect/Engineer before proceeding with any work that would necessitate cutting into or through any part of the building structure such as, but not limited to girders, beams, floors, or partition ceilings.

D. The Contractor shall install the materials in accordance with the manufacturers’ guidelines and specifications.

E. The Contractor shall promptly correct all system discrepancies or defects for which the Contractor is responsible.

F. The Contractor shall coordinate all work with the Architect/Engineer prior to purchase of products or installation of cable plant.

G. The Contractor shall submit product data sheets for all materials to the Architect/Engineer.
prior to the purchase or installation of cable plant.

H. The Contractor shall maintain a work area free of debris, trash, empty cable reels, scrap wire, etc., and dispose of such items on a daily basis and return the site to the original state of cleanliness. The Contractor shall not use Owner’s facilities for the disposal of excess or scrap materials.

I. The Contractor shall be certain that all work areas are in compliance with the Occupational Safety and Health Administration (OSHA) regulations.

J. The Contractor shall have written approval from the Architect/Engineer for any additional work outside the Contract Documents prior to beginning such work.

K. The Contractor shall not roll or store cable reels without an appropriate underlay.

L. The Contractor shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.

M. The Contractor shall insure that the maximum pulling tensions of the specified distribution cables are not exceeded at any time during placement. Failure to follow the appropriate guidelines may require the contractor to provide additional material and labor necessary to rectify the situation. This shall also apply to any and all damages sustained to the cables by the installation contractor during the implementation.

N. The Contractor shall install all equipment as close to the wiring fields as possible, taking into consideration, testing, administration, maintenance, and future growth.

O. The Contractor shall be responsible for testing all cable prior to the installation of the cable. If the Contractor fails to perform this testing operation, the Contractor shall accept the cable as without defect and assume all liability for the replacement of the cable should it be found defective at a later date.

P. The Contractor shall plug ALL penetrations, conduits, sleeves, cable trays, etc., where cabling has been installed through rated walls/floors with an UL listed and approved intumescent re-enterable fire-stop system consisting of a re-enterable putty for sleeves and conduit penetrations and pillow stop systems for cable trays where they pass through rated walls.

Q. The Contractor shall be responsible for returning any and all penetrations through rated walls or floors made for communications cable to their pre-penetration rating.

R. The Contractor shall maintain a set of working specifications and drawings on site at all times and shall be responsible for keeping the drawings updated on a minimum of a weekly basis. These working drawings shall be made available for inspection at the request of the Architect/Engineer or the Owner.

S. Materials shall be consistent throughout the building. Where two or more units of the same class of equipment or wiring are required, these units shall be the standard product of a single manufacturer and shall be the same product with the same material, model, and manufacturer number.

T. All wiring, equipment and installation materials shall be new and of the highest quality. Cable, equipment and installation materials shall be delivered and stored in a clean, dry space at the Contractors expense. Materials and equipment will be properly packaged in factory-fabricated
type containers and protected from the environment, damaging fumes, construction debris, and traffic, etc. until the job is installed or completion of the project.

U. Labels on all wiring, materials, and equipment must show that a nationally recognized testing laboratory lists these. Original Equipment Manufacturer (OEM) documentation must be provided to the Architect/Engineer, which certifies performance characteristics and which meet ANSI/TIA/EIA 568-B.1 standard.

V. All external screws, nuts, and locking washers shall be stainless steel. No self-tapping screws shall be allowed unless specifically approved or specified by the Architect/Engineer.

W. All material used in the installation shall be made of corrosion-resistant material, such as plastic, anodized aluminum, or brass and be resistant to fungus growth and moisture deterioration. An inert dielectric material shall separate dissimilar metals apt to corrode through electrolysis under the environmental operating conditions specified.

X. All cable installed in a plenum rated environment shall meet or exceed the Underwriters Laboratories (UL) fire rated cable insulation requirements.

Y. Any pulling compound or lubricant used in the installation shall not deteriorate the conductor or the insulation of the cable.

Z. Ten (10') feet of service loop for inter-building backbone cable shall be coiled, mounted and stored at each cable end above or on the ladder rack in the ER/TR's.

AA. Ten (10') feet of service loop for intra-building backbone cable shall be coiled, mounted and stored at each cable end above or on the ladder rack in the ER/TR's.

BB. Ten (10') feet of service loop for horizontal cables shall be coiled, mounted and stored above or on the ladder rack in each ER/TR's.

CC. Twelve (12") inches of maintenance loop for horizontal distribution cable shall be coiled and stored on the J-hook directly above the workstation outlet.

DD. Twelve (12") inches of maintenance loop for horizontal distribution cable shall be coiled and stored in the gang-box or floor-box as applicable at the workstation location.

3.3 SYSTEM REQUIREMENTS

A. Intra-Building Cable Plant
   1. Fiber Optic Cable – Riser/Tie
      a. 50 µm Multi-Mode – OM3 (Aqua Sheath)
         The Contractor shall furnish and install plenum rated 50 µm multi-mode fiber optic cable from the MDF room to each Telecommunications Room as indicated on the technology drawings. These cables shall be installed utilizing the conduit/riser system as indicated on the technology drawing. Each cable shall be installed in its own contractor furnished and installed 1” plenum rated innerduct.
      b. Fiber Optic Termination
         The Contractor shall terminate all fiber optic cables utilizing contractor furnished and installed LC type connectors inside contractor furnished and installed fiber optic enclosures. The Contractor shall furnish and install fiber optic distribution shelves with all panels, covers, connectors, couplings and blanks.
   2. Horizontal Distribution Cable
No station cable shall be longer than ninety (90) meters. If the Contractor believes any station cable will be any longer than ninety (90) meters, written approval from the Architect/Engineer will be required prior to installation of the station cable.

a. 4-Pair UTP - Data (Blue Sheath)
   The Contractor shall furnish and install 4-pair UTP Category 6/6A cable runs from each Equipment Room and/or Telecommunications Room to each outlet location respectfully as indicated in the technology drawings. These cable runs will provide data communications at each outlet.

b. Data Termination
   The Contractor shall terminate all cables at the workstation locations in appropriately sized Contractor furnished and installed faceplates with Category 6 RJ-45 8-pin modular jacks with connector specifications as defined by the ANSI/TIA/EIA 568-A Commercial Building Wiring Standard with the EIA-568B sequence as indicated in the technology drawings. Any unused faceplate position(s) shall have the appropriate number and color of blanks installed.

   **Contractors shall coordinate with the Architect/Engineer and obtain written approval of the color of the Cable, faceplates and inserts before ordering and installation of the horizontal cable plant.**

   Contractor shall furnish and install rack mounted Category 6/6A RJ45 patch panels in each Equipment Room and/or Telecommunications Room for termination of the station Category 6 cable for data. The Contractor shall provide and install horizontal wire management between each patch panel installed. Contractor shall submit scaled drawings and obtain written approval from the Architect/Engineer as to the exact location of the Category 6 RJ-45 patch panels prior to the installation of any Category 6 RJ-45 patch panels.

3. Cable Support
   a. Inter-Building cable Plant
      Inter-Building cables shall be supported using the conduit and manhole systems, cores, sleeves and J-Hooks as indicated on the technology drawings.
   b. Intra-Building Cable Plant
      Intra-Building cables shall be supported using interior conduit systems, cores, sleeves and J-Hooks as indicated on the technology drawings.
   c. J-Hook Pathways
      Horizontal cables shall be supported using Contractor furnished and installed Category 5 J-Hooks. The Contractor shall furnish and install Category 5 J-hooks to support all communications cable as segments leave cable tray, conduits, cores, or sleeves.

      The contractor shall furnish a separate J-hook for each cable type (data, voice, video, security, public address, clock, etc.) and shall supply and spare J-hook for future growth. All J-hooks shall be installed four (4') to five (5') feet on center, using only manufacturer approved installation methods and materials.

      The Contractor is responsible for the establishment of all cable pathways supported by J-hooks and as such shall coordinate pathways with all other disciplines. Under no-circumstances shall J-hook pathways for structured cabling be used to support other low-voltage applications such as HVAC, Fire Alarm, etc.

4. Equipment Rooms/Telecommunications Room
   a. The Contractor shall furnish and install 8’ h x 4’ x ¾” w sheets of fire rated plywood on all walls in each Equipment Room/Telecommunications Room as indicated in the technology drawings. The Contractor shall paint the plywood with two (2) coats of Contractor furnished fire retardant paint leaving one (1) fire rated stamp visible per sheet of plywood.
   b. Ladder Racks
The Contractor shall furnish and install overhead ladder rack in each Equipment Room and/or Telecommunications Room as indicated on the communication drawings. Overhead ladder racks shall be installed using manufacturer approved hardware and installation methods and shall be grounded and bonded.

The Contractor shall furnish and install vertical sections of ladder rack to ensure the ladder rack provides for a smooth transition and support for all cable as the cable transitions from the Equipment Room and/or Telecommunications Rooms to the above ceiling cable pathway.

The Contractor shall furnish and install radius drops for the ladder rack where cables drop from a vertical segment of the ladder rack or exits the horizontal section of the ladder rack to termination equipment, racks, etc.

c. Relay Racks

The Contractor shall furnish and install relay racks with double sided vertical management in each Equipment Room and/or Telecommunications Room as indicated on the communication drawings. Relay racks shall be installed using manufacturer approved hardware and installation methods. Relay racks shall be secured to overhead ladder rack, grounded and bonded.

4. Grounding and Bonding

a. Telecommunications Main Grounding Busbar

The Contractor shall furnish and install a 4” x 20” x ¼” solid copper ground busbar in Equipment Room TR1.0 as indicated on the technology drawings.

b. Grounding Electrode Conductor

The Contractor shall furnish and install a #6 AWG solid copper conductor between the Main Ground Busbar and the main electrical building ground.

c. Telecommunications Grounding Busbar

The Contractor shall furnish and install a 4” x 10” x ¼” solid copper ground busbar in each Telecommunications Room as indicated on the technology drawings.

d. Telecommunications Bonding Backbone

The Contractor shall furnish and install a #6 AWG solid copper conductor in a star topology between the Main Ground Busbar inside the Equipment Room to each Telecommunications Ground Busbar in each Telecommunications Room as indicated on the technology drawings.

e. Equipment Bonding Conductor

The Contractor shall furnish and install a #6 AWG solid copper conductor from the ground busbar in each Equipment Room and/or Telecommunications Room to each applicable piece of contractor furnished and installed equipment. All contractor-furnished and installed equipment shall be properly bonded and grounded in accordance with ANSI/TIA/EIA-607.

5. System Labeling

A specific labeling scheme will be coordinated with the Owner and provided to the Contractor. The Contractor shall not permanently label any part of the structured cabling until the specific labeling scheme has been provided to the Contractor.

In general, the Contractor shall be required to provide the following type of labeling:

a. Inter-Building Cable

The Contractor shall furnish and install Machine generated wrap around type labels on each end of the cable indicating origin and destination.

b. Intra-Building Cable

The Contractor shall furnish and install Machine generated wrap around type labels on each end of the cable indicating origin and destination.

c. Horizontal Cable

The Contractor shall furnish and install Machine generated wrap around type labels on each end of the cable indicating origin and destination.

d. Terminations
- Fiber Optic
  The Contractor shall label fiber optic distribution shelves in accordance to manufacturer guidelines and ANSI/TIA/EIA-606.

- Copper
  The Contractor shall label 110 blocks in accordance to manufacturer guidelines and ANSI/TIA/EIA-606.

- Faceplates
  The Contractor shall label workstation faceplates in accordance to manufacturer guidelines and ANSI/TIA/EIA-606.

3.4 TESTING REQUIREMENTS

A. Fiber Optic Cable
   1. All fiber optic cable links installed shall be tested in accordance with the field test specifications defined in ANSI/TIA/EIA-568-C standard.
   2. 100% of the installed cable shall be tested and must pass the requirements of ANSI/TIA/EIA-568-C.
   3. Failing links shall be diagnosed and corrected by the Contractor. Corrective actions shall be followed by a new test of the previously failing link(s). The Contractor shall promptly submit all link re-test data to Architect/Engineer in both hard and soft copy.
   4. Only Certified Technicians shall perform all fiber optic link testing.
   5. Field test equipment for multi-mode fiber optic cables shall meet the requirements of ANSI/TIA/EIA-526-14A.
   6. The light source shall meet the launch requirements of ANSI/TIA/EIA-455-50B.
   7. Field test equipment for single-mode fiber optic cables shall meet the requirements of ANSI/TIA/EIA-526-7.
   8. All fiber optic launch cables and test adapters used for testing shall be of high quality and devoid of excessive wear or exhibit anomalies between strand tests. Test results that indicated anomalies between strands within the same sheath shall be declared a failure unless all strands within the same sheath unconditionally pass testing. The Contractor shall diagnose and repair any fiber optic cable exhibiting strand-to-strand anomalies that result in any test failure(s).
   9. The Contractor shall test and certify all fiber optic cable plant with approved field tester(s) that are within their calibration period. The Contractor shall be liable for all re-testing required in the event tests are performed with un-approved test equipment or tester(s) that are not within their calibration period.
   10. The Contractor shall invite the Architect/Engineer to witness/verify field testing prior to final acceptance. The Architect/Engineer shall randomly select 5% of the installed links for test verification purposes. The Contractor shall re-test these links in the presence of the Architect/Engineer and the results shall be compared to the previously Contractor submitted test results. In the event that 2% of the verification tests differ in terms of pass/fail from the previously submitted test results, testing shall be declared a failure and the Contractor shall re-test 100% of the installed links with the cost of such tests borne by the Contractor.
   11. Fiber optic connector attenuation shall not exceed 0.75dB.
   12. Fiber optic splice attenuation (if allowed) shall not exceed 0.3dB.
   13. Multi-mode fiber optic cables shall be tested using the following attenuation coefficient parameters:
       a. 50/125 Multi-mode 850nm ≤ 3.5dBI/km
       b. 50/125 multi-mode 1300nm ≤ 1.5dBI/km
   14. Single-mode fiber optic cables shall be tested using the following attenuation coefficient parameters:
       a. 9/125 single-mode (Inside Plant) 1310 ≤1.0dBI/km
       b. 9/125 single-mode (Inside Plant) 1550 ≤1.0dBI/km
15. Link attenuation for all fiber optic strands shall be calculated using the ANSI/EIA/TIA-568-8 Standards formula.

B. Category 6/6A UTP Cable
1. All Category 6 cable links installed shall be tested in accordance with the field test specifications defined in ANSI/TIA/EIA-568-8.1 standard.
2. 100% of the installed cable shall be tested and must pass the requirements of ANSI/TIA/EIA-568-8.1.
3. Failing links shall be diagnosed and corrected by the Contractor. Corrective actions shall be followed by a new test of the previously failing link(s). The Contractor shall promptly submit all link re-test data to Architect/Engineer in both hard and soft copy.
4. Only Certified Technicians shall perform all Category 6 testing.
5. Field test equipment for Category 6 UTP cables shall meet or exceed the accuracy requirements for enhanced Level II testers as defined in ANSI/TIA/EIA-526-8; Annex I: Section 1.4.
6. All test interfaces used for testing shall be of high quality and devoid of excessive wear or exhibit anomalies between pairs. Test results that indicated anomalies between pairs shall be declared a failure unless all pairs unconditionally pass testing. The Contractor shall diagnose and repair any Category 6 cable exhibiting pair-to-pair anomalies that result in any Fail, *Fail or *Pass conditions.
7. The Contractor shall test and certify all Category 6 cable plant with approved field tester(s) that are within their calibration period. The Contractor shall be liable for all re-testing required in the event tests are performed with un-approved test equipment or tester(s) that are not within their calibration period.
8. Any Fail or *Pass result yields a Fail for the link under test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass.
9. The Contractor shall invite the Architect/Engineer to witness/verify field testing prior to final acceptance. The Architect/Engineer shall randomly select 5% of the installed links for test verification purposes. The Contractor shall re-test these links in the presence of the Architect/Engineer and the results shall be compared to the previously Contractor submitted test results. In the event that 2% of the verification tests differ in terms of pass/fail from the previously submitted test results, testing shall be declared a failure and the Contractor shall re-test 100% of the installed links with the cost of such tests borne by the Contractor.
10. Reported test parameters for Category 6 shall comply with ANSI/TIA/EIA-568-8.1 standard. All measurements shall be tested at a frequency range from 1MHz and 350MHz.
11. Testing shall indicate and record the following for each tested link:
   a. Wire Map
   b. Link Length
   c. Insertion Loss / Attenuation
   d. Near end cross talk Loss (NEXT)
   e. Power Sum NEXT Loss (PSNEXT)
   f. Pair to Pair Loss (ELFEXT)
   g. Power Sum Pair to Pair Loss (PSELFEXT)
   h. Return Loss (RL)
   i. Attenuation to Cross-talk Ratio (ACR)
   j. Power Sum ACR (PSACR)
   k. Propagation Delay
   l. Delay Skew

3.5 PROJECT CLOSEOUT DOCUMENTATION
A. The Contractor shall provide the following to the Owner upon final acceptance and completion of the cable plant installation:

1. One Original Reproducible Drawing indicating the "as-built" condition of the structured cabling as it was installed. As-Built drawings must be provided in original hardcopy format and on a CD-ROM in AutoCAD 2014 or higher. The "as-built" drawings shall use the original scale, indicating exact dimensions and locations of all telecommunication rooms, frames, racks, trays, terminal blocks, patch panels, cable runs, cable pathways, workstation locations, and labeling scheme. These drawings shall be turned over to the Architect/Engineer at the time of final systems acceptance of the cable plant installation. Final payment will not be made until these drawings are received and approved by the Architect/Engineer.

2. One set of Power Meter and Light Source Fiber Optic Tests in accordance with Section 3.4 of this specification in electronic and hardcopy. Electronics shall be provided on CD. Final payment will not be made until these test results are received and approved by the Architect/Engineer. Test documentation shall be bound, sectioned and tabbed in the following order:
   - Intra-Building Fiber Optic Cable

3. One set of Category 6 Test results for each cable drop in accordance with Section 3.4 of this specification in electronic and hardcopy. Electronics shall be provided on CD. Final payment will not be made until these test results are received and approved by the Architect/Engineer. Test documentation shall be bound, sectioned and tabbed in the following order:
   - Horizontal 4-Pair UTP Data Cable
   - Horizontal 4-Pair UTP Voice Cable

4. One original Manufacturer Certificate of Warranty for the Structured Cable System

5. One original warranty information to include the name, address and phone number contacts for warranty call outs. Final payment will not be made until this warranty information is received and approved by the Architect/Engineer.

6. Two duplicate copy sets of the above documentation.

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 SCOPE

A. The scope of work is to install a complete operational licensed fully addressable fire alarm system with combination smoke/heat detectors in all typical indoor spaces and heat detectors in breezeway and indicated utility spaces. Detectors shall have sounder bases in lieu of providing separate visual or audio-visual appliances.

B. Fire alarm provider shall compute all devices requirements. Contractor shall coordinate power for any expansion panels with electrical contractor and provide 120V circuits as required. Contractor shall bid a complete and working system. Refer to specifications for devices and locations in addition to the floor plan drawings. The contractor shall be responsible prior to bid for a price for a complete system to include; manual stations, detectors, signal equipment, controls, expansion panels, and devices. The drawings are schematic in nature and include approximate locations of devices. The fire alarm contractor shall coordinate the exact location of the visual signaling device in accordance with the candela of the installed devices.

C. Provide software programming for individual testing of devices without putting the building in alarm (walk-thru mode) or shutting down the entire system.

1.3 SUMMARY

A. This Section includes fire alarm systems with detectors and related devices.

1.4 DEFINITIONS

A. FAP: Fire alarm panel.

B. LED: Light-emitting diode.

C. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.5 SYSTEM DESCRIPTION

A. General: Noncoded, addressable-analog system with and automatic alarm initiation; automatic sensitivity control of certain smoke detectors. System shall individually identify each addressable initiating device and other addressable monitor functions.

B. Provide a fully automatic fire alarm in all building.
C. A full system test/inspection shall be provided by the fire alarm Contractor for a period of one (1) year as a part of the contract.

D. The system as described shall be installed, programmed, tested and delivered to the Owner complete and in fully operational condition. The system shall include all necessary hardware, software, raceways and interconnecting wiring to accomplish the requirements of this specification and the Contract Drawings.

1.6 SUBMITTALS

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

B. Shop Drawings: Show details of graphic annunciator.
   1. Wiring Diagrams: Detail wiring and differentiate between manufacturer-installed and field-installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified.
   2. Battery: Sizing calculations.
   3. Floor Plans: Indicate final outlet locations and routings of raceway connections.
   4. Device Address List: Coordinate with final system programming.
   5. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.

C. Coordination Drawings: Plans, sections, and elevations drawn to scale and coordinating installation of smoke detectors, control modules, and relays in ducts and access to them. Show the following near each duct smoke provision of detector installation:
   1. Size and location of ducts, including lining.
   2. Size and location of piping.
   4. Size and location of duct smoke detector, including air-sampling elements.

D. Operating Instructions: For mounting at the FAP.

E. Product Certificates: Signed by manufacturers of system components certifying that products furnished comply with requirements.

F. Installer Certificates: Signed by manufacturer certifying that installers comply with requirements.

G. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Comply with NFPA 72.

H. Maintenance Data: For fire alarm systems to include in maintenance manuals specified in Division 1. Comply with NFPA 72.

I. Submissions to Authorities Having Jurisdiction: In addition to distribution requirements for Submittals specified in Section “Submittals,” make an identical submission to authorities having jurisdiction. Include copies of annotated Contract Drawings as needed to depict component locations to facilitate review. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.

J. Certificate of Completion: Comply with NFPA 72, AHJ, and local amendments.
1.7 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is an authorized representative of the FAP manufacturer for both installation and maintenance of units required for this Project.

B. Manufacturer Qualifications: A firm experienced in manufacturing systems similar to those indicated for this Project and with a record of successful in-service performance.

C. Source Limitations: Obtain fire alarm system components through one source from a single manufacturer.

D. Compliance with Local Requirements: Comply with applicable building code, local ordinances and regulations, and requirements of authorities having jurisdiction.

E. Comply with NFPA 72.

1.8 SEQUENCING AND SCHEDULING

A. Existing Fire Alarm Equipment: Maintain fully operational until new equipment has been tested and accepted. As new equipment is installed, label it “NOT IN SERVICE” until it is accepted. Remove labels from new equipment when put into service and label existing fire alarm equipment “NOT IN SERVICE” until removed from the building.

B. Equipment Removal: After acceptance of the new fire alarm system, remove existing disconnected fire alarm equipment and restore damaged surfaces.
   1. Package operational fire alarm and detection equipment that has been removed and deliver to Owner.
   2. Remove from site and legally dispose of existing material not designated for other disposition.

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cerberus Pyrotronics.
   2. Edwards Systems Technology; Unit of General Signal.
   3. Firetrol.
   4. Fire Lite Alarms, Inc.
   5. Gamewell Co. (The).
   6. Notifier; Div. of Pittway Corp.
   7. Silent Knight.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Control of System: By the FAP.

B. System Supervision: Automatically detect and report open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.

C. Priority of Signals: Automatic alarm response functions resulting from an alarm signal from one zone or device are not altered by subsequent alarm, supervisory, or trouble signals. An alarm signal is the highest priority. Supervisory and trouble signals have second- and third-level priority. Higher-priority signals take precedence over signals of lower priority, even
when the lower-priority condition occurs first. Annunciate and display all alarm, supervisory, and trouble signals regardless of priority or order received.

D. System Reset: All zones are manually resettable from the FAP after initiating devices are restored to normal.

E. System Alarm Capability during Circuit Fault Conditions: System wiring and circuit arrangement prevent alarm capability reduction when an open circuit, ground or wire-to-wire short occurs, or an open circuit and a ground occur at the same time in an initiating device circuit, signal line circuit, or notification-appliance circuit.

F. Loss of primary power at the FAP initiates a trouble signal at the FAP and the annunciator. An emergency power light is illuminated at both locations when the system is operating on the secondary power supply.

G. Smoke detection with alarm verification initiates the following:
   1. Audible and visible indication of an “alarm verification” signal at the FAP.
   2. Activation of a listed and approved “alarm verification” sequence at the FAP and the detector.
   3. General alarm if the alarm is verified.
   4. Cancellation of the FAP indication and system reset if the alarm is not verified.

H. Removal of an alarm-initiating device or a notification appliance initiates the following:
   1. A “trouble” signal indication at the FAP and the annunciator for the device or zone involved.

I. FAP Alphanumeric Display: Plain-English-language descriptions of alarm, supervisory, and trouble events; and addresses and locations of alarm-initiating or supervisory devices originating the report. Display monitoring actions, system and component status, system commands, programming information, and data from the system's historical memory.

1.3 SMOKE DETECTORS

A. General: Include the following features:
   1. Operating Voltage: 24V powered from the fire alarm control panel.
   2. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
   3. Plug-in Arrangement: Detector and associated electronic components are mounted in a module that connects in a tamper-resistant manner to a fixed base with a twist-locking plug connection. Terminals in the fixed base accept building wiring.
   4. Integral Visual-Indicating Light: LED type. Indicates detector has operated.
   5. Sensitivity: Can be tested and adjusted in-place after installation.
   6. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FAP.
   7. Base sounder.

B. Smoke detectors shall be photoelectric type.
   1. Sensor: LED or infrared light source with matching silicon-cell receiver.
   2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.
   3. Integral Thermal Detector: Fixed-temperature type with 135 deg F setting.

C. Duct Smoke Detector: Photoelectric Type.
1. Sampling Tube: Design and dimensions as recommended by the manufacturer for the specific duct size, air velocity, and installation conditions where applied. Detectors shall be capable of self-sensitivity testing and report back to the fire alarm panel. All detectors shall be addressable and resettable from FAP.

2. Provide necessary relays and control module to interface with the fire alarm for damper closure and AHU shutdown.


4. Unit shall have local reset.

5. Provide remote test station and status indicator for duct smoke detectors above hard ceilings or mounted higher than 12 feet AFF.

6. Unit shall be 24V powered from the Fire Alarm Control Panel.

7. Each smoke sensor and its duct housing shall be self-compensating for the effects of air velocity (from 300 to 4000 FPM), temperature, humidity and atmospheric pressure. It shall not be necessary to field adjust the sensitivity to compensate for the above effects.

2.5 OTHER DETECTORS

A. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or rate of rise of temperature that exceeds 15 deg F per minute, unless otherwise indicated.

1. Mounting: Adapter plate for outlet box mounting.


3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FAP.

4. Unit shall be 24V powered from the fire alarm control panel.

5. Sounder base.

2.6 CENTRAL FAP

A. Cabinet: Lockable steel enclosure. Arrange interior components so operations required for testing or for normal maintenance of the system are performed from the front of the enclosure.

1. Identify each enclosure with an engraved, red, laminated, phenolic-resin nameplate with lettering not less than 1-inch high. Identify individual components and modules within cabinets with permanent labels.


2.7 EMERGENCY POWER SUPPLY

A. General: Components include sealed maintenance free battery, charger, and an automatic transfer switch.

1. Battery Nominal Life Expectancy: 20 years, minimum.

B. Battery Capacity: Comply with NFPA 72.

1. Magnetic door holders are not served by emergency power. Magnetic door holders are released when normal power fails.

C. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 percent of the connected system load while maintaining batteries at full charge. If batteries are fully discharged, the charger recharges them completely within four hours. Charger output is supervised as part of system power supply supervision.
D. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.

2.8 WIRE

   1. Low-Voltage Circuits: No. 16 AWG, minimum.
   2. Line-Voltage Circuits: No. 12 AWG, minimum.

B. Power-Limited Circuits: NFPA 70, Types FPL, FPLR, or FPLP, as recommended by manufacturer.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Connect the FAP with a disconnect switch with lockable handle or cover. Install smoke detectors above the FAP and all power supplies.

B. Connect devices to FAP.

C. Ceiling-Mounted Smoke Detectors: Not less than 4 inches from a side wall to the near edge. For exposed solid-joist construction, mount detectors on the bottom of joists. On smooth ceilings, install not more than 30 feet apart in any direction.

D. Wall-Mounted Smoke Detectors: At least 4 inches, but not more than 12 inches, below the ceiling.

E. Smoke Detectors near Air Registers: Install no closer than 60 inches.

F. Duct Smoke Detectors: Comply with manufacturer’s written instructions.
   1. Verify that each unit is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
   2. Install sampling tubes so they extend the full width of the duct.
   3. Install necessary relays and control modules to accomplish mechanical equipment operation upon detector activation.
   4. Provide remote test and remote reset switches.

G. All exterior fire alarm devices shall be weatherproof.

3.2 WIRING INSTALLATION

A. Wiring Method: Wiring installed in non-accessible ceiling cavities shall be installed in metal raceway according to specification section “Raceways and Boxes.” Wiring in accessible ceiling cavities may be installed without raceways were otherwise permitted by code.
   1. Exceptions:
      a. All wiring in mechanical/electrical/equipment rooms shall be in conduit.
      b. All wiring 9’ AFF and below or below ceilings shall be in conduit.

B. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Install conductors parallel with or at right angles to sides
and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Cable Taps: Use numbered terminal strips in junction, pull and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

D. Color-Coding: Red fire alarm plenum rated conductors. Paint fire alarm system junction boxes and covers red.

E. Provide TVSS and grounding for all devices connected to a FA or NAC panel, external to the building conditioned space.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to specification section Electrical Identification.

B. Install instructions frame in a location visible from the FAP.

C. Paint power-supply disconnect switch red and label FIRE ALARM.

3.4 GROUNDING

A. Ground cable shields and equipment according to system manufacturer's written instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes of type, size, location, and quantity as indicated. Comply with installation requirements in Section "Grounding and Bonding.”

D. Ground equipment and conductor and cable shields. For audio circuits, minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

3.5 APPLICATION SCHEDULE

A. General Application: Provide fire alarm devices where indicated on drawings or as scheduled below. Locations on drawings are approximate. Contractor shall coordinate exact locations with architectural drawings. Contractor shall submit locations of fire alarm devices to engineer/architect as part of fire alarm shop drawings. Locations shall be based upon ability to mount the device to building construction and coverage afforded the device.

B. Duct Smoke Detectors: Provide as shown on the drawings and as indicated below (applications may be redundant with drawings).  
1. Duct smoke detectors shall be provided within five feet, with no breaks in the ductwork, of all smoke fire dampers in the direction of airflow. Mount the duct smoke detectors to
provide unrestricted access to the control section and for full removal of the sampling tubes.

2. Duct smoke detectors shall be provided at the discharge to all air handling units and mounted in accordance with NFPA 72.

C. Weatherproof Horn/Strobe: Provide weatherproof horn/strobe for all interior courtyards.

D. Weatherproof Horn: Provide weatherproof horns to be mounted high on exterior wall (coordinate with architectural), audible from any entrance to the building.

E. Detectors in all Areas: Provide with integral sounder bases. Detectors shall have local sounder bases which activate in alarm and provide signal to the FAP.

3.6 MECHANICAL COORDINATION

A. See mechanical duct accessory specification for smoke fire dampers and mechanical drawings for sequences of operation. Provide control circuits, relays, monitor modules as required. Fire alarm system shall be capable of shutting down all dampers and air handlers during a fire alarm activation. Coordinate for sequencing as per duct accessories specification, mechanical specifications, and mechanical sequence of operation.

3.7 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect field-assembled components and connections and to supervise pretesting, testing, and adjustment of the system. Report results in writing.

B. Pretesting: After installation, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the compliance of the system with requirements of Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones, and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

C. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of witnesses to preliminary tests.

D. Final Test Notice: Provide a minimum of 10 days’ notice in writing when the system is ready for final acceptance testing.

E. Minimum System Tests: Test the system according to procedures outlined in NFPA 72. Minimum required tests are as follows:

1. Verify the absence of unwanted voltages between circuit conductors and ground.
2. Test all conductors for short circuits using an insulation-testing device.
3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on record drawings.
4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.
5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
6. Test each initiating and indicating device for alarm operation and proper response at
the control unit. Test smoke detectors with actual products of combustion.

7. Test the system for all specified functions according to the approved operation and
maintenance manual. Systematically initiate specified functional performance items at
each station, including making all possible alarm and monitoring initiations and using all
communications options. For each item, observe related performance at all devices
required to be affected by the item under all system sequences. Observe indicating
lights, displays, signal tones, and annunciator indications. Observe all voice audio for
routing, clarity, quality, freedom from noise and distortion, and proper volume level.

8. Test Both Primary and Secondary Power: Verify by test that the secondary power
system is capable of operating the system for the period and in the manner specified.

F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by
such deficiencies. Verify by the system test that the total system meets Specifications and
complies with applicable standards.

G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed
test results in the form of a test log. Submit log on the satisfactory completion of tests.

H. Tag all equipment, stations, and other components at which tests have been satisfactorily
completed.

3.8 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and
marred finish to match original finish. Clean unit internally using methods and materials
recommended by manufacturer.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel
as specified below:
   1. Train Owner's maintenance personnel on procedures and schedules for starting and
      stopping, troubleshooting, servicing, adjusting, and maintaining equipment and
      schedules. Provide a minimum of 8 hours’ training.
   2. Training Aid: Use the approved final version of the operation and maintenance manual
      as a training aid.
   3. Schedule training with Owner, through Architect, with at least seven days’ advance
      notice.

3.10 ON-SITE ASSISTANCE

A. Occupancy Adjustments: When requested within one year of date of Substantial Completion,
provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual
occupied conditions. Provide up to three requested visits to Project site for this purpose.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION
A. The work covered by this section consists of the installation and maintenance of all erosion siltation control devices, wash down areas, or seeding and sodding applications necessary to effectively prevent storm water pollution of adjoining or downstream areas that may occur as a direct or indirect result of the construction of this project. The contractor is responsible for creating and maintaining the storm water pollution prevention plan by utilizing the base sheets and narrative provided in the bid documents. The contractor is also responsible for submitting the Notice of Intent (NOI) and Notice of Termination (NOT) and conducting inspections as required by the Texas Commission on Environmental Quality (TCEQ). The required forms for these activities are included in the bid documents.

The engineer will provide:
1. Base Sheets for Erosion Control Plan (ECP)
2. The Narrative for the Storm Water Pollution Prevention Plan (SWPPP)

The contractor will generate, submit, and maintain the:
1. ECP
2. SWPPP
3. NOI (if required)
4. NOT (if required)

1.02 SUBMITTALS
A. The contractors shall submit the initial erosion control plan along with the NOI (if required) prior to receiving a notice to proceed.
B. If required, the Contractor is responsible for filing a “Notice of Intent” (NOI). The contractor shall comply with all TCEQ and EPA regulations and pay the filing fees associated with the regulations. Fees associated with these regulations are subsidiary to the bid item Storm Water Prevention. The forms are available at:
C. Said NOI must be postmarked two days before construction begins. NOI’s and NOT’s shall be submitted to the address shown on the forms. It is the Contractor’s responsibility to file and provide the owner a copy of the Notice of Termination (NOT) at the completion of the project.

PART 2 PRODUCTS
N/A

PART 3 EXECUTION

3.01 GENERAL
A. It is the responsibility of the Contractor to utilize whatever techniques are necessary to address erosion problems as they occur during construction.
B. Siltation control and sediment trapping devices shall be installed prior to site clearing, grading or utility construction operations. All devices should be positioned so as to effectively...
remove silt from storm water before it leaves the site. Of particular concern, are gravel or stone blankets placed at construction traffic exits and entrances. These controls should be closely monitored to see that they trap sediment before it reaches the existing street and drainage system.

C. Construction activities should be phased to expose a minimum of graded area at one time. Earth exposed by the construction process shall be re-vegetated every two weeks until vegetation is established. Re-vegetation shall require seeding, hydromulching or sodding. Fresh growth of vegetation shall eliminate the need for additional re-vegetation but does not constitute stabilization.

D. Should a construction process remove any portion of the perimeter controls, the controls should be replaced in accordance with the TCEQ guidelines. Prior to the completion of the project, all bare areas shall be re-vegetated with a cellulose fiber hydromulch seeding process or sodded.

E. Siltation control devices placed at storm drain inlets and culverts shall be removed by the Contractor once the site has been stabilized.

3.02 MAINTENANCE AND INSPECTION

A. The contractor shall familiarize himself with the erosion control requirements of TCEQ. The site superintendent, or his representative, shall make a visual inspection of all structural and/or natural controls and newly stabilized areas as required by TCEQ, especially after a rainfall to insure that all controls are maintained and properly functioning. Any damaged controls shall be repaired prior to the end of the work day, including re-seeding and mulching or re-sodding if necessary. All inspections shall be documented with a written report. Reports shall include the effectiveness of erosion control measures, construction activities conducted since the last report and their location. Reports shall be maintained by the Contractor along with the Erosion Control Plan per the TCEQ guidelines.

B. The contractor is responsible for the ECP. The contractor shall continuously update the plan with all changes. Areas already stabilized shall be noted on the plan. All sediment trapping devices shall be installed as soon as practical after the area has been disturbed (never more than 14 days). All sediment trapping devices shall be cleaned when the sediment level reaches 25% capacity. Sediment shall be disposed of by spreading on site or hauling away if not suitable for fill.

END OF SECTION
SECTION 31 5000
TRENCH SAFETY

PART 1  GENERAL

1.01  DESCRIPTION
A. The work specified under this section requires the Contractor to provide for the safety of the workmen in strict compliance with 29 CFR Part 1926 1993 (Revised as of July 1, 1996 of latest Edition or Revision to) Excavations and Applicable Subparts. The submission of a "TRENCH SAFETY PLAN" which shall fully satisfy the requirements of this specification is required prior to a notice to proceed to start the project.

1.02  SUBMITTALS
A. CERTIFICATES
   Submit manufacturer’s “Certificate of Compliance,” stating that the devices (trench boxes, speed shoring, etc.) to be used for trench safety comply with the requirements of this specification. The certificate should show the design assumptions and limitations of the device and should be sealed by an engineer registered and licensed to practice in the state of Texas.

B. TRENCH SAFETY PLAN
   Submit a detailed TRENCH SAFETY PLAN for all work areas. Calculations shall be provided for any areas beyond the capacity of the trench box or speed shoring and sealed by an engineer registered and licensed to practice in the state of Texas. This plan shall include evacuation routes for personnel.

C. COMPETENT PERSON
   Contractor shall have a “Competent Person” with regard to OSHA standards, on site at all times. Competent person is generally defined as an individual who, by training and experience, is knowledgeable of applicable standards, capable of identifying hazards, is designated by the employer, and has the authority to take actions as needed. Contractor shall provide written proof showing the competent person(s) for the work being performed.

PART 2  PRODUCTS

2.02  MATERIALS
A. MATERIALS
   1. Timber
      Trench sheeting materials shall be full size, a minimum of 2 inches in thickness, solid and sound, free from weakening defects such as loose knots and splits.

   2. Sheet Piling
      Steel sheet piling shall conform to one or more of ASTM A328/328M, ASTM A572/A572M/ ASTM A690/A690M material requirements.

   3. Structural Steel
      Steel for stringers (wales) and cross braces shall conform to ASTM A588.

   4. Trench Boxes
      Steel trench Boxes to be constructed of steel conforming to ASTM A36/A36M. Connecting bolts used to conform to ASTM A307. Welds shall conform to the requirements of AWS D1.1.
5. Miscellaneous

Miscellaneous materials to be utilized shall conform to applicable ASTM standards.

B. REFERENCED SPECIFICATIONS

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

American Society of Testing and Materials (ASTM)

ASTM A307 1997 Revision A-Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi tensile length
ASTM A328/A328M 1996 (REV) Standard Specification for Steel Sheet Piling
ASTM A572/A572M 1997 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality
ASTM A588/A588M 1997 Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4 inch (100 mm) thick
ASTM A690/A690M 1994 Standard Specification for High-Strength Low-Alloy Steel H-Pipes and Sheet Piling for Use in Marine Environments

American Welding Society, Inc. (AWS)

AWS D1.1 1998 Structural Welding Code-Steel

Occupation Safety and Health Administration (OSHA)

29 CFR Part 1926 1993 (Revised as of July 1, 1996 of latest Edition or Revision to) Excavations and Applicable Subparts

PART 3 EXECUTION

3.01 CONSTRUCTION METHODS

A. GENERAL:

The trench safety system shall be constructed, installed and maintained in accordance with the Trench Safety Plan. Bed and backfill pipe to a point at least one (1) foot above top of pipe or other embedded items prior to removal of any portion of trench safety system. Bedding and backfill shall be in accordance to other applicable Specification Sections. Backfilling and removal of trench supports shall be in accordance with Contractor’s Trench Safety Plan. Removal of trench safety system to be accomplished in such a manner to cause no damage to pipe or other embedded items. Remove no braces or trench supports until all personnel have evacuated the trench. The trench shall be backfilled to within 5 feet of natural ground prior to removal of entire trench safety system.

B. SUPERVISION:

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 Section are sufficient to meet requirements of OSHA Standards.

C. INSPECTION:
The CONTRACTOR shall make daily inspection of trench safety system to ensure that the system meets OSHA requirements. Daily inspection shall be made by competent personnel. If evidence of possible cave-ins or slides is apparent, all work in the trench is to cease until necessary precautions have been taken to safeguard personnel entering trench. The CONTRACTOR shall maintain permanent record of daily inspections.

D. TIMBER SHEETING

Timber sheeting and size of uprights, stringers (wales,) and cross bracing to be installed in accordance with the TRENCH SAFETY PLAN. Place cross braces in true horizontal position, spaced vertically, and secure to prevent sliding, falling or kick outs. Cross braces to be placed at each end of stringers (wales) in addition to other locations required. Cross braces and stringers (wales) to be placed at splices of uprights, in addition to other locations required.

E. STEEL SHEET PILING

Steel sheet piling of equal or greater strength may be used in lieu of timber trench shoring shown in the OSHA tables (proposed standards). Drive steel sheet piling to a least minimum depth below trench bottom as recommended by CONTRACTOR’s Registered Licensed Professional Engineer providing design. Place cross braces in true horizontal position and spaced vertically. Secure to prevent sliding, falling, or kick outs. Cross braces to be placed at each end of stringers (wales), in addition to other locations required.

F. MAINTENANCE OF SAFETY SYSTEM

The safety system to be maintained in the condition as shown on the Trench Excavation and Shoring Safety Plan as designed by the CONTRACTOR’s Registered Licensed Professional ENGINEER. The CONTRACTOR shall take all necessary precaution to ensure the safety systems are not damaged during their use. If at any time during its use a safety system is damaged, personnel to be immediately removed from the trench excavation area and the safety system repaired. The CONTRACTOR is to take all necessary precautions to ensure no loads, except those provided for in the plan, are imposed upon the trench safety system.

END OF SECTION
SECTION 32 1613
CONCRETE SIDEWALK

PART 1 GENERAL
1.01 DESCRIPTION
This item shall consist of Reinforced Concrete Sidewalk constructed on approved subgrade in conformity with the lines and grades established by the City Engineer. Sidewalks shall also be in accordance with the standard section, specifications and ordinances for sidewalks adopted by the city in which sidewalk is to be placed.

1.02 SUBMITTALS
See SECTION 03 3010 – SITE CONCRETE.

PART 2 PRODUCTS
2.01 MATERIALS
This item shall consist of a mixture of reinforcing steel, coarse aggregate, fine aggregate, cement and water. The mixture shall conform to SECTION 03 3010 – SITE CONCRETE.

2.02 TESTING REQUIREMENTS
See SECTION 03 3010 – SITE CONCRETE.

PART 3 EXECUTION
3.01 GENERAL
A. The subgrade shall be excavated and fine graded to a true grade. Any backfill shall be watered and tamped well ahead of the placing of the concrete. If dry, the subgrade shall be sprinkled immediately before depositing any concrete. Forms shall be metal or wood, free of warp and of a depth equal to the depth of the concrete. They shall be secured and accurately staked to line and grade and held in a true position during the placing of the concrete. Expansion joints of an approved material shall be used between the sidewalk and all abutting concrete. Placement of concrete may begin after the subgrade is thoroughly compacted and the forms, expansion joints (where necessary) and reinforcing steel are in place. The concrete shall be thoroughly worked with a flat spade or similar tool along the forms as the pouring continues to insure the absence of honeycombs. No concrete over thirty (30) minutes old or retempered concrete shall be used. After the placing of the concrete has sufficiently advanced, the concrete shall be struck off flush with the forms. Then the concrete shall be worked with a wooden float to flush excess mortar to the surface. All exposed corners are to be edged or rounded to the radius shown on the Plans.

B. Unless otherwise shown on the plans, the walk shall be cut transversely with a jointing tool at a width equal to the sidewalk width after the concrete has been thoroughly worked and has sufficiently set. Expansion joints shall be located every forty (40) feet.

C. After the finished concrete has sufficiently set, it shall be covered with burlap and kept wet for a period of four (4) days. As an alternate the concrete may be cured by the application of a clear membrane seal coat that will retain 85% of the original mixing water at the end of three (3) days.

D. After the construction work has been completed, the Contractor shall remove all debris, trash, excess materials, forms, stakes, empty sacks, etc. occasioned by his work from the premises. The site shall be left with a neat appearance. All excavation shall be backfilled and all excess excavated materials shall be disposed of.

END OF SECTION
PART 1 - GENERAL
1.1 SECTION INCLUDES
A. Work specified in this section: Provide all labor, materials, transportation, and services necessary to furnish tree protection fencing, tree armor, watering, pruning and fertilization to existing trees.

1.2 RELATED WORK
A. The requirements of the "General and Supplementary Conditions of the Contract" and Division 1 specification sections shall apply to all work of this Section with the same force and effect as though repeated in full herein.
   1. General Scope of Work and Requirements - Section 00 1000.
   2. Irrigation System: Section 32 8423.
   3. Landscape Planting: Section 32 9300.

1.3 REFERENCES
A. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1.4 GOVERNING STANDARDS:
A. Work procedures will be guided by the current provisions of the American National Standard Institute. Complete detail of the provisions are to be found in the references listed. The two basic objectives of the pruning operation shall include:
   1. Hazard Reduction Pruning: Hazard reduction pruning shall be completed to remove visible hazards in a tree. Hazard pruning shall consist of one or more of the maintenance pruning types.
   2. Maintenance Pruning: Maintenance pruning shall be completed to maintain and improve tree health and structure and includes hazard reduction pruning.

1.5 DESCRIPTION OF WORK
A. Contractor shall employ a qualified Arborist to monitor construction activities that impact trees, pruning and feeding. Arborist is to be acceptable to the Owner’s Representative.
B. Arborist shall have the following minimum qualifications:
   1. Membership in:
      a. NAA - National Arborist Association
      b. ISA - International Society of Arborists
   2. Meet state requirements for insurance.
   3. Licensed for application and use of pesticides.
   4. Bonded.

1.6 SUBMITTALS
A. Contractor shall submit:
   1. Certification: Copy of Arborist qualifications.
   2. Mulch: Label from bag (Supplier’s statement of analysis if bulk), and 1-gallon container of mulch sample.
   3. Fertilizer: Label from bag or Supplier’s brochure.
   4. Tree Armor: Cut sheet of wood and plywood.
1.7 QUALITY ASSURANCE AND REQUIREMENTS
A. General: Comply with applicable federal, state, county, and local regulations governing, landscape materials and work.
B. Permits and Fees: The Contractors shall obtain and pay for any and all permits and all inspections as required. Contractor shall also be responsible for all fees and costs involved for work.
C. Ordinances and Regulations: All local, municipal and state laws, and rules and regulations governing or relating to any portion of this work are hereby incorporated into and made a part of these specifications, and their provisions shall be carried out by the contractor. Anything contained in these specifications shall not be construed to conflict with any of the above rules and regulations or requirements of the same. However, when these specifications and drawings call for or describe materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by the above rules and regulations, the provisions of these specifications and drawings shall take precedence.
D. Personnel: Personnel shall be supervised by a Certified Arborist. Employ only experienced personnel who are familiar with the required work. Provide adequate supervision by a qualified foreman with minimum of five years experience.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING
A. Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery and while stored at site.

1.9 PROJECT CONDITIONS
A. Inspection: Contractor, Arborist and Owner’s Representative shall review pruning work to be completed prior to initiating work.

1.10 SCHEDULES
A. The Contractor shall begin pruning and tree protection work upon acceptance of the Contract by the Owner. Arborist shall submit a schedule for the work to be performed to the Landscape Architect for approval.

1.11 PROTECTIONS
A. All items required to complete this contract remain the property and responsibility of the Contractor until final acceptance. Take adequate precautions to protect all existing trees. Cooperate fully with other trades to insure a satisfactory completion.

1.12 MAINTENANCE SERVICE
A. All existing trees to remain within shall have 6” layer of mulch at Root Protection Zone (RPZ) and to dripline and tree protection fencing properly maintained throughout construction work period.

PART 2 - PRODUCTS
2.1 MATERIALS
A. Tree Barricade Fencing: Fabric of square link orange 4’ width, high density polyethylene with 5-7 year life. Posts of 6’ height studded T-posts with painted on finish for rust protection.
B. Mulch:
1. Mulch shall be free of deleterious material and shall be stored as to prevent inclusion of foreign material. Mulch shall be native shredded hardwood mulch, manufactured by Gardenville Horticultural Products, San Antonio, Texas, 210/651-6115.
2. On-site existing tree mulch: Existing trees that are scheduled to be removed and removed branches may be grinded/double shredded and debris free.
C. Tree Wound Paint: Bituminous based paint of standard manufacture specifically formulated for tree wounds.
D. Fertilizer for Trees: Davey Arbor Green 30-10-7 for liquid suspended application, distributed by The Davey Company in San Antonio, Texas (210) 698-0515.

E. Tree Armor:
   1. Wood: SPFA utility grade, 2x4.
   2. Plywood: SPFA utility grade, 3/4" nominal thickness.
   3. Wire: Annealed steel wire, 16 gage minimum.

PART 3 - EXECUTION
3.1 PROTECTION FOR EXISTING TREES TO BE PRESERVED
A. All existing trees to remain within 30’ of work on the project site shall be protected against damage from construction operations. Only remove those trees which are scheduled to be removed per plans. Contractor shall flagged tree to remain for review by Landscape Architect.

B. Contractor shall erect fencing protection prior to beginning any clearing, demolition or construction activity, maintain in place until construction is completed.

C. All trees to remain are to be protected by barricade fencing and is subject to approval of the Landscape Architect. The tree protection barricade shall be placed before any excavating or grading is begun and maintained in good repair for the duration of the construction work. No material shall be stored or construction operation shall be carried on within the tree protection barricade.

D. Trees exposed to construction activity within the dripline or within twenty-five (25) feet of any construction activity are to have trunks protected with tree armor. See requirements per tree armor section of this specification.

E. Tree protection barricade shall be erected at the edge of the dripline where possible. In circumstances where site improvements and construction operations interfere with fencing, fencing may be located at the edge of the root protection zone. The minimum distance the barrier shall be erected is five (5) feet from the trunk of tree or clump of trees.

F. Protect trees that are to remain, whether within barricade fencing or not, from the following:
   1. Compaction of root area by equipment or material storage; construction materials shall not be stored closer to trees than the farthest extension of their limbs (dripline).
   2. No vehicular traffic shall occur within the drip line of any tree.
   3. The proposed finished grade within the root protection zone of any preserved tree shall not be raised or lowered more than three (3) inches. Retaining methods can be used to protect and/or provide lateral support to the area outside the root protection zone. No soil shall be spread, spoiled or otherwise disposed of under any tree within the drip line.
   4. Cutting on roots by excavating, ditching, etc. Prior to excavation within the tree driplines or the removal of trees adjacent to other trees that are to remain, make a clean cut between the disturbed and undisturbed root zones with a rock saw or similar equipment to minimize root damage.
   5. Strangling by tying ropes or guy wires to trunks or large branches.
   6. Poisoning by pouring solvents, gas, paint, etc., on or around trees and roots.
   7. Trunk damage by moving equipment, material storage, nailing or bolting.
   8. Damage of branches by improper pruning.
   9. Drought from failure to water or by cutting or changing normal drainage pattern past roots. Contractor shall provide means as necessary to ensure positive drainage.
   10. Changes of soil pH factor by disposal of lime base materials such as concrete, plaster, lime treatment at pavement subgrade, etc. When installing concrete adjacent to the root zone of a tree, use a minimum 6 mil. plastic vapor barrier behind the concrete to prohibit leaching of lime into the soil.

G. Any damage done to existing tree crowns or root systems shall be repaired by the Arborist to the satisfaction of the Owner’s Representative. Broken branches shall be cut cleanly. Any roots cut shall be cut cleanly with a saw other means approved by the Landscape Architect.
H. Repairs to the trees necessitated by damage caused through negligence of Contractor or his employees will be completed at the Contractor's expense. When trees other than those approved for removal are destroyed or killed, or badly damaged as a result of construction operations, the contract sum will be reduced by the value of the tree as determined by using the accepted International Society of Arboriculture's formula.

3.2 TREE ARMOR
A. All trees exposed to construction activity within the dripline and within the limits of construction are to have trunks protected with tree armor to a height of 8' or to the limits of the lower branching in addition to barricade fencing. Butt 2x4's side to side completely around trunk. Wire wrap, do not nail, around trees. Maintain armor the duration of construction operations.

B. Where existing trees will be Root Zone (RPZ) shall be protected by plywood. Install 6" of shredded bark mulch and cover with 3/4" plywood. Install both to dripline of tree(s).

C. Remove one week prior to Substantial Complete walk through.

3.3 ROOT PROTECTION ZONE
A. The root protection zone (RPZ) is measured with a radius from the trunk of 12" for each caliper inch of trunk measured at four and one-half (4-1/2') feet above grade or at the point where the smallest diameter closest to the branching occurs. No disturbance shall occur closer to the tree than one-half the radius of the RPZ or within five (5) feet of the tree whichever is greater.

3.4 ROOT PROTECTION ZONE IMPACTS
A. Those trees to remain which have some encroachment on their root protection zone shall have the following maximum allowable impacts:
   1. No disturbance of natural grade, e.g. trenching or excavation, can occur closer to the tree than one-half the radius of the RPZ or within five (5) feet of the tree whichever is greater.
   2. No cut or fill greater than three (3) inches will be located closer to the tree trunk than $\frac{1}{2}$ the RPZ radius distance.

B. Existing trees to remain shall have a minimum of a six (6) inch layer of mulch placed and maintained over the root protection zone and to the dripline. Immediate pruning and shall occur per the pruning sections of this specification.

3.5 ARBORIST'S REQUIREMENTS
A. General:
   1. Arborist is to survey the condition of existing trees to remain. Notify Landscape Architect of any problems/conditions affecting the livability of trees to remain. Document site as necessary.
   2. Arborist is to install and/or inspect tree protection barriers before start of demolition and excavation activities. Notify Landscape Architect of any problems/conditions that affect the livability of trees to remain.
   3. Arborist is to observe excavation of site around existing trees from start of excavation until its conclusion. Arborist shall direct excavation which occurs near major root systems, relocation of roots, and installation of tree aeration systems as required to ensure livability and good health of trees. Arborist shall prescribe additional measures or protection required to provide optimal growth conditions at the construction site. Report any problems/conditions affecting the livability of trees to remain to Landscape Architect.
   4. Arborist shall make periodic inspections of the construction site for possibly dangerous or damaging practices, in relation to the existing trees, occurring or developing at the site. Inform Landscape Architect of any problems/conditions and develop plan to repair damage that has occurred and prevent further damage.
B. Reports:

Arborist shall provide a monthly inspection report of the construction site to the Landscape Architect during the course of construction work.

3.6 EXCAVATION AT EXISTING TREES

A. Any excavation within the dripline of trees shall be under the direction of the Arborist. Excavate within the dripline of trees only where required and when absolutely necessary. Arborist shall be at site at all times while excavation is occurring within the dripline.

B. When excavation is required within dripline of trees, hand excavate to minimize damage to root systems. Use narrow tine spading forks and comb soil to expose roots. Relocate roots back into backfill areas wherever possible. If large main lateral roots are encountered, expose beyond excavation limits as required to bend and relocate without breaking.

C. If root relocation is not practical, clean cut roots using sharp ax approximately three (3) inches back from new construction. Paint all exposed root cuts with tree paint.

D. Where existing grade is higher than new finish grade, carefully excavate within the dripline to the new finish grade. Carefully hand excavate an additional eight (8) inches below the finish grade. Use narrow tine spading forks to comb the soil to expose the roots, and prune the exposed root structure as recommended by the Arborist. Keep the exposed roots damp by watering and mulch cover. Treat the cut roots as specified and as recommended by the Arborist. After pruning and treatment of the root structure is complete, backfill to finish grade with eight (8) inches of approved plant mix.

E. Temporarily support and protect roots against damage until permanently relocated and covered with recommended landscape material.

F. Where trenching is to occur within hitting distance of equipment to tree trunk, install tree armor per tree armor section of this specification.

G. Where removal of existing trees comes in conflict with existing hardscape/utilities to remain, the contractor shall:
   a. Coordinate with utility companies (if necessary)
   b. Remove existing tree to grade.
   c. Expose roots
   d. Use chainsaw to cut roots
   e. Grind stump 18" below grade
   f. Use trencher 2’-3’ deep to cut roots if necessary.

3.7 WATERING REQUIREMENTS

A. Drought is defined as a protracted period of deficient precipitation resulting in extensive damage to plants, trees and lawn, resulting in loss.

B. During construction operations, provide water in a slow drip manner to existing trees. Provide water to apply equivalent to 1 inch once per week to deeply soak in over the area within the dripline of the tree. Spray tree crowns periodically to reduce dust accumulation on the leaves.

C. At Stage 2, 3 and 4 (Section 1.4, B. Watering Restrictions), install drip line (gallons per hour) within the dripline of the trees at grade. Install required drip valves with filters and pressure regulators with battery operated controllers. Install 6" of mulch over drip irrigation. Protect valves as required. All zones of temporary irrigation shall contain an isolation ball valve to separate from permanent irrigation system.

3.8 PRUNING

A. Pruning shall be required only at protected existing trees where the removal of limbs and branches is needed to provide clearance for work as approved by the Owner’s Representative or to repair damage to trees. Pruning shall be done per 3.9 Schedule. Pruning shall be completed to the satisfaction of the Owner’s Representative.

B. Pruning shall include but is not limited to removal of dead and broken branches, correction of
structural defects or whenever the following conditions exist. Remove diseased wood, or structurally weak limbs that may cause a safety hazard. Remove branches that extend over buildings. Remove branches in front of windows and which obstruct traffic signs or street intersections. Provide clearance for emergency vehicles, buses, moving vans and similar vehicles along the streets. Prune trees according to their natural growth characteristics leaving trees well shaped and balanced.

C. Remove all ball moss, mistletoe, etc. from all existing trees.

3.9 SCHEDULE
A. Pruning shall be Class 1 Fine Pruning. All pruning shall be completed to accomplish the thinning of live branches. Thinning shall result in an even distribution of removal of branches on individual limbs and through-out the crown. Remove dead, dying, diseased and broken branches ½” in diameter or larger within the crown. No more than 25% of the crown shall be removed.

3.1 TREE CROWN PRUNING
A. Existing trees disturbed by construction shall have a maximum of 30 percent of the viable portion of a tree’s crown removed as approved by the Owner’s Representative. Removal of more than 30 percent of the viable portion of a tree’s crown will necessitate the tree’s removal and replacement at the Contractor’s expense. Replacement shall be governed at the ratio of 1 inch of new tree per inch of tree removed up to trees of size less than 24” caliper. For trees 24” caliper and greater the ratio shall be 3 inches per new tree per inch of tree removed. Replacement trees shall have permanent irrigation bubblers and a one (1) year warranty. Refer to Section 02900.

3.2 STERILIZATION: All tools used will be sterilized with alcohol between trees.

3.3 PAINT CUTS: Paint all cuts with an approved tree wound paint on all Oak species trees.

3.4 DISPOSAL: Wood and debris shall become property of the Contractor and shall be removed from the site. Cost of disposal to be paid by Contractor.

3.5 FERTILIZATION OF PRESERVED TREES:
A. All existing trees that have root damage shall be fertilized. Feeding of existing trees shall be as follows:
   1. Feeding shall be completed prior to construction of permanent improvements adjacent to all trees including site fill or paving including trenching operations.
   2. Liquid tree fertilizer applied with a standard hydrant sprayer at a pressure of 100 to 200 psi shall be injected in slightly slanted holes approximately twelve (12) inches in depth.
   3. Concentration of suspension to be forty (40) pounds of fertilizer for trees in each 100 gallons of water. Application rate: six (6) pounds of actual nitrogen per 1,000 square feet of area under drip-line.
   4. Holes are to be made in concentric circles and 3’ on center around the tree with the last ring located at the dripline of the foliage of the trees.
   5. Area beneath the dripline of the trees is to be well watered after the fertilization is placed.

3.6 MULCH:
A. Mulch base of all existing trees with 6” deep mulch layer to RPZ or dripline which ever one is larger. If existing trees are grouped, the entire area is to be mulched in between the trees.
B. If acceptable to Owner, wood from tree removal and pruning activities can be grinded/ double shredded and used on site as mulch at locations as approved by Owner’s Representative.
3.7 CLEANUP:
A. Wood and debris shall become property of the Contractor and shall be removed from the site. Cost of disposal to be paid by Contractor.

END OF SECTION
PART 1 GENERAL
1.01 DESCRIPTION
A. This item shall govern the furnishing of materials and for placement of filter fabric as indicated on the Drawings or directed by the Engineer or designated representative. Filter Fabric shall have the capability for allowing the passage of ground water through it without transporting the soil placed around the filter fabric.
B. This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

1.02 SUBMITTALS
The submittal requirements of this specification item include:
A. catalog cuts,
B. samples of material selected,
C. testing results,
D. manufacturer's recommended installation procedures, and
E. manufacturer certification of compliance with this specification.

PART 2 PRODUCTS
2.01 MATERIALS
A. General
1. The fabric shall be constructed exclusively of synthetic thermoplastic fibers and may be either woven or non-woven to form a mat of uniform quality. Fabric fibers may be either continuous or discontinuous and oriented in either a random or an aligned pattern throughout the fabric. The fabric shall be mildew resistant, rot proof and shall be satisfactory for use in a wet soil and aggregate environment. The fabric shall contain ultraviolet stabilizers and shall have non-raveling edges.
B. Physical Requirements
1. The fabric shall meet the requirements of table 1, when sampled and tested in accordance with the methods indicated in the table below.
2. All material shall be shipped with suitable wrapping to protect the fabric during shipping and storage at the job site.

PART 3 EXECUTION
3.01 CONSTRUCTION METHODS
A. The submittal requirements shall be completed before any materials are ordered.
B. The "Filter Fabric" shall be installed in accordance with the manufacturer's recommendations, as indicated on the Drawings or as directed by the Engineer or designated representative. When lapping is required, it shall be in accordance with the manufacturer's recommendations. Backfilling around the Filter Fabric shall be done in such a manner that the Filter Fabric material will not be damaged during the placement.
<table>
<thead>
<tr>
<th>Original Physical Properties</th>
<th>Test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fabric weight (mass), on an ambient temperature air-dried tension free sample, expressed in oz/ sq. yd (grams/ square meter)</td>
<td>TxDOT Tex-616-J*</td>
<td>Underdrains/Slope Stabilization</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.0 (135) minimum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gabions and Revet Mattresses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0 (200) minimum</td>
</tr>
<tr>
<td>Water flow rate by falling head method, 7.9 inches (20 cm) to 3.9 inches (10 cm) on 2 inch (50 mm) ID cylinder with 1 inch (25 mm) diameter orifice, with flow rate expressed in gal/sq.ft/minute (liters/square meter/minute).</td>
<td>TxDOT Tex-616-J*</td>
<td>80 (3,260) minimum</td>
</tr>
<tr>
<td>Breaking load in either machine or cross-machine direction, expressed in pounds (newtons)</td>
<td>ASTM D-1682 grab method G**</td>
<td>100 (445) minimum</td>
</tr>
<tr>
<td>Equivalent opening size for US Standard (SI) sieves.</td>
<td>CW-02215</td>
<td>70 to 100 (212 to 150µm)</td>
</tr>
<tr>
<td>&quot;Apparent elongation&quot; at breaking load in either machine or cross-machine direction, expressed as percent</td>
<td>ASTM D-1682 grab method G**</td>
<td>100 maximum</td>
</tr>
</tbody>
</table>

* TxDOT Tex-616-J, "Testing of Construction Fibers

** ASTM D 1682 grab method G, "Test Methods for Breaking Load and Elongation of Textile Fabrics" as modified by TxDOT Test Method Tex-616-J


END OF SECTION
PART 1 - GENERAL
1.01 DESCRIPTION
A. This item governs the construction of a stabilized pad of crushed stone located at any point where traffic will be entering or leaving a construction site to or 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 deposition of sediment onto public right of way.
B. This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

1.02 SUBMITTALS
The submittal requirements for this specification item shall include:
A. Source, type and gradation of rock
B. Drainage technique (i.e. drainage swale or entrance grading) proposed to prevent runoff from exiting the construction site.

PART 2 - PRODUCTS
2.01 MATERIALS
Aggregate for construction shall conform to the following gradation:

|Table 1: Aggregate Gradation Chart (TEX 401-A, % Retained per sieve) |
|---------------------------------|-------------|
|US 5 inch (SI 125 mm)           |US 3 inch (SI 75 mm)|
|0                               |100           |

PART 3 - EXECUTION
3.01 CONSTRUCTION METHODS
A. All trees, brush, stumps, obstructions and other objectionable material shall be removed and disposed of in a manner that will not interfere with the excavation and construction of the entrance as indicated on the Drawings. The entrance shall not drain onto the public right of way or shall not allow surface water runoff to exit the construction site.
B. When necessary, vehicle wheels shall be cleaned to remove sediment prior to entrance onto public right of way. When vehicle washing is required, it shall be done on an area stabilized with crushed stone, which drains into an approved sediment trap or sediment basin. All sediment shall be prevented from entering any storm drain, ditch or watercourse through use of sand bags, gravel, boards, silt fence or other methods approved by the Engineer or designated representative.
C. The entrance shall be maintained in a condition that will prevent tracking or disposition of sediment onto public right of way. This restriction may require periodic top dressing with additional stone as conditions demand, as well as the repair and/or cleanup of any measures used to trap sediment. All sediment that is spilled, dropped, washed or tracked onto public right of way must be removed immediately.

END OF SECTION
SECTION 32 4050
SILT FENCE

PART 1 GENERAL

1.0 DESCRIPTION
A. This item shall govern the provision and placement of a filter fabric fence (Environmental Criteria Manual Section 1.4.2.G) including maintenance of the fence, removal of accumulated silt and removal of the silt fence upon completion of the project.
B. This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

1.02 SUBMITTALS
The submittal requirements for this specification item shall include:
A. Source, manufacturer, characteristics and test data for the filter fabric.
B. Manufacturer, characteristics and test data for the posts and wire fence.

PART 2 PRODUCTS

2.01 MATERIALS
A. Fabric
   1. General:
      a. The filter fabric shall be of nonwoven 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 (0.9 meter) wide.
   2. Physical Requirements:
      a. The fabric shall meet the requirements presented in Table 1, when sampled and tested in accordance with the methods indicated herein, on Standard Detail No. 642S-1 and/or on the Drawings.
B. Posts:
   1. Posts shall be painted or galvanized steel Tee or Y-posts with anchor plates, not less than 5 feet (1.5 meters) in length with a minimum weight of 1.3 pounds per foot (1.9 kilograms per meter) 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 A-702.
C. Wire Fence:
   1. Wire fence shall be welded wire fabric 2 x 4 - W1.0 x W1.0 (50 x 100 - MW7 x MW7) and shall conform to Standard Specification Item No. 406, "Reinforcing Steel".
TABLE 1. Filter Fabric Requirements

<table>
<thead>
<tr>
<th>Physical Properties</th>
<th>Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fabric Weight</td>
<td>TEX-616-J</td>
<td>4.5 minimum (150 minimum)</td>
</tr>
<tr>
<td>(ounces per square yard)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(grams/square meter)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Flow Rate</td>
<td>TEX-616-J</td>
<td>40 maximum (1630 maximum)</td>
</tr>
<tr>
<td>(gallons/sq. foot/minute)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(liters/square meter/minute)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equivalent Sieve Opening Size</td>
<td>CW-02215</td>
<td>40 to 100 (425 to 150 µm)</td>
</tr>
<tr>
<td>(US Standard)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(SI Standard sieve size)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mullen Burst Strength</td>
<td>ASTM D-3786</td>
<td>300 minimum (2 minimum)</td>
</tr>
<tr>
<td>(lbs. per sq. inch (psi) megaPascal (mPa))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ultraviolet Resistance</td>
<td>ASTM D-1682</td>
<td>70 minimum</td>
</tr>
</tbody>
</table>

1  TxDoT Test Method Tex-616-J, "Testing of Construction Fabrics".
4  ASTM D-1682, "Test Methods for Breaking Load and Elongation of Textile Fabrics".

PART 3 EXECUTION

3.01 CONSTRUCTION METHODS

A. The silt fence fabric shall be securely attached to the posts and the wire support fence with the bottom 12 inches (300 mm) of the filter material buried in a trench a minimum of 6 inches (150 mm) deep and 6 inches (150 mm) wide to prevent sediment from passing under the fence. When the silt fence is constructed on impervious material, a 12-inch (300-mm) flap of fabric shall be extended upstream from the bottom of the silt fence and weighted to limit particulate loss. No horizontal joints will be allowed in the filter fabric. Vertical joints shall be overlapped a minimum of 12 inches (300 mm) with the ends sewn or otherwise securely tied.

B. The silt fence shall be a minimum of 24 inches (0.6 meter) high. Posts shall be embedded a minimum of 12 inches (300 mm) in the ground, placed a maximum of 8 feet (2.4 meters) apart and set on a slight angle toward the anticipated runoff source. When directed by the Engineer or designated representative, posts shall be set at specified intervals to support concentrated loads.

C. The silt fence shall be repaired, replaced, and/or relocated when necessary or as directed by the Engineer or designated representative. Accumulated silt shall be removed when it reaches a depth of 6 inches (150 mm).

END OF SECTION
SECTION 32 4060
MULCH SOCK

PART 1  GENERAL

1.01 DESCRIPTION
A. A Mulch sock consists of material encased in a tube of mesh. It is used to intercept, settle, and filter sheet flow and pond runoff. Mulch socks provide an environmentally sensitive and cost-effective alternative to sediment fences.

1.02 SUBMITTALS
The submittal requirements for this specification item shall include the following:

A. MULCH MATERIAL
a. A small sample of mulch material proposed to be used on the site will be provided to the engineer.
b. Provide a designated project stockpile of mulch for sampling and testing at the producer's site.
c. A copy of the lab analysis, performed by an STA-certified lab, verifying that the mulch material meets the requirements of Table 1.

<table>
<thead>
<tr>
<th>Item</th>
<th>Requirement</th>
<th>Reference Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle Size</td>
<td>3” minus screening process</td>
<td>Equivalent to TXDOT item 161, Compost, Section 1.6.2.B, Wood Chip requirements</td>
</tr>
<tr>
<td>pH</td>
<td>5.5-8.5</td>
<td>TMECCA 04. 11-A, “1.5 Slurry pH”</td>
</tr>
</tbody>
</table>

B. TUBE MATERIAL
The CONTRACTOR shall submit a sample of the material that the CONTRACTOR proposes to use on the project. A sample of the material should be accompanied by material data sheet identifying composition, ability of the material to biodegrade, and size of openings in tube at a minimum.

PART 2  PRODUCTS

2.01 MATERIALS
A. Mulching material can be manufactured on or off the project site and may consist of:
   a. Shredded bark:
   b. Stump grindings
   c. Composted bark
B. The mulch shall have the following composition:
   a. Wood chips shall be produced from a 3-inch minus screening process (equivalent to TxDOT item 161, Compost, Section 1.6.2.B Wood Chip Requirements).
   b. Large portions of silts, clays, or fine sands are not acceptable.
c. The pH of the mulch shall be between 5.5 and 8.5.
d. The organic matter content shall be greater than or equal to 25% on a dry weight basis.

C. Mulch material must be free of refuse, physical contaminants, and material toxic to plant growth. It is not acceptable for the mulch material to contain ground construction debris, biosolids, manure, or recyclable material.

D. Prior to placement, a representative sample of the mulching material must be tested and certified by the project engineer or his/her designee and accepted by the city inspector.

E. "Sock" material will be 100% biodegradable, photodegradable, or recyclable such as burlap, twine, UV photodegradable plastic, polyester, or any other acceptable material. The material mesh opening should be equal to or less than 3/8 inch (10 mm) and the material tensile strength should be equal to or greater than 202 psi (14.2 kg/cm²).

PART 3 EXECUTION

3.01 INSTALLATION

A. Use 12 or 18 inch diameter mulch socks for all sediment control applications. This diameter of mulch sock material has proven to be the most consistent for all sediment control applications (TxDOT, April 2006).

B. Mulch socks should be used at the base of slopes no steeper than 2:1 and should not exceed the maximum spacing criteria provided in the following table:

<table>
<thead>
<tr>
<th>Slope</th>
<th>Max. Slope Length Between 18 in. Dia. Sock (ft)</th>
<th>Max. Drainage Area (sf) per 100 ft of Sock</th>
</tr>
</thead>
<tbody>
<tr>
<td>100:1 – 50:1</td>
<td>100</td>
<td>10,000</td>
</tr>
<tr>
<td>50:1 – 30:1</td>
<td>75</td>
<td>7,500</td>
</tr>
<tr>
<td>30:1 – 25:1</td>
<td>65</td>
<td>6,500</td>
</tr>
<tr>
<td>25:1 – 20:1</td>
<td>50</td>
<td>4,800</td>
</tr>
<tr>
<td>20:1 – 10:1</td>
<td>25</td>
<td>2,600</td>
</tr>
<tr>
<td>10:1 – 5:1</td>
<td>15</td>
<td>1,300</td>
</tr>
<tr>
<td>5:1 – 2:1</td>
<td>10</td>
<td>1,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Slope</th>
<th>Max. Slope Length Between 12 in. Dia. Sock (ft)</th>
<th>Max. Drainage Area (sf) per 100 ft of Sock</th>
</tr>
</thead>
<tbody>
<tr>
<td>100:1 – 50:1</td>
<td>100</td>
<td>6,000</td>
</tr>
<tr>
<td>50:1 – 30:1</td>
<td>40</td>
<td>4,000</td>
</tr>
<tr>
<td>30:1 – 25:1</td>
<td>30</td>
<td>3,000</td>
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<tr>
<td>25:1 – 20:1</td>
<td>25</td>
<td>2,600</td>
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<tr>
<td>10:1 – 5:1</td>
<td>10</td>
<td>1,000</td>
</tr>
<tr>
<td>5:1 – 2:1</td>
<td>5</td>
<td>5000</td>
</tr>
</tbody>
</table>

C. Place mulch socks at a 5 ft or greater distance away from the toe of the slopes to maximize space available for sediment deposition.

D. When placed on level contours, sheet flow of water should be perpendicular to the mulch sock at impact and un-concentrated.

E. Install mulch socks using rebar (#5 minimum with safety caps) a minimum of 48 inches in length placed on 2-ft centers. In order to prevent the movement or floating of the mulch sock during rain events or construction operations, install steel posts on alternating sides of the sock. Drive the posts into the ground to a minimum depth of 24 inches, leaving less than 12 inches of post
above the exposed mulch sock.

F. In order to prevent water flowing around the ends of the mulch socks, point the ends of the socks up slope.

G. In order to prevent water from flowing between the gaps at adjacent ends of mulch socks, overlap the ends of adjacent mulch socks a minimum of 12 inches. Never stack mulch socks on top of one another.

H. Mulch Socks should be placed using 'smiles' and 'j-hooks'.

I. For steeper slopes, an additional mulch sock can be constructed on the top of the slope and within the slope area as determined by specific field conditions. Multiple mulch socks are recommended on steeper slopes.

J. Do not use mulch socks in areas of concentrated flow as they are intended to control sheet flow only.

3.02 INSPECTION AND MAINTENANCE

A. Inspect mulch socks after installation for gaps under the mulch socks and for gaps between the joints of adjacent ends of mulch socks. Contractor shall repair gaps such that no water flows under or around sock.

B. Inspect every seven days and within 24 hours of a rainfall event of 0.5 inches or greater. Replace and repair mulch socks as necessary.

C. Sediment retained by the mulch socks shall be removed when it has reached one third of the exposed height of the mulch socks.

D. Mulch socks can be vegetated or un-vegetated. Vegetated mulch socks can be left in place. The vegetation will grow in the slope, further anchoring the sock.

END OF SECTION
SECTION 32 9223
SODDING FOR EROSION CONTROL (BLOCK SODDING)

PART 1 GENERAL
1.01 DESCRIPTION
A. Sodding for erosion control shall consist of providing and planting Bermuda grass, San Augustin grass, or other acceptable sod along or across such areas as are designated on the drawings and in accordance with the specification requirements herein outlined.

1.02 SUBMITTALS
A. Contractor shall submit material data on the source of the sod including the date the sod was cut.

PART 2 PRODUCTS
2.01 MATERIALS
A. The sod shall consist of live, growing Buffalo grass secured from sources where the soil is fertile and has been fumigated. The sod shall have a healthy virile root system of dense, thickly matted roots throughout. The sod shall be cut from the field so that there is a minimum of one-half inch of soil on the roots of the sod, and so that no roots show on the bottom of the soil. Sod shall be dense, with the grass having been mowed to 1 inch height before lifting from field. Sod shall be in a vigorous condition, dark green in color, free of disease and harmful insects. The contractor shall not use sod from areas where the grass is thinned out, nor where the grass roots have been dried out by exposure to the air and sun to such an extent as to damage its ability to grow when transplanted. The sod shall be free from obnoxious weeds or other grasses and shall not contain any matter deleterious to its growth or which might affect its subsistence or hardiness when transplanted. Unless the area has been closely pastured, it shall be closely mowed and raked to remove all weeds and long-standing stems.

B. Care shall be taken at all times to retain the native soil on the roots of the sod during the process of excavation, hauling and planting. Sod material shall be kept moist from the time it is dug, until planted. When so directed by the Engineer, the sod existing at the source shall be watered to the extent required, prior to excavating. Do not stack sod for more than 36 hours between the time of cutting and the time of installation. The Engineer reserves the right to reject any sod deemed unacceptable for installation.

C. All plantings shall be done between the average date of the last freeze in the spring and six weeks prior to the average date for the first freeze in the fall, according to the U.S. Weather Bureau.

D. Fertilizer shall conform to the requirements of the Item, “Fertilizer” and shall be applied at the rate of 480-pounds per acre.

PART 3 EXECUTION
3.01 CONSTRUCTION METHODS
A. Immediately after the finished grade has been approved, begin sodding operations to reduce excessive weed growth. If the sod bed is dry, immediately prior to sod installation, dampen the surface with a fine mist of water.

B. Grass shall be turf sod, cut into 16 inch by 24 inch strips.

C. All areas to be sodded shall be raked to true lines, free from all unsightly variations, bumps ridges or depressions. All sticks, stones, roots or other objectionable material which might interfere with the formation of a finely pulverized seed bed, shall be removed from the soil.
D. Lay sod so that adjacent strips butt tightly, with no spaces between strips. Lay sod on mounds and slopes, with strips parallel to contours. Stagger joints. Sodded areas shall be flush with adjoining seeded areas. All sod shall, of course, be laid green side up. Tamp and roll the sod thoroughly to make contact with the sod bed, or as directed by the Engineer.

E. Peg sod on slopes three to one or steeper with pegs driven through sod into soil, until pegs are flush with the turf. Space pegs 18 inches on center. Pegs to be 1 inch square, 6 inches long or, 6 inch lengths of lath. Commercial fertilizer as outlined in the Item, “Fertilizer” shall be applied to the entire sodded area at the prescribed rates, immediately following laying of the sod. Immediately after fertilizing, water the entire area to a saturated depth of 2-inches.

F. Immediately after installation of the sod, remove sod clumps on soil, wash off any plant materials and pavements not to have sod. Edges along curbs and drives, walkways, etc., shall be carefully trimmed and maintained until accepted.

3.02 CONTRACTOR’S MAINTENANCE & GUARANTEE PERIOD

A. Maintenance of sodded areas shall be for 60 days after completion of the project and shall consist of watering, weeding, repair of all erosion and resodding as necessary to establish a uniform growth of the specified grass. Contractor shall guarantee growth and coverage of the sod planted under this contract to the effect that a minimum of 95% of the area planted will be covered with the specified planting after 60 days. Sod panels that are dead or dying shall be replaced.

B. The Contractor shall be responsible for one (1) mowing every two weeks between the months of April to October. The Contractor shall also be responsible for one (1) mowing every three (3) weeks between the months of November to March. In addition, the Contractor shall water the entire sodded and hydro-mulched areas to a saturated depth of one (1) inch at least once a week between the months of April to September and a least once a month between the months of October to March.

C. Contractor shall make a second planting to those bare areas not meeting specified planting as determined by the Engineer. Such replanting is to be performed within 90 days of initial application and upon notification by the Engineer to replant.

END OF SECTION
SECTION 32 9300
LANDSCAPE PLANTING

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Work specified in this section: Provide all labor, materials, transportation, and services necessary to furnish and install all landscape planting, complete in place, as shown and specified on drawings.
B. Landscape work shall include, but is not limited to, fine grading, soil preparation, planting, seeding, sodding, pruning, fertilizing and pest/disease control.

1.2 RELATED WORK
A. The requirements of the "General and Supplementary Conditions of the Contract" and Division 1 specification sections shall apply to all work of this Section with the same force and effect as though repeated in full herein.
B. General Scope of Work and Requirements - Section 00 1000.
C. Earthwork - Section 02200.
D. Site Grading – See Specifications.
E. Treatment of Existing Trees: Section 02940

1.3 REFERENCES
C. Hortus third, 1976 - Cornell University - Plant Nomenclature.
E. Turfgrass Producers International (TPI) - Guideline Specifications to Turfgrass Sodding.
F. U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act and the Texas Seed Law.

1.4 SUBMITTALS
A. General Requirements:
   1. The Contractor shall furnish the articles, equipment, materials, or processes specified by name in the drawings and specifications. No substitution will be allowed without prior approval by the Landscape Architect.
   2. Complete material list shall be submitted prior to performing any work. Material list shall include the manufacturer, description of all materials to be used and samples as outlined below.
   3. Submit contractor qualifications per 1.5 Quality Assurance and Requirements.
B. Plant Selection:
   1. Submit plant schedule naming quantities and supplier of each tree for Landscape Architect's approval.
   2. If material is to be approved on-site, tag and maintain plant material as representative samples. Samples may be use to complete installation, provided they remain tagged until final acceptance of entire installation.
C. Miscellaneous Materials:
   1. Submit for approval 1 gallon quantities and product information of topsoil, prepared soil and mulch.
   2. Submit topsoil analysis with recommendations of amendments required to support plant growth. See paragraph 2.4 Source Quality Control And Tests, D.
   3. Submit for approval product information on packaged materials, edger, tree stakes, tree boots, fabric and fertilizer, herbicide and insecticide. Samples shall be approved by the Landscape Architect before use on the project.
   4. All samples shall be delivered in a box. Clearly mark samples with job name and contractor name.
1.5 QUALITY ASSURANCE AND REQUIREMENTS
A. Permits and Fees: The Contractors shall obtain and pay for any and all permits and all inspections as required. Contractor shall also be responsible for all fees and costs involved for work.
   1. Landscape Contractor shall comply with City inspector directions with agreement from Landscape Architect without additional cost to Owner.
B. Ordinances and Regulations: All local, municipal and state laws, and rules and regulations governing or relating to any portion of this work are hereby incorporated into and made a part of these specifications, and their provisions shall be carried out by the contractor. Anything contained in these specifications shall not be construed to conflict with any of the above rules and regulations or requirements of the same. However, when these specifications and drawings call for or describe materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by the above rules and regulations, the provisions of these specifications and drawings shall take precedence.
C. Personnel: Personnel shall be supervised by a Certified Landscape Professional Contractor (CLPC) as administered by Texas Association of Landscape Contractors (TALC) or hold a college degree relating to the landscape industry or an approved equivalent. Employ only experienced personnel who are familiar with the required work. Provide adequate supervision by a qualified foreman with minimum of five years experience.
D. Plant Material: Plants shall be subject to inspection and approval of Landscape Architect at place of growth or upon delivery for conformity to specifications. Such approval shall not impair the right of inspection and rejection during progress of the work. Inspection and tagging of plant material by the Landscape Architect is for design intent only and does not constitute the Landscape Architects’ approval of the plant materials in regards to their health and vigor as specified in Part 2, Section 2.1 Plant Material. The health and vigor of the plant material is the sole responsibility of the Contractor.
   1. General: comply with applicable federal, state, county, and local regulations governing, landscape materials and work.
   2. Any plant material in shock, decline or not meeting specified planting size, height and caliper shall be rejected by the Landscape Architect at any time during the project.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING
A. Deliver plant material to site in containers. Protect plant material from sun-scald and wind burn during transport to site. Prune only limbs that have broken in transport.
B. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable. Deliver seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.
C. Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery and while stored at site.

1.7 SUBSTITUTIONS
A. Submit proof to Landscape Architect if plant material is not available 30 days prior to plant installation. Substitution will be approved by Owner or Landscape Architect by Architect’s Supplemental Instructions.

1.8 GUARANTEE
A. Replace plants with same kind and sizes as originally planted, at no cost to Owner. Provide one year guarantee on replacement plants. At direction of the Landscape Architect, trees may be replaced at the start of next year’s planting or digging season. In such cases, remove dead trees immediately. Protect irrigation system and any other piping, conduit, or other work during replacement. Repair any damage immediately.
B. Guarantee excludes replacement of plants because of injury by storm, drought, hail, freeze, insects or diseases, and other acts of God contacted after final acceptance.
1.8 PROJECT CONDITIONS
A. Site Utilities:
A. Determine locations of underground utilities, especially site lighting, cable, telephone, and irrigation lines. Perform all work in a manner which will avoid possible damage. Do not permit heavy equipment or trucks to damage utilities. Hand excavate, as required to minimize possibility of damage to underground utilities.
B. Coordinate work with the irrigation contractor to prevent damage to underground wire and other obstruction work located in landscape areas.
B. Water will be provided on site by the Owner. Landscape contractor will provide hoses, other watering equipment and labor necessary for the work.

1.9 SCHEDULES
A. The Contractor shall begin exterior landscape work upon acceptance of the Contract by the Owner. Landscape Contractor shall submit a schedule for the work to be performed to the Landscape Architect for approval.

1.10 PROTECTIONS
A. All items required to complete this contract remain the property and responsibility of the Contractor until final acceptance. Take adequate precautions to protect all work and materials against damage. Cooperate fully with other trades to insure a satisfactory completion.

1.11 MAINTENANCE SERVICE
A. Maintain plant material until Date of Substantial Completion.
B. Maintain plant material immediately after placement and until plants are well established and exhibit a vigorous growing condition.
C. Maintenance to include:
1. Cultivation and weeding plant beds and tree pits.
2. Applying herbicides for weed control of all areas in accordance with manufacturer's instructions. Remedy damage resulting from use of herbicides.
3. Applying insecticides for insect control and fungicides for fungus control of all areas and plant materials in accordance with manufacturer's instructions. Remedy damage from use of chemicals. Remedy damage resulting from use of chemicals
4. Irrigating sufficiently to saturate root system of all plant material. 
5. Pruning, including removal of dead or broken branches, and treatment of pruned areas or other wounds.
6. Disease control. Provide chemicals as required to control any disease that may occur during the maintenance period. Notify Owner and Landscape Architect for any problems.
7. Maintaining guys and tree stakes. Adjust to keep guy wires firm. Repair or replace accessories when required.
8. Replacement of mulch.
9. Watering, mowing, edging, weeding and fertilizing of lawn areas.

PART 2 - PRODUCTS
2.1 PLANT MATERIALS
A. General:
1. Plants shall be in accordance with the latest edition of "American Standard for Nursery Stock" sponsored by the American Association of Nurserymen, Inc. (A.A.N.). All plants shall have a normal habit of growth and shall be sound, healthy, vigorous and free of insect infestations, plant diseases, sunscalds, fresh abrasions of the bark, excessive abrasions, in shock or other objectionable disfigurements. If the sample plants inspected are found to be defective, the Landscape Architect reserves the right to reject the entire lot or lots of plants represented by the defective samples. Any plants rendered unsuitable for planting because of this inspection will be
rejected and will be the responsibility of the Contractor and removed from site.

2. The size of the plants will correspond with that normally expected for species and variety of commercially available nursery stock or as specified on drawings. The minimum acceptable size of all plants measured before pruning with the branches in normal position, shall conform with the measurements, specified on the drawings in the plant list. Plants larger in size than specified may be used with no change in contract price. If the use of larger plants is approved, the rootball for each plant will be increased proportionately.

3. Under no conditions will there be any substitutions of plants or sizes listed on the accompanying plans, except with the express consent of the Landscape Architect.

4. Plant material shall be tree to botanical and common name and variety as specified in "American Standard for Nursery Stock Editions" and "Standardized Plant Names."


6. Plants shall be hardy under climatic conditions similar to those in locality of project.

B. Shade and Ornamental Trees:
1. Healthy, vigorous, full-branched, well-shaped, trunk diameter and height requirements as specified. Trees shall be in containers unless otherwise noted on plans.
2. B&B trees shall not be accepted for containerized materials.
3. B&B trees shall have rootballs that are firm, neat, slightly tapered, heeled for a period of one (1) year.
4. Trees with loose or broken rootballs at time of planting shall be rejected.
5. Trees in grow bags, grow liners will be rejected.
6. Trees will be individually approved by the Landscape Architect.
7. Rootballs shall be 10” in diameter for each 1” caliper measured 6” above the tree rootball.

C. Turf Materials:
C. Sod: TPI, Certified Turfgrass Sod quality; cultivated grass sod; with strong fibrous root system, rich green in color, free of stones, burned or bare spots, free of foreign grasses, weeds and nut grass; Minimum age of 18 months, with root development that will support its own weight without tearing, when suspended vertically by holding the upper two corners.
   a. Buffalo Grass 609 (Buchloe dactyloide ‘609’).
   b. Deliver to site on pallets. Do not stack for more than 24 hours between time of cutting and time of delivery.

2. Seed: Seed mix shall be hulled Thunder Turf - 2#PLS/1000SF. If seed is applied after September 15, Winter Rye Grass (Lolium perenne) - 4#PLS/1000SF. Available from Native American Seed, 800-728-4043.

2.2 SOIL PREPARATION MATERIALS
A. Sandy Loam Topsoil: Fertile, dark sandy loam topsoil free of rubble, stones, lumps, plant roots and reasonably free of weeds. Loam shall have a minimum pH value of 5.4 to maximum of 7.0. Loam containing high clay content, rock or debris greater than ½” diameter, Nut grass or Dallisgrass will be rejected and Contractor will be responsible for removing it from site.

B. Soil Amendment: Garden-Ville 4-way landscape mix, as manufactured by Garden-Ville Materials, 210-651-6115.

C. Fertilizer:

D. Herbicide:
1. Pre-emergent herbicide shall be Eptam Granules by Green Light Company, San Antonio, Texas, or XL 2G, or approved equal.

E. Pesticides:
1. Fungicides: Mancozeb, Armada.
2. Insecticides: Dursaban, Sevin, Volck Oil.
3. Other chemicals: Submit information as required

2.3 MISCELLANEOUS MATERIALS
A. Seed Mulching Material: Wood cellulose fiber, dust form, free of growth or germination inhibiting ingredients.
B. Seed Gluing Agent: Flexterra (FGM) as manufactured by Profile Products LLC, 750 Lake Cook Road, Suite 440, Buffalo Grove, IL 60089, 800-966-1180Mulch: Mulch shall be shredded pine bark mulch. Submit sample for approval.
C. Mulch: Mulch shall be double shredded hardwood mulch. Submit sample for approval
D. Water: Water will be available on site.
E. Stakes: Metal T-posts, 6' ht., green in color.
F. Wire: Minimum 10 gauge wire, provide 2 strands of pliable galvanized iron wire.
G. Hose: 3/4" diameter, 2 ply, green rubber hose. Cut in sufficient length to protect tree from wire damage. Thread wire through hose.

2.4 SOURCE QUALITY CONTROL AND TESTS
A. Soil analysis will ascertain the percentage of nitrogen, phosphorus, potash, soluble salt, organic matter and pH value.
B. Submit minimum 1 gallon sample of topsoil proposed. Forward another sample to approved testing laboratory in sealed containers to prevent contamination.
C. Testing is not required for imported soil if recent tests are available. Submit these test results to the Landscape Architect for approval. Contractor is to indicate, by test results, information (amendments both organic and inorganic) necessary to amend soil to support plant growth.
D. Soils analysis must be dated within 45 days of installation of topsoil.

PART 3 - EXECUTION

3.1 INSPECTION
A. Observe site prior to construction and accept site when satisfied with conditions. Landscape Contractor shall be responsible for shaping all planting areas as indicated on plans or as directed by Landscape Architect.
B. Inspect trees, shrubs and other plant material for injury, insect infestation and trees and shrubs for improper pruning.
C. Do not begin planting until deficiencies are corrected or plants replaced. Do not start work until grading is complete and approved by Architect.

3.2 SOIL PREPARATION
A. Preparation of Subgrade:
   1. Prepare subgrade to eliminate uneven areas. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.
   3. Scarify subgrade to a depth of 4 inches where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.
B. Placing Topsoil:
   1. Spread topsoil to a minimum depth of 4 inches over entire area to be planted. Rake smooth.
   2. Place topsoil during dry weather and on dry unfrozen subgrade. Remove organic matter and foreign non-organic material from topsoil while spreading. Break up soil clods as possible, remove those that cannot be broken.
   3. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.
4. Install topsoil into pits and beds intended for plant root balls, to a minimum thickness of 6 inches.

C. Final Grades:
1. Minor modifications to grade may be required to establish the final grade.
2. Finish grading shall insure proper drainage of the site as determined by the Landscape Architect. Surface drainage shall be away from all building pads.
3. All areas shall be graded so that the final grades will be 1" below adjacent paved areas, sidewalks, valve boxes, edging, concrete headers, clean-outs, drains, manholes, etc., in lawn areas and in bed areas.
4. Eliminate all erosion scars prior to mulching and commencing maintenance period

D. Disposal of Excess Soil: Dispose of any unacceptable soil or debris offsite. Excess soil may be spread on site.

3.3 PLANTING INSTALLATION
A. General:
1. Actual planting shall be performed during those periods when weather and soil conditions are suitable and in accordance with locally accepted practices.
2. All planting beds shall be free of any deleterious materials, including but not limited to concrete debris, trash, buried organic material, and base material from drive and building construction.
3. 

B. Pre-Plant Weed Control:
1. Clear and remove existing weeds by grubbing weeds over the entire area to be planted.
2. Prior to planting install pre-emergent per manufacturer's recommendations

C. Planting of Shade and Ornamental Trees:
1. Protect all areas from excessive compaction when trucking plants or other material to the planting site.
2. All excavated holes shall have vertical sides with roughened surfaces and shall be of a size that is twice the diameter of the rootball and the same depth as the rootball for all trees.
3. Face plants with fullest growth to most visible direction.
4. Trees shall be backfilled with:
   a. 2 parts existing soil/topsoil
   b. 1 part landscape amendment (or manure or peat moss)
   c. 1 part sand
   d. 1 lb. fertilizer per c.y. of mix
   e. Agriform tablets
5. All plants which settle deeper than the surrounding grade shall be raised to the correct level. Additional backfill shall be added as necessary.
6. If B&B is specified, remove any polyethylene rope from rootballs and trunks. Bend 1/3 of wire down away from trunk and rootball.
7. Tamp soil as backfilling occurs to minimize settling of soil.
8. After backfilling, an earthen basin shall be constructed around each plant. Each basin shall be 4" depth. Basins shall be constructed of amended backfill materials, or existing soil.
9. Install 4" layer of mulch at 4' diameter at each tree.
10. Pruning shall be limited to the minimum necessary to remove injured twigs and branches.

D. Install gatorbag per manufacturer's recommendations.
E. Installation of Lawn:
F. General:
   a. Contractor shall inspect final grade is free from ruts, uneven spots, and roughness. Final grade shall be smooth and free from large clods or debris. If this requirement is not met and lawn is installed, the grade shall be repaired to satisfaction of Landscape Architect and hydromulch or sod
re-installed at no cost to Owner.

b. Contractor is responsible for establishing a healthy and full stand of lawn of sod or seed. Contractor shall maintain lawn until established and approved by Landscape Architect.

c. Winter rye grass installation shall be considered a temporary grass application. Should rye grass be installed, the contractor shall return to site after March 15 to apply bermuda grass hydromulch.

d. Disturbed areas: All areas that are disturbed due to construction operations shall be hydromulched according to specifications. Any slopes 3:1 and greater shall be solid sodded per specifications. This will apply to areas on site whether or not identified on the plans.

G. Seeding:

e. Apply seeded slurry with a hydraulic seeder at a rate of 2 lbs per 1000 sq. ft. evenly in two intersecting directions with following mixture:

   (1) Mixture 1 (Standard Mix):
       (a) 45#/1000 sq.ft. mulching agent
       (b) 20#/1000 sq.ft. water soluble fertilizer

   (2) Mixture 2 (Flexterra for Slopes (over 6:1 or 17%) and Problem Areas):
       (a) 50#/1000 sq.ft. mulching agent
       (b) 20#/1000 sq.ft. water soluble fertilizer
       (c) 1.5#/1000 sq.ft. glue agent

f. Do not hydroseed area in excess of that which can be mulched on same day.

g. Immediately following seeding, apply mulch to a thickness of 1/8 inches. Maintain clear of shrubs and trees.

h. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil. Water to prevent grass and soil from drying out.

i. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.

j. Immediately reseed areas which show bare spots.

H. Sodding:

k. Lay sod immediately after delivery to site to prevent deterioration.

l. Lay sod tight with no open joints visible, and no overlapping; stagger end joints 12 inches minimum. Do not stretch or overlap sod pieces.

m. Lay smooth. Align with adjoining grass areas. New finished grade and existing grade shall be flush.

n. Place top elevation (top of sod mat) of sod 1 inch below adjoining edging and curb or paving.

o. On slopes 4 inches per foot and steeper, sod shall be laid. Lay sod perpendicular to slope and secure every row with wooden pegs at maximum 2 feet on center. Drive pegs flush with soil portion of sod.

p. Prior to placing sod, on slopes exceeding 6 inches per foot or where indicated, place wire mesh over topsoil. Securely anchor in place with wood pegs sunk firmly into the ground.

q. Water sodded areas immediately after installation. Saturate sod to 4 inches of soil.

r. After sod and soil have dried, roll sodded areas to ensure good bond between sod and soil and to remove minor depressions and irregularities. Roll sodded areas with roller not exceeding 150 lbs.

I. Contractor is responsible for the establishment of lawn areas. Provide temporary irrigation as required for growth of a full stand of lawn.

s. Should construction project last longer than 20 days beyond specified finish date with any area of lawn in disrepair or in an unacceptable state
to Landscape Architect, Landscape contractor shall install solid sod in sod or seed areas to complete project with no additional cost to Owner.

J. Contractor is to leave a 3 to 5 foot diameter ring around each tree, whether newly planted or existing, free of turf material. Contractor is to install 4 inches of pine bark mulch in each tree ring as specified in this section.

3.4 INSTALLATION OF MISCELLANEOUS MATERIALS
A. Tree stake: Install tree stakes per details. Install wire to 40-50% height of tree. Tighten wire to hold trees firmly. Do not pull wires extremely taut on trees. Install tree guards per manufacturer’s recommendations. Join two tree guards together for larger caliper trees.

B. Pruning: At no time shall trees, trimmed or topped prior to delivery and any alteration of their shape shall be conducted only with the approval and when in the presence of the Landscape Architect.

C. Gatorbags: Install gatorbags per manufacturer’s specifications and details.

3.5 AREAS DISTURBED BY CONSTRUCTION
A. Recondition areas disturbed by construction operations including, but not limited to, graded areas, laydown areas, construction trailers and movement of vehicles. All compacted areas shall be tilled to 6” depth. Install 1-2” depth topsoil, rake smooth and free of any rock or other deleterious materials. Apply hydromulch seed as specified in these specifications. Solid sod all slopes 3:1 and greater. Install temporary irrigation.

3.6 TEMPORARY IRRIGATION
A. Contractor shall provide and install an above ground irrigation system and equipment/materials as required to establish lawn areas not covered by the automatic irrigation system. Coordinate with landscape contractor to insure proper coverage for the time required to establish the lawn. Remove temporary irrigation system when lawn is established and accepted by Landscape Architect.

3.7 MAINTENANCE OF SITE (While under construction or until Date of Substantial Completion)
A. Until final acceptance, maintain all plant materials and trees by watering, cultivating, weeding, spraying chemicals, cleaning and replacing as necessary to keep landscape in a vigorous, healthy condition. Landscape contractor is responsible for maintenance of his work whether or not existing or new irrigation system is operational. Landscape contractor is to notify the Owner and Landscape Architect for any deficiencies in the irrigation system. Failure to do so does not relieve the Landscape Contractor from replacing plant materials that have died.

B. Watering: As necessary to keep top 2” of soil moist.

C. Watering Trees: Tree rootballs are to be kept moist to the depth of the rootball.

D. Cultivating: Cultivate bed areas to a depth of approximately 3” at least twice a month. Care should be taken not to damage plant roots.

E. Weeding: Remove weeds and foreign grass over bed and lawn areas at least once a week. Herbicides may be used only when approved by Landscape Architect. Rake bed areas as required. Work will not be accepted with a presence of weeds in landscape.

F. Mowing and Edging: Mow and edge newly planted lawns weekly when growth reaches 2 ½”. Maintain at this height weekly.

G. Fertilizer, Pesticides, Insecticides, and Fungicides: It is the responsibility of the contractor to insure plant material is in vigorous, healthy condition. Application of chemicals per manufacturer requirements and state and local codes is required as necessary to control any pest, insect, or fungal problems.

3.8 CLEAN UP
A. After all planting operations have been completed, remove all trash, excess soil, empty plant containers from the property. All scars, ruts or other marks in the ground caused by this work shall be repaired and the ground left in a neat and orderly condition throughout the site. Contractor shall pick up all trash resulting from his work at the end of each working day. Dispose of trash properly.
B. The Contractor shall leave the site area broom-clean and shall wash down all paved areas within the contract area, leaving the premises in a clean condition. All walks shall be left in clean and safe condition.

END OF SECTION

04.09.2021
SECTION 33 0501
POLYVINYLCHLORIDE PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The work specified under this section includes the manufacture, construction and installation of Polyvinylchloride (PVC) pipe and fittings for Water Lines and for Gravity and Pressure Sanitary Sewers.

1.02 REFERENCES

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C33 Standard Specification for Concrete Aggregates
ASTM C150 Standard Specification for Portland Cement
ASTM D1598 Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
ASTM D2122 Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
ASTM D2152 Standard Test Method for Adequacy of Fusion of Extruded Poly (Vinyl Chloride) (PVC) Pipe and Molded Fittings by Acetone Immersion
ASTM D2241 Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM F679 Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM D2672 Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement
ASTM D3034 Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer
Pipe and Fittings


AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C900  Polyvinyl Chloride (PVC) Pressure Pipe, 4-Inch through 12-Inch for Water Distribution (Latest Edition)

AWWA C909  Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4-Inch Through 12-Inch for Water Distribution (Latest Edition)

AWWA C104  ANSI Standard for Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water

AWWA C105  ANSI Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems

AWWA C111  ANSI Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings


AWWA C153  Ductile Iron Compact Fittings, 3 in. through 24 in. and 54 in. through 64 in. for Water Service

AWWA C905  Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In.-48 In.

1.03 SUBMITTALS

A. Submit manufacturer’s data on pipe furnished, indicating compliance with the specifications regarding dimensions, thickness, weights, and materials.

B. Submit manufacturer’s “Certificate of Compliance,” stating that the materials furnished comply with this specification.

1.04 STORAGE AND HANDLING

A. UNLOADING - COLD WEATHER HANDLING

As the temperature approaches and drops below freezing extra care should be used in handling during cold weather. Pipe at the bottom of a stack may become out-of-round due to the weight of material above it. Allow the pipe to recover to full initial roundness before installation. Pipe may be unloaded by hand, either by passing over the side or off the truck end. Sliding one length on another is permissible in unloading pipe, but lengths in the bottom layer shall be lifted off of the rough surface of the truck body to avoid abrasion. Compact shipping units (palletized bundles in a wood frame) may be unloaded by conventional fork lifts.

B. STOCKPILES

Store pipe on a flat surface so as to support the barrel evenly with bell ends overhanging.
Store random lengths separately where they will be readily available. Individual lengths of pipe should be stacked in piles no higher than 5 feet. Pipe shall be protected during long exposures (over 3 months) to sunlight. Do not use clear plastic sheets. Provide for air circulation under sheet.

C. STORING RUBBER RINGS

Store all rubber rings at a central point and distribute them as needed. Keep them clean, away from oil, grease, excessive heat and electric motors which produce ozone. If rubber rings are not to be used immediately, store them in their cartons, as shipped, in a cool dark place out of the direct rays of the sun.

PART 2 – PRODUCTS

2.01 MATERIALS

A. WATER LINES

1. Pipe

   a. Blue colored Polyvinyl chloride (PVC) pressure pipe, six inch (6") through twelve inch (12") shall conform to the current AWWA – C900 or C909 standard, be UL listed, be approved by the Texas State Board of Insurance and the National Sanitation Foundation. PVC pipe wall thickness shall be based on a working pressure rating of 125 psi at 100° F (DR-14, Class 200 for C900 or Class 200 for C909.). The outside diameter shall be identical to ductile-iron pipe (CIOID Standard, Table 2, AWWA – C900). All pipe shall be new and have the AWWA designation, pressure class, DR pressure rating and size of pipe stamped on the outside of each joint (follow requirements of C900 2.5.2 Markings). All piping shall be new. Partial pieces from other projects shall not be approved for installation. Metal detector tape shall be installed above all PVC pipe at an elevation of 2 feet below natural ground.

   b. Blue colored PVC 4" pipe shall be SDR 21, ASTM D2241.

   c. PVC Pressure Pipe shall be designed and tested in accordance with ASTM D1598, D1599, and D2152.

   d. Fittings for PVC water pipe shall be ductile-iron, and shall conform to AWWA C153, unless otherwise specified.

       Fitting joints shall be mechanical joints. Bolts and nuts for mechanical joints, or flanged ends will be of high strength corrosion resistant low-alloy steel and shall conform to AWWA C111. Flange bolts and nuts for above ground installation shall conform to Appendix A of AWWA C115. Flange bolts and nuts for below ground installation shall be 316 stainless steel. All fittings shall be epoxy coated and lined unless stainless steel is used.

       Where joints are to be restrained, use mega-lug type fitting for pipe six (6") inches in size and larger. Mega-lug type mechanical restraints with less than 6 contact points will not be allowed for six (6") inch pipe sizes and larger. Four (4") inch lines shall be restrained by mid-co restraint or pre-approved equal.

       Polyethylene wrap or encasement of metal fittings shall conform to AWWA C105. Joint tape shall be self-sticking PVC or 8-mil-thick polyethylene.

   e. Joints: PVC water pipe shall be furnished with an elastomeric gasket at each joint and an integral thickened bell as part of each joint. Pipe and fittings
must be assembled with a non-toxic lubricant. Provisions must be made at each joint for expansion and contraction. Refer to ASTM F477, D3139 and D3212.

B. GRAVITY SANITARY SEWER

1. Pipe

Flexible pipe and fittings shall be un-plasticized polyvinyl chloride gravity sewer pipe shall be green in color, made from clean, virgin, NSF approved Class 12454-B PVC conforming to ASTM D1784. All pipe shall be new and have the ASTM designation, SDR, pressure rating and size stamped on the outside of each joint. All markings shall follow requirements of ASTM D3034.

Polyvinyl chloride (PVC) gravity pipe and fittings in sizes six inch (6") through twelve inch (12") shall conform to ASTM D3034 and be UL listed and approved by the National Sanitation Foundation. Pipe and fittings shall be SDR-26. Eighteen inch (18") pipe and fittings shall be SDR-26 and conform to ASTM F-679, be UL listed and approved by the National Sanitation Foundation.

2.02 TESTING REQUIREMENTS

See: SECTION 33 01 30 - TESTING OF GRAVITY SEWER SYSTEMS
SECTION 33 13 00 - DISINFECTION OF WATERLINES

Also: HYDROSTATIC TESTING (Under SECTION 33 1000 – WATER DISTRIBUTION)

PART 3 – EXECUTION

3.01 TRENCHING

A. See Standard Details.

3.02 JOINT ASSEMBLY

A. Push-on joints shall be assembled as follows:

1. Thoroughly clean the groove and bell and insert the gasket, making sure that it faces the proper direction and that it is correctly seated.

2. Dirt or foreign material shall be cleaned from the spigot end to a point one inch (1") beyond the reference mark. A joint lubricant shall be used and applicable recommendations of the manufacturer shall be followed.

3. Be sure that the spigot end is beveled, as square or sharp edges may damage or dislodge the gasket and cause a leak. Push the spigot end into the bell of the pipe while keeping the joint straight. Brace the bell while the beveled end is pushed under the ring, so that previously completed joints in the line will not be closed up. Make deflection after the joint is assembled.

4. Push the spigot end in until the reference mark on the spigot end is flush with the end of the bell. If excessive resistance to insertion of the beveled end is encountered or the reference mark does not reach the flush position, disassemble the joint, and check the position of the ring. If it is twisted or pushed out of its seat,
clean the ring, bell and beveled end and repeat assembly. Be sure both lengths are in proper alignment. If the ring was not out of position, measure the distance between the reference mark and beveled end, and check it against correct values from the manufacturer. Relocate the reference mark if it is out of position.

5. Small pipe can be pushed into the bell end with a long bar. Large pipe requires additional power, such as a jack, lever puller, or backhoe. A timber header should be used between the pipe and jack or backhoe bucket to avoid damage to the pipe.

6. At times when pipe laying is not in progress, the open ends of pipe shall be closed by watertight plug or other means pre-approved by the Engineer. The plug shall remain in place until the trench is pumped completely dry. Care must be taken to prevent pipe flotation should the trench fill with water.

B. Mechanical joints shall be assembled as follows:

1. Wipe clean the bell and spigot end. The spigot end, bell, and gasket should be washed with a soap solution to improve gasket seating.

2. Place the gland on the spigot end with the lip extension toward the spigot end, followed by the gasket with the narrow edge of the gasket toward the spigot end of the pipe.

3. Insert the pipe into the bell and press the gasket firmly and evenly into the gasket recess. Keep the joint straight during assembly. Make deflection after joint assembly but before tightening the bolts.

4. Push the gland toward the bell and center it around the pipe with the gland lip against the gasket.

5. Align bolt holes and insert bolts, with bolt heads behind the bell flange, and tighten opposite nuts to keep the gland square with the bell.

6. Tighten the nuts in accordance with manufacturer's recommendations.

C. When it is necessary to deflect pipe from a straight line in either the vertical or horizontal plane, or where long radius curves are permitted, the amount of deflection shall not exceed that shown in Table 1. Pipes greater than twelve-inches (12") in diameter shall not be deflected.

<table>
<thead>
<tr>
<th>Pipe Diameter in.</th>
<th>Deflection Angle Deg.</th>
<th>Minimum Radius of Curve ft. *</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>2.5</td>
<td>230</td>
</tr>
<tr>
<td>8</td>
<td>1.9</td>
<td>300</td>
</tr>
<tr>
<td>12</td>
<td>1.3</td>
<td>450</td>
</tr>
</tbody>
</table>

* All curvature results from the bending of pipe lengths. There is no deflection at the joint.

D. Cutting and Beveling
1. A square cut is essential to insure proper assembly. Use either a tubing cutter or a miter box and carpenter's fine-toothed hand saw or hacksaw. (Do not use standard pipe cutters. The cutting wheel will crush or damage the pipe.)

2. Use a factory-finished beveled end as a guide to determine the angle and length of taper. The end may be beveled using a Pilot beveling tool which will cut the correct taper automatically or a thin steel, "cheese-grater" type of hand tool, Stanley "Sureform" No. 399.

3. With a pencil or crayon, locate the reference mark at the proper distance from the bevel end as indicated by the manufacturer.

### 3.03 POLYETHYLENE TUBE PROTECTION

A. All cast iron and ductile iron fittings shall be provided with 8 mil polyethylene tube protection. Completely cover all fittings and connections with polyethylene film held securely in place with joint tape or strapping according to the provisions of AWWA C105.

### 3.04 EMBEDMENT

A. Install embedment as shown on the Plans and in accordance with SECTION 31 2333 - EXCAVATING, TRENCHING, AND BACKFILLING.

### 3.05 TAPPING WATER LINES

A. Where a tap occurs within a deflected section of pipe, utilize a fitting (ie: 8" x 1" tapped tee) in lieu of tapping the pipe.

B. The tapping sleeve specified will be the Smith-Blair 662 or the Ford FTSS Stainless Steel Tapping Sleeve with Epoxy Coated Flange for pipe sizes 6"-24".

### 3.06 GRAVITY SANITARY SEWER DEFLECTION TEST

A. The sewer line shall be tested for deflection in accordance with SECTION 33 0130 - TESTING FOR SANITARY SEWAGE GRAVITY SYSTEM.

**END OF SECTION**
SECTION 33 0502
DUCTILE IRON PIPE

PART 1 GENERAL

1.01 DESCRIPTION

A. Related Work Specified Elsewhere
   1. Submittals. Section 01300
   2. Painting. Section 09902
   3. Excavating Trenching and Backfilling for Utilities. Section 02221
   4. Embedment and Encasement of Pipe. Section 02225
   5. Disinfection and Testing of Structures of Pipes. Section 15042
   6. Supports and Hangers. Section 15094

B. Scope. Under this Section of the Specifications the Contractor shall provide the labor, materials, tools, equipment and related items required to furnish and install complete in place all ductile iron pipe and fittings.

1.02 SUBMITTALS

A. Submittals shall comply with the requirements of Section 01300, Submittals.

B. The Contractor shall submit for review working drawings of all ductile iron piping containing the following information.
   1. Drawings shall be dimensioned and shall indicate size, class and laying dimensions of all pipes, valves, fittings, expansion couplings, specials and appurtenances.
   2. Drawings shall show the locations of all hangers and supports, whether or not specifically indicated on the plans.
   3. The number, size, and length of all bolts required for flanged pipe installations shall be shown on the pipe schedule listed on the working drawings.

C. The Contractor shall furnish a sworn statement from the manufacturer that the inspection and all of the specified tests have been made and the results thereof comply with the requirements of ANSI A21.51 and A21.11.

PART 2 PRODUCTS

2.01 DUCTILE IRON PIPE

A. All ductile iron pipe furnished under this Section of the Specification shall have its wall thickness design in accordance with the method described in ANSI A21.4, AWWA C104, and NSF Standard 61. The minimum pipe wall thickness shall be the greater of the thickness as determined by the following methods.
   1. Truck Load, Thickness for Earth Load Plus Truck Load, for laying Condition Type 2 and the maximum trench cover indicated on the plans, but in no case less than 5 feet of cover.
   2. Thickness for Internal Pressure, for working pressures as specified in the pipeline schedule or on the plans, but in no case less than 150 psi.
   3. Flanged joints shall be used on all exposed ductile iron piping with the flanges complying with requirements of AWWA C115. The flanges shall be ductile iron and may be either screwed or cast integrally with the pipe barrel.
   4. Segmented mechanical couplings may be used as an alternate to flanged joints with the grooved pipe and dimensions, complying with the joint suppliers requirements for flexible radius grooving, complying with AWWA C606.
2.02 PIPE FITTINGS AND APPURTENANCES

A. Push-on, mechanical and flanged pipe fittings shall comply with the requirements of ANSI A21.10.

B. Grooved pipe fittings used with segmented mechanical couplings shall conform to ANSI A21.10 for all dimensions with the exception of the end preparation. The ends shall be grooved in accordance with the segmented mechanical coupling supplier’s requirements.

C. Gaskets for flanged joints shall be full-faced, ASTM D1330, Grade I, red rubber, 1/8-inch thick; or SBR, Neopreme, 1/8-inch thick.

D. Nuts and Bolts used for flanged joints shall be either machine bolts having a hex head with a hexagon nut or a bolt-stud with two hexagon nuts complying with the requirements of ASTM A307, Grade B, Low Carbon Steel Externally and Internally Threaded Fasteners.

E. All fittings shall be new and fabricated in North America. Refurbished fittings are not acceptable.

2.03 SEGMENTED MECHANICAL COUPLINGS

A. As an alternative to flanged joints, segmented mechanical couplings may be used to join grooved end pipe and fittings. The segmented mechanical coupling shall consist of a segmented housing, one piece gasket and connecting balls and nuts as manufactured by Victaulic, ITT Grinnell, NAAPCO or equal. The materials shall comply with the following.

1. Housing shall be fabricated in two or more parts of malleable iron in compliance with “Standard Specification for Malleable Iron Castings” ASTM A47, Grade 32510 or ductile iron per ASTM A636. Housing shall be primed and painted with one coat of alkyd enamel.


B. For connection to flanged valves, fittings, etc., segmented, gasketed flanges for grooved end pipe or slip-on, gasketed, uni-flange may be used.

2.04 EXPANSION COUPLINGS

A. Couplings. The pipe couplings shall be of a gasketed, sleeve type with diameter to properly fit the pipe. Each coupling shall consist of one (1) steel middle ring, two (2) steel followers, two (2) rubber-compounded wedge section gaskets and sufficient track-head steel bolts to properly compress the gaskets. Field joints shall be made with this type of coupling.

1. The middle ring and followers of the coupling shall be true circular sections free from irregularities, flat spots, or surface defects. They shall be formed from mill sections with the follower-ring section of such design as to provide confinement of the gasket. After welding, they shall be tested by cold expanding a minimum of 1% beyond the yield point.

2. The coupling bolts shall be of the elliptic-neck, track-head design with rolled threads. The manufacturer shall supply information as to the recommended torque to which the bolts shall be tightened. All bolt holes in the followers shall be oval for greater strength.

3. The gaskets of the coupling shall be composed of a crude or synthetic rubber base compounded with other products to produce a material which will not deteriorate from age, from heat, or exposure to air under normal storage conditions. It shall also possess the quality of resilience and ability to resist cold flow of the material so that the joint will remain sealed and tight indefinitely when subjected to shock, vibration, pulsation and temperature or other adjustments of the pipe line.
B. Pipe ends preparation. The outside diameter of the plain ends of the pipe sections which are to be joined by an expansion coupling shall be smooth and round for a distance of 8" from each end. The pipe diameter variances shall comply with the coupling supplier’s requirements.

C. Expansion couplings shall be Smith Blair Style 411, or equal.

2.05 COATINGS
A. Interior. The interior surfaces of all ductile iron pipe and fittings shall have cement motor lining conforming to the requirements for a standard thickness lining per ANSI 21.4. The cement lining shall receive a seal coat of bituminous material per ANSI 21.4.

B. Exterior. All ductile iron pipe and fittings shall have an exterior coating of bituminous material per ANSI 21.51. Piping and fittings above ground and not insulated shall be field painted in accordance with Section 09902 - Painting.

2.06 POLYETHYLENE ENCASEMENT
A. All buried ductile iron pipe and fittings shall be wrapped with 8-mil polyethylene tubing or sheets in accordance with ANSI 21.5.

2.07 SUPPORT AND HANGERS
A. The Contractor shall furnish and install all necessary supports and hangers indicated on the plans or required for the proper installation of the ductile iron pipelines.

PART 3 EXECUTION
3.01 HANDLING
A. Care shall be taken to prevent injury to pipe or fittings during loading transport and unloading. Loading and unloading shall be performed in such a manner that the piece being moved is under perfect control at all times. Under no circumstances shall a pipe or large fitting be dropped.

B. Pieces shall be examined for defects. No piece which is known to be defective shall be laid or installed. Any piece found defective after being laid or installed shall be removed and replaced by the Contractor at no additional cost to the Owner.

3.02 LAYING AND INSTALLATION
A. Proper and suitable tools and equipment for the installation of the pipelines ad appurtenant valves and fittings in a safe and workmanlike manner shall be furnished and used on the work.

B. All pipelines shall be kept clean during construction. Small lines laid in excavated trenches shall have open ends or other openings plugged with temporary bulkheads or caps at any time the work will be left in an uncompleted state for a period of more than eight (8) hours. All costs incidental to the removal of all foreign objects from the pipe lines shall be borne by the Contractor at no additional cost to the Owner.

C. For buried pipelines, trench excavation shall be in accordance with Section 02221 – Excavating Trenching and Backfilling for Utilities, with the embedment and encasement accomplished in accordance with Section 02225 – Embedment and Encasement of Pipe. All pipelines shall be installed to grade and line as required by the plans.

D. Polyethylene encasement shall be installed as specified in ANSI 21.5. Care shall be taken not to damage film.

E. Elbows, tees, valves, crosses, reducers, adapters, bends and similar fittings causing a change in direction of fluid flow shall be blocked and anchored with concrete so that there is no movement of pipe due to internal or external pressures. Concrete thrust blocking shall be in accordance with Section 02225 – Embedment and Encasement of Pipe, and as indicated on the plans.

F. Where vertical P.I. angles are not standard pipe fittings, the pipe may be adjusted to match the profile by deflecting the joints near the P.I. The angle of deflection per joint shall not exceed the manufacturer’s recommended limits per joint.
3.03 INSTALLING MECHANICAL JOINTS

A. Rubber Gaskets shall have their surface cleaned with a wire brush and lubricated with soapy water prior to slipping the gasket over the spigot end of the pipe and into the bell of the adjoining pipe. The spigot shall be centered in the bell.

B. Bolts shall be tightened in such a manner as to bring the gland up towards the pipe flange at an even and uniform rate, maintaining approximately the same distance between the gland and the face of the flange around the perimeter at all times.

C. The normal ranges of bolt torques to be applied to standard iron bolts in joints are:

<table>
<thead>
<tr>
<th>Bolt Size, Inches</th>
<th>Range of Torque (ft-lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/8</td>
<td>40-60</td>
</tr>
<tr>
<td>3/4</td>
<td>60-90</td>
</tr>
<tr>
<td>1</td>
<td>70-100</td>
</tr>
<tr>
<td>1-1/4</td>
<td>90-120</td>
</tr>
</tbody>
</table>

D. Torque wrenches shall be available on the job to check the average pull required with a regular socket wrench of definite length. If a tight joint has not been attained at the maximum torque above indicated, the joint shall be disassembled and reassembled after cleaning. Overstressing of bolts to compensate for poor installation will not be permitted.

3.04 TESTING

A. Pipelines shall be subjected to a hydrostatic test as specified in Section 15042 – Disinfection and Testing of Structures and Pipes.

3.05 RESTRAINED JOINTS

A. Use Series 1100 Mega Lug Restrained Joints for all mechanical joints and on installations for fire hydrants, ring connections, blow off assemblies, and carrier pipe through encasements on all bores.

END OF SECTION
SECTION 33 1000
WATER DISTRIBUTION

PART 1 GENERAL

1.01  SCOPE OF WORK

A. This Section specifies the requirements for furnishing and installing water lines, laterals, stubs, and appurtenances for both potable and non-potable water distribution systems. The pipe shall be of the size, type and location, and to the lines, grades and elevations shown on the plans and constructed in accordance with these specifications.

1.02  RELATED WORK SPECIFIED ELSEWHERE

A. Section 31 23 33 Trenching, Backfilling, and Compaction
B. Section 31 41 33 Trench Safety

1.03  APPLICABLE PUBLICATIONS

A. The following publications of the latest issues listed below, but referred to thereafter by basic designation only, form a part of these specifications to the extent indicated by reference thereto:

1. American Water Works Association (AWWA)
   b. C 900 AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4" through 12", for Water Transmission and Distribution.
   c. C 151 AWWA Standard for Ductile Iron Pipe, Centrifugally Cast, for Water
   f. C 104 AWWA Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
   g. C 701-70 AWWA Standard for Cold-Water Meters-Turbine Type, for Customer Service
   h. C 703-70 AWWA Standard for Cold Water Meters Fire Service Type

   a. F 645 - Standard Guide for Selection, Design, and Installation of Thermoplastic Water-Pressure Piping Systems

3. National Fire Protection Association (NFPA)
   a. NFPA 24 - Standard for the Installation of Private Fire Service Mains and Their Appurtenances
   b. NFPA 70 – national electric code

4. National Sanitation Foundation International (NSF)
   a. NSF 14 Plastics Piping System Components and Related Materials
   b. NSF 61 Drinking Water System Components - Health Effects
1.04 PROJECT/SITE CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
   1. Follow the University of Houston’s Plant Operations Planned and Emergency Utility Outage Policy.

B. Do not proceed with interruption of water-distribution service without prior approval and coordination with local municipal water supplier.

1.05 SUBMITTALS

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

B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

C. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

D. Field quality-control test reports.

1.06 DEFINITIONS

A. LLDPE: Linear, low-density polyethylene plastic.

B. PE: Polyethylene plastic.

C. PP: Polypropylene plastic.

D. PVC: Polyvinyl chloride plastic.

1.07 QUALITY ASSURANCE

A. Regulatory Requirements for potable water systems:
   1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
   2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
   3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

B. Regulatory Requirements for Non-potable water systems
   1. The system shall be comprised of purple components. Use purple colored pipe, Pantone 522 embossed or integrally stamped/markd in English and in Spanish “CAUTION RECLAIMED WATER DO NOT DRINK” and “AGUA DE RECUPERACIÓN - NO BEBER”.
   2. A minimum of an eight inch by eight inch sign, in English and Spanish, is prominently posted on/in the area that reads “Reclaimed Water – Do not drink” and "AGUA DE RECUPERACIÓN - NO BEBER" on the storage tank of such non-potable system if within the construction site.

C. Piping materials shall bear label, stamp, or other markings of specified testing agency.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   1. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.

PART 2 PRODUCTS

2.01 PIPE

A. For water line construction 9 feet or more from any existing or proposed sanitary sewer, all materials and equipment shall be:
   1. New, or best grade and standard manufacture.
   2. PVC pipe and joints shall conform to AWWA C-900, latest edition, schedule 40 for 150 PSI rated systems and schedule 80 for 200 PSI rated systems.
   3. Ductile iron pipe shall conform to AWWA C 151, pipe class per Table 51.1, latest edition, standard outside coating with cement mortar lining to AWWA C 104 standards. All ductile iron pipe and fittings shall be wrapped with polyethylene per AWWA C 105.
   4. Fittings shall conform to AWWA C 110, latest edition, Pressure Rated 150 psi, 250 psi, 350 psi as directed by the engineer wrapped with polyethylene per AWWA C 105.

B. For construction within 9 feet of any existing or proposed sanitary sewer and all water services, all materials and equipment shall be:
   1. New, or best grade and standard manufacture.
   2. Ductile iron pipe shall conform to AWWA C 151, latest edition, standard outside coating with cement mortar lining to AWWA C104 standards. Wrap pipe with 8 mil polyethylene.
   3. PVC pipe and joints shall conform to AWWA C-900 - 200 psi pressure pipe.
   4. Fittings shall conform to AWWA C 110, latest edition, Pressure Rated 250 PSI, wrapped with polyethylene per AWWA C 105.

C. For offsets of water mains 6” and larger required to miss conflicts with other lines or objects, steel pipe shall be used meeting the requirements of AWWA 200, Schedule 40.

2.02 VALVES

A. Line Valves:
   1. Valves shall have a minimum working pressure of not less than 175 PSI.
   2. The operating nut shall be 2-inch square and shall have an arrow, cast in the metal, indicating the counter-clockwise direction of opening.
   3. Gate valves shall conform to AWWA C 500, latest edition, standard NRS bronze double disk type.
   4. Valves shall have push-on or mechanical joint hubs.

B. Tapping Valves:
   1. Tapping valves shall conform to AWWA Standard C 500, latest edition, standard NRS bronze double disc type water works valve.
   2. The operating nut shall be 2-inch square and shall have an arrow, cast in the metal, indicating the counter-clockwise direction of opening.
   3. Inlet shall be a Class 125 flange with a machined projection.
   4. Outlet shall be a standard push-on or mechanical joint.
   5. Valves shall have a minimum working pressure of not less than 175 psi.
C. Valves for Meter Installation:
   1. Commercial meter valves shall meet the specifications for line valves except that they shall have a handwheel, Class 125 flanges and shall open counter-clockwise.
   2. Fire flow meter valves shall be OS&Y double disc valves (line valves only), Fire Marshall approved, clockwise to close with Class 125 flanges.

2.03 VALVE BOXES
   A. Valve boxes shall be installed over each line and tapping valve except as otherwise noted.
   B. Lids shall be cast with the word "Water".
   C. Valve boxes shall be extension type with screw or locking slide adjustment with flapped base.

2.04 FIRE HYDRANTS
   A. Fire hydrants shall be as manufactured by Mueller Company, or approved equal, AWWA type, No. A 24015, 3 way 5 1/4 inch valve opening, bury as shown to a depth shown, 6 inch MJ shoe, open left, 1 1/2 inch top operating nut, 2 1/2 inch hose coupling, 4 1/2 inch pumper connection with national standard threads.

2.05 METERS
   A. All meters and meter boxes shall be of the size shown and meet the specifications of the local governing agency.

2.06 WATER
   A. All water used for testing and sterilizing must be supplied by municipal supplies approved by the state’s Department of Health.

PART 3 EXECUTION

3.01 LOWERING/RELOCATING EXISTING WATER LINES
   A. Water lines to be lowered/relocated shall not be shut down without prior approval of the local governing agency.
   B. Contractor shall install necessary valves so as not to disrupt service outside limits of water lines to be lowered/relocated whether or not indicated on the plans.
   C. Whether or not indicated on the plans, the lowered/relocated water line shall have minimum of four (4) feet of cover. Location shall be a minimum distance from existing location as necessary to facilitate construction.
   D. If the lowered/relocated water lines are of potable water systems, they shall be required to meet same hydrostatic and sterilization test results as new water lines.
   E. Installation of lowered/relocated water lines shall meet the same requirements of new water lines as in paragraph 3.2 below.

3.02 INSTALLATION
   A. The interior of the pipe shall be thoroughly cleaned of all foreign matter before lowered into the trench, and shall be kept clean during these operations.
   B. Pipes for potable water lines shall not be laid in water, or when trench or weather conditions are unsuitable for work.
   C. For potable water line installation, when work is not in progress, open ends of pipes and fittings shall be securely closed so that water, earth, or other substances will not enter the pipes or fittings.
   D. All bends, tees, valves, and plugs shall have thrust blocks installed in accordance with the details on the plans. Thrust blocking will be installed such that joints will be accessible for inspection and repair. Concrete used in thrust blocking shall have a compressive strength of at least 3,000 psi.
E. For potable water line installation, when a water line is to be installed such that it will cross over an existing or proposed sanitary sewer, a section of pipe at least 18' long of either ductile iron or PVC pipe C-900 (200 PSI) shall be installed such that it will be centered over the sanitary sewer. Water lines shall in no case be installed below a sanitary sewer.

F. For potable water line installation, when a water line is being installed parallel to a sanitary sewer, a horizontal distance of separation of nine (9) feet (outside to outside) must be maintained.

G. A minimum clearance of 6" must be maintained between water lines and all other utility lines.

H. When trenches exceed five feet in depth Contractor shall utilize trench safety measures per Section 31 50 00 Trench Safety.

3.03 TESTING

A. All water lines to be installed shall be hydrostatic tested and all potable water lines shall also be sterilized.

B. Hydrostatic Test

1. General
   a. After the pipe has been laid and initial backfill completed, the water line shall be subjected to a hydrostatic pressure of 150 psi. Joints shall remain exposed during testing whenever possible.
   b. The Contractor shall furnish, install, and operate, at his expense, the necessary connections, pumps, meters, and gauges necessary to conduct the test. The meters used in the testing shall be tested, sealed and approved at the Contractor's expense prior to running any test.

2. Procedures
   a. Before applying the specified pressure test, all air shall be expelled from the pipe by slowly filling each valved section of pipe with water and providing taps if necessary to expel trapped air.
   b. All pipe, fittings, and joints will be examined during testing.
   c. Any defective material shall be replaced with sound material and the test repeated until satisfactorily completed and approved.
   d. Allowable leakage shall not exceed 25 gallons per inch of diameter per mile of pipe per 24 hours. Minimum duration of testing for each section shall be 2 hours when joints are exposed and 8 hours when joints are covered.
   e. All visible leaks at exposed joints and all leaks evident on the surface where joints are covered, shall be replaced, regardless of total leakage shown.
   f. Where practicable, pipe lines shall be tested in lengths between valves or plugs of no more than 1500 feet. Contractor must have written approval for test sections greater than 1500 feet.

C. Sterilization

1. General
   a. After approved completion of the hydrostatic tests, the water distribution system shall be sterilized before acceptance for domestic operation.

2. Procedures
   a. Distribution system shall be disinfected using chlorine or chlorine compounds added to the water resulting in 50 ppm (parts per million) chlorine.
   b. After the water containing this amount of chlorine has been in contact with the pipe and appurtenances at least 24 hours, the water shall be replaced with water
to be transported normally, and samples of water taken and tested to assure that the disinfection procedure was effective.

c. No main shall be placed in service or accepted until water samples are approved by applicable regulatory agency.

d. Prepare reports of purging and disinfecting activities.

END OF SECTION
INTRODUCTION

This specification covers the design, manufacture, and testing of 1 in. (25 mm) through 36 in. (900 mm) Control Valves

PART 1 - GENERAL

A. Standard products - use the same manufacturer for multiple units of same type.

B. "Tying" of equipment into packages for the purpose of thwarting competition shall be considered to be in non-compliance with these specifications.

C. Manufacturers shall price items under different subsections or sections separately.

PART 2 - PRODUCTS

2.1 COMBINATION BACK PRESSURE AND SOLENOID SHUT-OFF CONTROL VALVE

A. FUNCTION

The Combination Back Pressure and Solenoid Shut-Off Control Valve shall automatically modulate to maintain upstream pressure above a preset minimum when activated by a solenoid control. (Specify: “energize to open” or “de-energize to open” for the solenoid). The solenoid control shall intercept the back pressure control and allow for remote override capability to close the main valve.

B. MATERIALS

1. Material Specification for the Back Pressure and Solenoid Shut-Off Control Valves Main Valve as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body &amp; Cover</td>
<td>Ductile Iron-ASTM A536</td>
</tr>
<tr>
<td>Main Valve Trim</td>
<td>Steel</td>
</tr>
<tr>
<td>Disc Retainer</td>
<td>Cast Iron</td>
</tr>
<tr>
<td>Diaphragm Washer</td>
<td>Cast Iron</td>
</tr>
<tr>
<td>Seat</td>
<td>Stainless Steel</td>
</tr>
<tr>
<td>Stem, Nut and Spring</td>
<td>Stainless Steel</td>
</tr>
<tr>
<td>Seal Disc</td>
<td>Buna-N® Rubber</td>
</tr>
<tr>
<td>Diaphragm</td>
<td>Nylon Reinforced Buna-N® Rubber</td>
</tr>
<tr>
<td>Internal Trim Parts</td>
<td>Stainless Steel; Bronze; Brass</td>
</tr>
</tbody>
</table>

Cast Steel or Bronze (optional)  
Other Materials Available (optional)
End Details

<table>
<thead>
<tr>
<th>Flanged (1-1/2&quot; – 36&quot;)</th>
<th>Threaded (1&quot; – 3&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grooved (1-1/2&quot; – 8&quot;)</td>
<td></td>
</tr>
</tbody>
</table>

Pressure Rating

| Class 150 lb. (250psi Max.) | Class 300 lb. (400psi Max.) |

Temperature Range

| Water to 180°F |

Any other wetted parts

| Stainless Steel; Bronze; Brass |

Coating

| Fusion Bonded Epoxy Coating (Interior and Exterior); ANSI / NSF 61 Approved / AWWA coating specifications C116-03 |

Optional Accessories

| Position Indicator, Limit Switch, Opening & Closing Speed Controls, Check Feature, Isolation Valves, Gauges, Anti Cavitation Trim, Etc. |

C. MANUFACTURE

1. Main Valve:

   a. The main valve shall be hydraulically operated, single diaphragm actuated, globe or angle pattern. The valve shall consist of three major components; the body with seat installed, the cover with bearing installed and the diaphragm assembly. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating the operating pressure from line pressure. Packing glands, stuffing boxes and/or rolling diaphragm technology will not be permitted and there shall be no pistons operating the main valve or pilot controls. No fabrication or welding shall be used in the manufacturing process. Y-pattern valves shall not be permitted. Main valve shall comply with NSF/ANSI Standard 61 and certified lead free to NSF/ANSI 372 as a safe drinking water system component.

2. Main Valve End Connections:

   a. End Connections for control valve shall be flanged per ASME/ANSI B16.42, Class 150 or Class 300 (1-1/2" thru 36") or Threaded End Connections (1" thru 3") or Grooved End Connections (1-1/2" thru 8").

3. Main Valve Body:

   a. No separate chamber(s) below the diaphragm shall be allowed between the main valve cover and body. No fabrication or welding shall be used in the manufacturing process.

   b. The valve shall contain a resilient, synthetic rubber disc with a rectangular cross-section contained on three and one half sides by a disc retainer and forming a tight seal against a single removable seat insert. No O-ring type discs (circular, square, or quad type) shall be permitted as the seating surface. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the discs firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edge sides and a radius at the top edge to prevent excessive diaphragm wear as the diaphragm flexes across this sur-
face. No hours-glass shaped disc retainers shall be permitted and no V-type or slotted-type disc guides shall be used.

c. The diaphragm assembly containing a non-magnetic stainless steel stem; of sufficient diameter to withstand high hydraulic pressures and shall be fully guided at both ends by a bearing in the main valve cover and an integral bearing in the valve seat. The valve seat shall be a solid, one-piece design and shall have a minimum five-degree taper on the seating surface for a positive, drip-tight shut off. No center guides shall be permitted. The stem shall be drilled and tapped in the cover end to receive and affix such accessories as may be deemed necessary. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating the operating pressure from the line pressure. No bolts or cap screws shall be permitted for use in the construction of the diaphragm assembly.

d. The flexible, non-wicking, FDA approved diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The diaphragm’s center hole for the main valve stem must be sealed by the vulcanized process or a rubber grommet sealing the center stem hole from the operating pressure. The diaphragm must withstand a Mullins Burst Test of a minimum of 600 X per layer of nylon fabric and shall be cycled tested 100,000 times to insure longevity. The diaphragm shall not be used as the seating surface. The diaphragm shall be fully supported in the valve body and cover by machined surfaces which support no less than one-half of the total surface area of the diaphragm in either the fully opened or fully closed position. Bellofram type rolling diaphragms shall not be permitted.

e. The main valve seat and stem bearing in the valve cover shall be removable. The cover bearing and seat in the 6” and smaller size valve shall be threaded into the cover and body. Valve seat in the 8” and larger size valves shall be retained by flat head machine screws for ease of maintenance. The lower bearing of the valve stem shall be contained concentrically within the seat and shall be exposed to the flow on all sides to avoid deposits. To insure proper alignment of the valve stem, the valve body and cover shall be machined with a locating lip. No “pinned” covers to the valve body shall be permitted. Cover bearing, disc retainer and seat shall be made of the same material. All necessary repairs and/or modifications other than replacement of the main valve body shall be possible without removing the valve from the pipeline. The valve shall be designed such that both the cover assembly and internal diaphragm assembly can be disassembled and lifted vertically straight up from the top of a narrow opening/vault. Y-pattern valves shall not be permitted. The seat shall be of the solid one piece design. Two piece seats or seat inserts shall not be permitted. Packing glands and/or stuffing boxes shall not be permitted.

4. Pilot Control System

a. The pressure relief/sustaining pilot shall be a direct-acting, adjustable, spring-loaded, diaphragm valve designed to permit flow when controlling pressure exceeds the adjustable spring setting. The pressure relief pilot control is normally held closed by the force of the compression in the spring above the diaphragm and it opens when the pressure acting on the underside of the diaphragm exceeds the spring setting. Pressure relief pilot control sensing shall be upstream of the pilot system strainer so accurate control may be maintained if the strainer is partially blocked. Pilot shall comply with NSF/ANSI 61 and certified lead free to NSF/ANSI 372 as a safe drinking water system component.
b. The pilot control system shall include a strainer, a fixed orifice closing speed and all required control accessories, equipment, control tubing and fittings. No variable orifices shall be permitted. The pilot system shall include an opening speed control on all valves sizes 3” and smaller as standard equipment. The pilot system shall include isolation ball valves on sizes 4” and larger as standard equipment. A full range of spring settings shall be available in ranges of 0 to 400 psi. Pilots to be manufactured by control valve manufacturer.

c. The solenoid pilot control shall be a direct acting three way solenoid valve controlling a two way auxiliary hydraulic diaphragm valve. Solenoid is controlled by an external electrical power source. Solenoid shall have a NEMA IV enclosure.

5. Material Specification for Pilot Control

<table>
<thead>
<tr>
<th>System: Component</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Relief/Sustaining Pilot Control</strong></td>
<td></td>
</tr>
<tr>
<td>Body &amp; Cover</td>
<td>Cast Bronze ASTM B62</td>
</tr>
<tr>
<td>Pilot Trim</td>
<td>Brass &amp; Stainless Steel 303</td>
</tr>
<tr>
<td>Rubber</td>
<td>Buna-N</td>
</tr>
<tr>
<td>Connections</td>
<td>FNPT</td>
</tr>
<tr>
<td>Pressure rating</td>
<td>400 psi Max.</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>Water to 180°F Max.</td>
</tr>
<tr>
<td><strong>Auxiliary Diaphragm Pilot Valve</strong></td>
<td></td>
</tr>
<tr>
<td>Body &amp; Cover</td>
<td>Bronze, Low Lead CuZn21Si3P or UNS C87850</td>
</tr>
<tr>
<td>Trim</td>
<td>Brass &amp; Stainless Steel 303</td>
</tr>
<tr>
<td>Rubber</td>
<td>Buna-N®</td>
</tr>
<tr>
<td>Connections</td>
<td>FNPT</td>
</tr>
<tr>
<td>Pressure rating</td>
<td>400 psi Max.</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>Water to 180°F Max.</td>
</tr>
<tr>
<td><strong>Solenoid Pilot Control</strong></td>
<td></td>
</tr>
<tr>
<td>Body</td>
<td>Brass B283 (standard)</td>
</tr>
<tr>
<td>Pilot Trim</td>
<td>Brass &amp; 303 Stainless Steel</td>
</tr>
<tr>
<td>Seals and Disc</td>
<td>NBR</td>
</tr>
<tr>
<td>Core and Plugnut</td>
<td>430F Stainless Steel</td>
</tr>
<tr>
<td>Core Springs</td>
<td>302 Stainless Steel</td>
</tr>
<tr>
<td>Shading Coil</td>
<td>Copper</td>
</tr>
<tr>
<td>Disc-Holder</td>
<td>CA</td>
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<tr>
<td>Core Guide</td>
<td>CA</td>
</tr>
<tr>
<td>Connections</td>
<td>FNPT</td>
</tr>
<tr>
<td>Pressure rating</td>
<td>400 psi Max.</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>AC: Water to 125°F Max.</td>
</tr>
<tr>
<td>Power Supply</td>
<td>DC: Water to 104°F Max.</td>
</tr>
<tr>
<td></td>
<td>120VAC / 60 Hz (standard)</td>
</tr>
<tr>
<td></td>
<td>Other AC Voltages (optional)</td>
</tr>
<tr>
<td></td>
<td>Other DC Voltages (optional)</td>
</tr>
</tbody>
</table>
### Enclosure
- NEMA Type 1, General Purpose, Watertight (standard)
- Other NEMA Types, including Explosion proof (optional)

### Manual Operator
- (optional)

### Control Tubing
- Copper
- Stainless Steel (optional)
- Flexible Braided Stainless Steel (optional)
- Polyethylene (optional)

### Control Fittings
- Brass
- Stainless Steel (optional)

---

6. **Factory Assembly:**
   
   a. Each control valve shall be factory assembled.
   
   b. For all control valves, the factory assembly shall include the complete main valve, pilot valve(s), and all associated accessories. Each control valve shall be factory assembled.
   
   
   d. For all control valves, the factory assembly shall include the complete main valve, pilot valve(s), and all associated accessories and control equipment.
   
   e. During factory assembly the control valve manufacturer shall make all necessary adjustments and correct any defects.

7. **Nameplates:**
   
   a. Each Control Valve and associated pilot(s) shall be provided with an identifying nameplate.
   
   b. Nameplates, depending on type and size of control valve, shall be mounted in the most practical position possible, typically on the inlet side of the valve body.
   
   c. Nameplates shall be brass and a minimum of 3/32" thick, ¾" high and 2-3/4" long.
   
   d. Pertinent control valve data shall be etched or stamped into the nameplate. Data shall include control valve Catalog number, function, size, material, pressure rating, end-connection details, type of pilot controls used and control adjustment range.

8. **Factory Testing:**
   
   a. Each control valve shall be factory tested.
   
   
   c. Tests shall conform to approved test procedures.
d. The standard factory tests shall include a valve body and cover leakage test, seat leakage test and a stroke test. Control valves and pilot valves, in the partially open position, with both ends closed off with blind flanges (valves) and pipe plugs (pilots), shall be subject to an air test. The applied air pressure shall be 90 psi minimum. All air pressure tests shall be applied for a minimum of 15 minutes. No visible leakage is permitted through the valve seat, the pressure boundary walls of the valve body, valve cover, pilot body, pilot cover or the body-cover joint.

e. Control valve manufacturer shall, upon request, offer additional testing, such as high pressure hydrostatic testing, positive material inspection testing, ferrite testing, liquid penetration inspection testing, magnetic particle examination testing and radiographic examination testing.

D. PRODUCT DATA

1. The following information shall be provided:
   a. Control Valve manufacturer’s technical product data.
   b. Control Valve manufacturer’s Installation, Operation and Maintenance manual (IOM).

2. Provide specific information on all optional features specified above and confirm that these items are provided.

3. The valve manufacturer shall be able to supply a complete line of equipment from 1” through 48” sizes and a complete selection of complementary accessories and equipment.

4. The control valve manufacture shall provide a computerized cavitation analysis report which shows flow rate, differential pressure, and percentage of valve opening. Cv factor, system velocity, and if there will be cavitation damage.

PART 3 - EXECUTION

A. DELIVERY, STORAGE AND HANDLING

1. Delivery
   a. The Manufacture shall deliver the control valves to:

      Address, City, State, Zip. Attention: Phone number:
      Call 48 hours prior to delivery.

   b. Upon delivery, control valves to be unloaded and stored by the:

      Owner, district or municipality.
2. Packing and Shipping

   a. Control valves specified herein shall be factory assembled. Any control valve
      appurtenances, accessories, parts and assemblies that are shipped unassembled shall be
      packaged and tagged in a manner that will protect the equipment from damage and facilitate
      the final assembly in the field.

   b. Care shall be taken in loading, transporting and unloading to protect control valves,
      appurtenances, or coatings from damage. Equipment shall not be dropped. All control valves
      and appurtenances shall be examined before installation and no piece shall be installed
      which is found to be defective. Any damage(s) shall be repaired.

   c. Prior to shipping, the control valves and all associated accessories shall be acceptably
      packaged and covered to prevent entry of foreign material.

   d. All packaged control valves shall be shipped, remain covered and stored on site until they
      are installed and put into use.

B. FIELD TESTING

   1. A direct factory representative shall be made available by the equipment supplier for start-up
      service, inspection and necessary adjustments.

The Control Valve manufacturer shall warrant the valve to be free of defects in material and workmanship for
a period of three years from date of shipment provided the valve is installed and used in accordance with all
applicable instructions. Electrical components shall have a one-year warranty.

The control valve shall be CLA-VAL Company Model No. 58-01, Combination Back Pressure and Solenoid
Shut-Off Control Valve, as manufactured by Cla-Val Co., Newport Beach, CA 92659-0325.

END OF SECTION
SECTION 33 1300
DISINFECTION OF WATERLINES

PART 1 GENERAL

1.01 DESCRIPTION
A. This specification specifies the procedure for disinfection of water systems, and in general, conforms to AWWA C651, Disinfecting Water Mains including Section 4.3.9.

PART 2 PRODUCTS

2.01 MATERIALS
A. CHLORINE AND WATER
1. Chlorine
   Calcium hypochlorite, or equal, which contains sixty-five (65%) percent chlorine by weight.
2. Water
   Water for disinfection will be metered and furnished to the Contractor at no cost. Existing water lines are to remain isolated from newly laid water lines by a physical air gap until the original copy of the negative coliform test results have been received by the Engineer from either the County Health Department or an approved TCEQ lab.

2.02 TESTING REQUIREMENTS
A. CHLORINE RESIDUAL-DROP DILUTION METHOD
   The drop dilution method of approximating total residual chlorine is suitable for concentrations above 10 mg/L, such as are applied in the disinfection of water mains or tanks.
1. Apparatus
   a.) A graduated cylinder for measuring distilled water.
   b.) An automatic or safety pipet
   c.) A dropping pipet that delivers a one-milliliter (1 ml) sample in twenty (20) drops. This pipet is for measuring the water sample and should not be used for any other purpose.
   d.) A comparator kit containing a suitable range of standards.
2. Procedure
   a.) Ascertain the volume of the comparator cell and using an automatic or safety pipet, add 0.5 ml of orthotolidine for each 9.5 ml of distilled water to be added.
   b.) Using a graduated cylinder, add a measured volume of distilled water.
   c.) With the dropping pipet, add the water sample a drop at a time, allowing mixing, until a yellow color is formed that matches one of the color standards.
   d.) Record the total number of drops used and the final chlorine value obtained.
   e.) Calculate the milligrams per liter residual chlorine as follows:
      i. Multiply by twenty the number of milliliters of distilled water used in Step 2.
      ii. Multiply product in step a. by the final chlorine value in milligrams per liter recorded in Step 4.
iii. Divide the product found in step b. by the total number of drops of water sample recorded in Step 4.

PART 3 EXECUTION

3.01 GENERAL

A. During the construction operations, workmen shall be required to use utmost care to see that the inside of pipes, fittings, jointing materials, valves, etc., which will come into contact with potable water be maintained in a sanitary condition.

B. Every effort must be made to keep the inside of the pipe, fittings, and valves free of all foreign matter, sticks, dirt, rocks, etc. As each joint of pipe is being laid, it must be effectively swabbed so that all foreign matter is removed. Placing dry powdered chlorine in the pipeline will be permitted in conjunction with certain methods of sterilization as specified by the Engineer. All fittings and exposed open ends of pipe must be blocked with a plug or capped until the line is completed.

C. Sterilization of the line, or any section thereof, shall not be commenced until the Engineer has approved the method, apparatus, sterilizing agent, and the section of the line.

D. When the entire pipeline, or certain section thereof, has been completed, tested, and made ready for use, the line or section of line shall be thoroughly sterilized according to the following procedure:

1. The Contractor shall provide all necessary taps to complete this section of the specifications.

2. The water main shall be flushed prior to disinfection.

3. The flushing velocity shall be greater than 2.5 feet per second. The rate of flow required to produce this velocity in various diameters is shown in Table 1. No site for flushing should be chosen, unless it has been determined by the Engineer or Inspector that drainage is adequate at that site. Flushing is no substitute for preventive measures taken before and during pipe laying. Certain contaminants, especially in caked deposits, resist flushing at any velocity.

TABLE 1
REQUIRED OPENINGS TO FLUSH PIPELINES (40 PSI RESIDUAL PRESSURE)

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Flow (gpm) Required to Produce 2.5 fps</th>
<th>Orifice Size (in.)</th>
<th>Number of Hydrant Outlet</th>
<th>Size (in.) of Hydrant Outlet</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>10</td>
<td>15/16</td>
<td>1</td>
<td>2-½</td>
</tr>
<tr>
<td>6</td>
<td>220</td>
<td>1-3/8</td>
<td>1</td>
<td>2-½</td>
</tr>
<tr>
<td>8</td>
<td>390</td>
<td>1-7/8</td>
<td>1</td>
<td>2-½</td>
</tr>
<tr>
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<td>610</td>
<td>2-5/16</td>
<td>1</td>
<td>2-½</td>
</tr>
<tr>
<td>12</td>
<td>880</td>
<td>2-13/16</td>
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<td>2-½</td>
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<td>1200</td>
<td>3-¾</td>
<td>2</td>
<td>2-½</td>
</tr>
<tr>
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<td>3-5/8</td>
<td>2</td>
<td>2-½</td>
</tr>
<tr>
<td>18</td>
<td>1980</td>
<td>4-3/16</td>
<td>2</td>
<td>2-½</td>
</tr>
</tbody>
</table>

Note: A 2-½" hydrant outlet nozzle will discharge approximately 1,000 gpm and a 4-½" hydrant outlet nozzle will discharge approximately 2,500 gpm with 40 psi residual pressure.
E. METHODS OF CHLORINE APPLICATION

1. Continuous Feed Method

   Note: This method is suitable for general applications.

   a. Water from the existing distribution system, or other pre-approved sources of supply, shall be made to flow at a constant, measured rate into the newly laid pipeline. The water shall receive a dose of chlorine concentration until the water in the pipe maintains a minimum of fifty milligrams per liter (50 mg/l) available chlorine. To assure that this concentration is maintained, the chlorine residual should be measured at regular intervals in accordance with the procedures described herein.

   Note: In the absence of a meter, the rate may be determined either by placing a pitot gauge at the discharge, or by measuring the time to fill a container of known volume.

Table 2 gives the amount of chlorine residual required for each 100 feet of pipe of various diameters. Solutions of one percent (1%) chlorine may be prepared with approximately one pound (1 lb.) of calcium hypochlorite (65% strength) in 8.5 gallons of water.

| Table 2 |
|-----------------|-----------------|-----------------|
| **Pipe Size (in.)** | **100% Chlorine (lb/100ft)** | **1% Chlorine Solution (gal/100ft)** |
| 4     | 0.027           | 0.33            |
| 6     | 0.061           | 0.73            |
| 8     | 0.108           | 1.30            |
| 10    | 0.170           | 2.04            |
| 12    | 0.240           | 2.88            |
| 16    | 0.427           | 5.12            |
| 18    | 0.540           | 6.48            |
| 24    | 0.960           | 11.50           |
| 30    | 1.500           | 18.00           |
| 36    | 2.160           | 25.90           |
| 42    | 2.940           | 35.30           |

b. During the application of the chlorine, valves shall be manipulated to prevent the treatment dosage from flowing back into the line supplying the water. Chlorine application shall not cease until the entire main is filled with the chlorine solution. The chlorinated water shall be retained in the main for at least twenty-four (24) hours during which time, all valves and hydrants in the section treated shall be operated in order to disinfect the appurtenances. At the end of this twenty-four (24) hour period, the treated water shall contain no less than fifty (50) milligrams per liter and no more than one hundred (100) milligrams per liter chlorine throughout the length of the main. A dosage of more than the maximum allowable chlorine will require the Contractor to dilute the flush
water with one of the TCEQ approved dilution chemicals. The chemical and description of procedure will be submitted in writing to the Engineer for approval.

2. Slug Method
   This method is suitable for use with mains of large diameter for which, because of the volume of water involved, the continuous feed method is not practical.
   a.) Water from the existing distribution system shall be made to flow at a constant, measured rate (see C.1.a. Note) into the newly laid pipeline. The water shall receive a dose of chlorine, also fed at a constant, measured rate. The two (2) rates shall be proportioned so that the concentration of the water entering the pipeline is maintained at no less than 300 milligrams per liter. As the chlorinated water passes along the line, it shall expose all interior surfaces to a concentration of at least 300 mg/L for at least three (3) hours. The application shall be checked at a tap near the upstream and downstream end of the line by chlorine residual measurements made according to the procedures described herein.
   b.) As the chlorinated water flows past tees and crosses, related valves and hydrants shall be operated so as to disinfect appurtenances.

3. Dry Treatment during Installation
   The dosage and application of sodium hypochlorite will be determined by the following:
   a.) Calculate weight of sodium hypochlorite required for water to be treated utilizing Table 2.
   b.) Add required amount of solution at the bell of each pipe as it is installed.

F. FINAL FLUSHING
   After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine concentration in the water leaving the main is less than three milligrams per liter (3 mg/L). Chlorine residual determination shall be made by the Inspector to ascertain that the heavily chlorinated water has been removed from the pipeline.

G. BACTERIOLOGIC TESTS
   1. Before the water main is placed in service, a sample or samples shall be collected from points designated by the Inspector and tested for bacteriologic quality. This sample shall be collected 24 hours after final flushing. The test shall show the absence of coliform organisms before the water main may be placed in service. At least one (1) sample per one thousand (1000) feet of new line or portion thereof shall be taken. Sampling shall be supervised by the Inspector. Samples shall be submitted by the city to a TCEQ approved laboratory and/or County Health Department for analysis.
   2. Samples of bacteriologic analysis shall be collected in sterile bottles obtained from the Brazos County Health Department. Samples shall be collected at points specified by the Engineer.
   3. A suggested sampling tap consists of a standard corporation cock installed in the main with a copper tube gooseneck assembly. After samples have been collected, the gooseneck assembly may be removed and retained for future use.

H. REPETITION OF PROCEDURE
   1. If the initial disinfection fails to produce samples with no coliform present, the contractor shall re-disinfect the line following the procedures stated in 695.04 of this
specification until samples indicating no coliform present have been obtained. When the samples indicate no coliform present and the Engineer has received original copies of the test report, the main may be placed in service.

3.02 PROCEDURE AFTER CUTTING INTO OR REPAIRING EXISTING MAINS

A. The procedure outlined in this section applies primarily when mains are wholly or partially dewatered. Leaks or breaks that are repaired with clamping devices while the mains remain full of water under pressure present little danger of contamination and require no disinfection.

1. Trench “Treatment”

When an old line is opened, either by accident or by design, the excavation will likely be wet and badly contaminated. Liberal quantities of hypochlorite applied to open trench areas will lessen the danger from such pollution. Tablets have the advantage in such a situation because they dissolve slowly and continue to release hypochlorite as water is pumped from the excavation.

2. Main Disinfection

a.) Swabbing and Flushing. The following procedure is considered as a minimum that may be used.

i. Swabbing With Hypochlorite Solution: The interior of all pipe and fittings used to make the repair (particularly couplings and tapping sleeves) shall be swabbed with a 5 percent hypochlorite solution before they are installed.

ii. Flushing: Thorough flushing is the most practical means of removing contamination introduced during repairs. If valving and hydrant locations permit, flushing from both directions is recommended. Flushing shall be started as soon as the repairs are completed and continued until discolored water is eliminated.

3. Slug Method: In addition to the swabbing and flushing procedures of section B.1., the section of main in which the break is located can be flushed and chlorinated using the slug method where practical, as determined by the Engineer or Inspector. This method requires isolating the section of main, shutting off all service connections, flushing the main, and chlorinating the main as described in the Slug Method in C.2, except that the dose may be increased to as much as 500 mg/1, and the contact time reduced to as little as ½ hour. After chlorination, flushing shall be resumed and continued until discolored water is eliminated.

4. Sampling: Bacteriologic samples shall be taken after repairs to provide a record by which the effectiveness of the procedures used can be determined by the Inspector. If the direction of flow is unknown, samples shall be taken on each side of the main break.

END OF SECTION
SECTION 33 3113
SANITARY SEWERAGE SYSTEM

PART 1 GENERAL
1.01 DESCRIPTION
A. This is a general specification, which applies to the furnishing of all plant, labor, equipment, appliances and materials and in performing all operations in connection with the construction of sanitary sewers, together with the manholes, cleanout structures and other incidentals, in accordance with the plans and these specifications.

1.02 RELATED WORK
Section 31 23 33 - Excavating, Trenching, & Backfill
Section 33 05 01 - PVC Pipe & Fitting
Section 33 05 02 - Ductile Iron Pipe
Section 33 39 13 – Manholes

1.03 SUBMITTALS
A. All submittal requirements are listed with the material specifications

PART 2 PRODUCTS
2.01 TESTING REQUIREMENTS
See: Section 33 0130 - Testing Of Gravity Sewer Systems

PART 3 EXECUTION
3.01 GENERAL
Construction methods for each material are specified in the material specifications.

A. Minimum Depth: The desired depth for sanitary sewer pipe shall be six feet (6') as measured from the outside top of pipe vertically to finished ground or pavement surface elevation. The minimum depth shall be two feet (2'). Where the cover is 3.5' or less, ductile iron pipe should be used and cement stabilized sand backfill required where erosion may occur.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION

A. This is a general specification, which applies to the furnishing of all labor, materials, tools, and equipment to perform all operations in connection with leakage testing for completed manholes and gravity sewer pipe and deflection testing for flexible sewer pipe.

PART 2 PRODUCTS

2.01 TESTING REQUIREMENTS

A. MANHOLE TESTING

After completion of manhole construction, wall sealing, or rehabilitation, test manholes for leakage using Vacuum Testing or, if pre-approved by the Engineer, Exfiltration Testing Procedures as specified herein.

1. General

Plug influent and effluent lines, including service lines, with suitably sized pneumatic or mechanical plugs. Ensure plugs are properly rated for pressures required in this test; follow Manufacturer’s safety and installation recommendations. Place plugs a minimum of 6 inches outside of manhole walls.

2. Vacuum Testing

a.) To perform a vacuum test, all lift holes and exterior joints shall be plugged with a non-shrink grout and all pipes entering a manhole shall be plugged.

b.) No grout must 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.

194x129

d.) Contractor shall use a minimum 60 inch/lb torque wrench to tighten the external clamps that secure a test cover to the top of a manhole.

194x100
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.

194x52

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.

3. 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.) Seal all wastewater pipes coming into a manhole with an internal pipe plug, fill the manhole with water up to the manhole cover 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.
B. GRAVITY PIPE LEAKAGE TESTING

1. General

Tests shall be made by the low-pressure air test, the infiltration test or the joint test. The infiltration test shall be used when the groundwater level is at least 2 ft above the crown of the pipe measured at the upstream manhole. The joint test shall be used for pipe sections greater than 36-inch inside diameter. The Contractor may use the joint test for pipe with a 27-inch through 36-inch average inside diameter at the approval of the Engineer or his representative. The low-pressure air test, the infiltration test and the exfiltration test shall be conducted from manhole to manhole. Trenches shall be completely backfilled and sewer line should be free of debris prior to testing. Plug all pipe outlets including laterals and secure plugs to prevent leakage blowout due to testing pressure.

2. Infiltration Test

a.) Performance:

The total infiltration, as determined by a hydrostatic head test, shall not exceed 50 gallons per inch of diameter per mile of pipe per 24 hours at a minimum test head of 2.0 feet above the crown of a pipe at an upstream manhole. For construction within the 100-year flood plain, the total infiltration shall not exceed ten gallons per inch of diameter per mile of pipe per 24 hours.

<table>
<thead>
<tr>
<th>SIZE OF PIPE</th>
<th>ALLOWABLE LEAKAGE*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gal/Min/100 Ft.</td>
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<tr>
<td>6&quot;</td>
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</tr>
<tr>
<td>36&quot;</td>
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</table>

* Equivalent to 50 gal. per inch diameter per mile per 24 hours
### Construction Within 100 Yr Flood Plain

<table>
<thead>
<tr>
<th>Size of Pipe</th>
<th>Allowable Leakage* Gal/Min/100 Ft.</th>
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<tbody>
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<td>0.0047</td>
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</table>

*Equivalent to 10 gal. per inch diameter per mile per 24 hours

The total leakage in cubic inches shall be the total cross-sectional area in square inches of the inside of the two risers and of any stacks in the sewer multiplied by the drop in water level in inches. For diameters not listed in chart, multiply the square of the diameter by the following chart value for 1" diameter.

<table>
<thead>
<tr>
<th>Diameter of Riser or Stack</th>
<th>Volume Per Inch of Depth</th>
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</thead>
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<tr>
<td></td>
<td>Cubic Inch</td>
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<td>28.7243</td>
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<td>8&quot;</td>
<td>50.2655</td>
</tr>
</tbody>
</table>
b.) *Execution:*

Stop all dewatering operations and allow the groundwater to return to its normal level and allow to remain so for at least 24 hours. Leakage shall be determined by measuring the flow through the opening in the downstream plug for at least 15 minutes. Five separate measurements shall be made. The average of the measurements shall be used, discarding any one of the five measurements except the last that varies by more than 50% from the average of the other four. If the results of the tests are otherwise satisfactory, but the last of the five measurements show leakage in excess of that permitted, the tests shall be continued to determine if additional leaks may have developed during testing.

3. **Air Test**

a.) *Performance:*

The pipe shall be pressurized to 5 pounds per square inch gauge (psig) greater than the pressure exerted by groundwater above the pipe. Once the pressure is stabilized, the minimum time allowable for the pressure to drop 1.0 psig shall be 5 minutes per every 100 feet of pipe plus (+) 5 minutes per each service connection. Pipe sizes larger than 27 inches shall be tested as per TCEQ requirements.

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 as outlined in this subparagraph or until failure.

b.) *Execution:*

Add air until the internal air pressure of the sewer line is raised to approximately 5.5 psig. Allow the air pressure to stabilize. The pressure will normally drop until the temperature of the air in the line stabilizes.

When the pressure has stabilized and is at or above the starting test pressure of 5 psig, commence the test by allowing the gage pressure to drop to 5 psig at which point the time recording is initiated. Record the drop in pressure for the test period.

4. **Joint Test**

The joint test may be conducted by an air test or water test. The joint and the pipe segment shall be visually inspected immediately after testing.

a.) *Performance:*

The pipe is to be pressurized to 3.5 psig greater than the pressure exerted by groundwater above the pipe. Once the pressure has stabilized, the minimum time allowable for the pressure to drop from 3.5 psig to 2.5 psig shall be ten seconds.

If the groundwater pressure is equal to or greater than 3.5 psig, and the sewer line or joint is not leaking the sewer line or joint is acceptable and no additional testing is required. If one or more joints are leaking, but the total amount of leakage in the sewer line being tested is equal to, or less than, the allowable leakage specified in 250.03-B-1 “Performance”, the line is acceptable and no additional testing is required provided visible leaks are repaired. Moisture or beads of water appearing on the surface of the joint
will not be considered as visible leakage.

b.) Execution:

Review proper operation, safety, and maintenance procedures as provided by the manufacturer of the joint test apparatus. Move the joint test apparatus into the sewer line to the joint to be tested and position it over the joint. Make sure the end element sealing tubes straddle both sides of the joint and the hoses are attached. For the water test, the bleed-off petcock must be located at top dead center. Inflate end element sealing tubes with air in accordance with equipment and manufacturer’s instructions.

i. Air Test - Pressurize the void volume with air to 3.5 psig greater than the pressure exerted by groundwater above the pipe. The drop in pressure shall be measured over ten seconds. Five separate measurements shall be made. The average of the measurements shall be used, discarding any one of the five measurements except the last that varies by more than 50% from the average of the other four. If the results of the tests are otherwise satisfactory, but the last of the five measurements show leakage in excess of that permitted, the tests shall be continued to determine if additional leaks may have developed during testing.

ii. Water Test - Introduce water into void volume until water flows evenly from open petcock. Close the petcock and pressurize with water to 3.5 psig above the pressure exerted by ground water. The drop in pressure shall be measured over ten seconds. Five separate measurements shall be made. The average of the measurements shall be used, discarding any one of the five measurements except the last that varies by more than 50% from the average of the other four. If the results of the tests are otherwise satisfactory, but the last of the five measurements show leakage in excess of that permitted, the tests shall be continued to determine if additional leaks may have developed during testing.

C. DEFLECTION TESTING

Deflection tests 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 pre-approved by the Engineer shall be used to test for vertical deflections. Other methods shall provide a precision of two tenths of one percent (0.2%) deflection. The test shall be conducted after the final backfill has been in place at least 30 days. No pipe shall exceed a deflection of 5.0%. If a pipe should fail to pass the 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.

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 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. A proving ring shall be provided and used for each size mandrel in use.

3. Method Options

Adjustable or flexible mandrels are prohibited. A television inspection is not a substitute for the deflection test. A deflectometer may be approved for use on a case-by-case basis. Mandrels with removable legs or runners may be accepted on a case-by-case basis. Mechanical devices will not be used to pull the mandrel.

D. O.S.S.F. TESTING

Testing for On-Site Sewage Facility shall meet applicable requirements set forth by Chapter 285 of the Texas Administrative Code, the Texas Commission on Environmental Quality (TCEQ), and/or Houston County.

E. TV CAMERA INSPECTION

T.V. Camera Inspection shall be performed on all sewer pipe installed before acceptance. When the Contractor performs the inspection, the Engineer or his representative shall be notified one working day prior so that he can view the procedure. The inspection shall be in digital video format, saved to a DVD or CD (enclosed within a protective case) and shall be given to the Engineer or his representative for review and final records.

The lines shall be completely filled with potable water between manholes to fill the service connections and drained prior to T.V. Camera Inspection. Line shall be cleaned prior to T.V. inspection. All dirt/debris, including pipe grease, in the line which could cover a defect shall be removed. Line should be cleaned before being filled with water. Jetting of the lines in conjunction with the T.V. Inspection is prohibited. If the line to be televised is discovered to contain foreign material, which prohibits an acceptable T.V. inspection, the line shall be jetted and televised again.

Select and use closed circuit television equipment that will produce a color digital video that clearly shows pipe, joints and all appurtenances, and shall be a self-propelled tractor-type system. Produce and use closed circuit television equipment using a panorama tilt, radial viewing, pipe inspection camera that pans plus and minus 75 degrees, rotates 360 degrees, and has optical zoom from 6 or less inches to infinity. The camera must have an accurate footage counter accurate to within 1 foot per 500 foot of pipe. Footage shall be continuously displayed on the video at all times. The camera operator shall pause at each tee, tilt camera and view up into the branch for inspection of joints and fittings maintaining a clear in focus picture at all times while zooming to the full extent of the camera. The camera operator shall stop at each fitting and change in pipe type and complete a 360 degree view of the fitting slow enough to identify all defects. Glare shall be avoided and shall not interfere with viewing the pipe segment. Maximum rate of travel for the camera shall be 30 feet per minute. DVDs or CDs shall be continuous from pipe segments between manholes. Provide DVDs or CDs with labels indicating project number, segment number, date televised, date submitted, starting manhole number, ending manhole number, pipe diameter, pipe length and street name.

The T.V. inspection shall be used to identify defective construction such as sags, debris, separated joints, etc. The Engineer shall make all final determinations if the severity of the defect constitutes failure and subsequent removal of the segment in question.
F. RETESTS

Manholes or sewers which fail to meet the testing requirements shall be repaired and retested by the Contractor. All repairs and retesting shall be performed at the expense of the Contractor.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall notify the Engineer or his representative when the manholes and line are ready to be tested. After the Engineer or his representative concurs that the line is ready to be tested, the Contractor may proceed with testing. The Contractor will supply and set-up the test plugs and risers for the test and will perform the test in the presence of the Engineer or his representative.

B. Contractor shall take such precautions as required to prevent damage to lines and appurtenances being tested. Damage resulting from tests shall be repaired at Contractor's expense.

END OF SECTION
SECTION 33 3913
MANHOLES

PART 1 GENERAL
1.01 DESCRIPTION
A. This item shall govern the manufacture, construction, and installation of sanitary sewer manholes. All manholes shall conform to TCEQ requirements. Submittal and approval shall be required for all pre-cast design.

PART 2 PRODUCTS
2.02 MATERIALS
A. Concrete: Refer to SECTION 03 3010 – SITE CONCRETE
B. Manhole Rings and Covers: The standard rings and covers (V-1432-3) and the water-tight ring and cover (V-2432-3) shall be manufactured by East Jordan Iron Works (or pre-approved equal.) The manhole shall bear the appropriate model number, the logo of City and the words "Sanitary Sewer". The cover shall have pick lugs cast into the surface. All manhole ring and covers shall have a 32” diameter.
C. Grade Rings: Grade rings shall be precast reinforced concrete. Minimum thickness shall be 2 inches by 8 inches wide by 30 inches inside diameter.
D. Precast Reinforced Manhole Sections: Precast manhole sections conform to the current ASTM C478 standard. Joints shall be O-ring gasketed. Thickness for manhole risers shall be as listed under wall “B” in the “Class Tables” of ASTM C76, Reinforced Concrete Pipe.
E. Pre-Cast Manhole Bases: Pre-cast manhole bases will conform to all TCEQ requirements and City Specifications for invert depths, reinforcement, base thickness and manhole depth for pipe size.

2.03 TESTING REQUIREMENTS
See SECTION 33 0130 - TESTING OF GRAVITY SEWER SYSTEMS.

PART 3 EXECUTION
3.01 INSTALLATION
A. Manhole Bases:
   1. Construct manhole bases in the configuration shown on the Plans. Minimum thickness below the flowline of sewer shall be 8 inches or as shown on the details.
   2. Insure that bases are constructed or installed on firm ground and that ground water is controlled. Install appropriate material for a minimum of 4” to stabilize bottom if directed to do so by the Engineer.
   3. The invert of manholes shall be formed in such a fashion that they are smooth and will not obstruct flow of sewage. Provide flow channels in the manhole base equivalent to the top of the pipe by forming the concrete base and trowelling it to a smooth, even finish with a steel trowel. Slope the manhole bench from the wall line to edge of flow channel and trowel it smooth on a grade of 1 inch per foot with a liberal radius applied at flow channel intercepts.
B. Precast Manholes:
   1. Precast Manhole bases shall be placed on a 6” minimum depth layer of cushion sand, gravel or pre-approved material.
2. Cast bottom section of precast manhole riser ring in manhole base as shown on the Plans. Place “Synko-Flex” waterstop (or pre-approved equal) per manufacturer’s recommendations prior to setting precast starter ring.

The base shall have a minimum diameter 12 inches greater than the outside diameter of the manhole, and a minimum thickness including the area under the pipe as follows:

- 0’ to 12’ deep manhole: 8” base thickness
- Greater than 12’ depth: 12” base thickness

3. All invert channels shall be smooth and accurately shaped to a semi-circular bottom conforming to the outside of the adjacent sewer section. Inverts shall be formed directly in the concrete of the manhole base or may be constructed by laying full section sewer pipe straight through the manhole and cutting out the top half after the base is constructed. Changes in the direction of the sewer and entering branches shall have a true curve of as large a radius as the size of the manhole will permit. Where the largest pipe at a manhole is less than 12”, the channel depth shall be one half of the largest pipe diameter. When the largest pipe at the manhole is between 12 and 24 inches (inclusive,) the channel depth shall be three fourths of the largest pipe diameter. When the largest pipe at a manhole is greater than 24”, the channel depth shall match the largest pipe. In all cases, the edges of the pipe along the invert and at the walls of the manhole shall be plastered and brush-finished. Plaster shall be non-shrink or hydraulic grout.

4. Where inlet leads, main or lateral pipe sewers enter manholes, pipes shall be cut off flush with inside of manhole any irregularities shall be grouted up with non-shrink grout. Install stub outs, where shown, to line and grade. Use one full joint of pipe, of size indicated, for stub out. Seal stub out with plug. Install plug in such a manner as to prevent seepage of leakage through stub outs. Installation of plug shall be such that it may easily be removed in future without damaging bell or groove end of stub out.

5. If manholes are constructed in streets where immediate subsequent paving or repaving is involved, readjust the manhole ring and covers, immediately prior to the paving operations. Manholes shall be installed with joints of size and numbers required to obtain correct depth. Contractor is responsible for verifying correct manhole depth before construction. Initially, manhole tops shall be not less than 6-inches nor greater than 18-inches from final grade. If manholes are relocated in the field because of unforeseen conflicts, the Contractor is responsible for correct depth of manhole. Manhole tops shall be set as follows:

a.) Developed Areas: Set manhole tops 1-inch higher than existing elevation of natural ground or other final grade when specified by the Engineer.

b.) Undeveloped Areas: Set manhole tops flush with paved surfaces and 6-inches higher than shoulder and/or proposed final grade elevations in easements or other unpaved areas. Where manholes are located in bottom of ditches, either set manhole top by EJIW V-2342, or pre-approved equal, flush with ditch bottom and seal with solid cover, or set twelve inches above ditch top and reshape ditch around manhole.

6. Prior to placing each section of manhole riser or cone, thoroughly clean the bells and spigots to be joined.

7. Backfilling will be performed evenly and carefully around the manhole after the full strength of the concrete is attained.

8. Carefully place the O-ring gasket and check for proper alignment.

10. Each manhole shall be individually vacuum tested according to the SECTION 0130 – TESTING FOR SANITARY SEWER GRAVITY SYSTEM. Stub-outs, boots, and pipe plugs shall be secured to prevent movement while the vacuum is being drawn.

C. Cast-In Place Manholes: Cast-In place manholes are not allowed without prior approval from the Texas Parks and Wildlife Department (TPWD) Engineer. This approval shall only be in emergency situations.

D. Fiberglass Manholes: Fiberglass manholes are permitted with written approval from the Texas Parks and Wildlife Department (TPWD) Engineer.

E. Service Connections: Service connections at manholes will meet all other requirements of this specification and shall be tied into the manhole with a manhole boot. At the time of construction, the Engineer will designate the locations of the service outlets and the depth to the top of the lateral pipe, if depth is not indicated on the plans. The minimum depth of cover over the end of the lateral pipe shall be no deeper than what is required to serve the intended lot.

F. Cleanout Structures: The Contractor shall construct cleanouts where shown on the plans and as specified. All backfill around and above the pipe shall be machine tamped in layers not exceeding 3- inches in depth so that no settlement shall occur after the cleanout is constructed. Cleanouts shall be provided at each service connection and located at the edge of an easement or at the right-of-way. The cleanouts shall be enclosed within a round plastic box which has a lid that makes the cleanout accessible, set flush with the ground. Cleanout shall include a brass plug.

G. Drop Manholes: Drop manholes shall be constructed for elevation differences of 24 inches or greater as measured from the flow line of the pipe to the flow line entrance of the manhole and constructed in a manner that will allow the water from the drop to drop in the flow line of the intersecting sewer.

END OF SECTION