PART 1 GENERAL

1.01 PROJECT IDENTIFICATION
A. Project Name: UDC_FBI FIRING RANGE & TRAINING FACILITY, located at:
B. Owner's Project Number: 19386100.
   1480 North 8000 West.
   Salt Lake City, Utah 84116.
C. The Owner, hereinafter referred to as Owner: DFCM
D. Owner's Project Manager: Levi Waldron.
   1. Department: Division of Facilities Construction and Management.
   2. Address: 4315 South 2700 West, 3rd Floor.
   4. Phone/Fax: 385-266-5384.
   5. E-mail: lwaldron@utah.gov.

1.02 PROJECT DESCRIPTION
A. Summary Project Description: This project is a joint venture between the UDC and the FBI to construct a Firing Range and Training Facility at the Utah State Correctional Facility Salt Lake location. The entire project sits on a 16.3 acre area. One 150 yard long range, one 75x75 yard combat range, and two 50 yard pistol/carbine ranges. 20 foot berms, targeting systems, bullet traps, utilities, parking, sidewalks, and training building.
B. Contract Scope: Construction.
C. Contract Terms: Lump sum (fixed price, stipulated sum). Three Phases are to be priced:
   1. Phase 1 Identified as Base Bid in DFCM Solicitation.
   2. Phase 2 Identified as Additive Alternate No. 1 in DFCM Solicitation.
   3. Phase 3 Identified as Additive Alternate No. 2 in DFCM Solicitation.
D. The currently occupied premises at the project site are open for examination by bidders only during the hours noted in the solicitation.

1.03 PROJECT CONSULTANTS
A. The Architect, hereinafter referred to as Architect: Andy Tongish.
   1. Address: 1445 West 8660 South.
   3. Phone: 801-865-0633.
   4. E-mail: andy@altarchitecture-ut.com.

PART 2 PRODUCTS (NOT USED)
PART 3 EXECUTION (NOT USED)

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Identification of project team members and their contact information.

1.02 OWNER:
A. Name: Division of Facilities Construction and Management.
   1. Address Line 1: 4315 South 2700 West, 3rd Floor.
   2. City: Taylorsville.
   5. Telephone: 385-266-5384.
B. Primary Contact: All correspondence from the Contractor to the Architect will be direct, with copies to this party, unless alternate arrangements are mutually agreed upon at preconstruction meeting.
   1. Title: Project Manager.
   2. Name: Levi Waldron.
   3. Email: iwaldron@utah.gov.

1.03 CONSULTANTS:
A. Architect: Design Professional of Record. All correspondence from the Contractor regarding construction documents authored by Architect's consultants will be through this party, unless alternate arrangements are mutually agreed upon at preconstruction meeting.
   1. Company Name: alt architecture.
      a. Address Line 1: 1445 West 8660 South.
      b. City: West Jordan.
      c. State: Utah.
      e. Telephone: 801-865-0633.
   2. Primary Contact: 
      a. Title: Project Architect.
      b. Name: Andy Tongish, AIA.
      c. Email: andy@altarchitecture-ut.com.
B. Civil Engineering Consultant:
   1. Company Name: Psomas.
      a. Address Line 1: 4179 S. Riverboat Road #200.
      b. City: Salt Lake City.
      c. State: Utah.
      e. Telephone: 801-284-1336.
   2. Primary Contact: 
      a. Title: Project Engineer.
      b. Name: Leslie Morton, PE.
      c. Email: lmorton@psomas.com.
C. Structural Engineering Consultant:
   1. Company Name: Reaveley Engineers.
      a. Address Line 1: 675 East 500 South.
      b. City: Salt Lake City.
      c. State: Utah.
      e. Telephone: 801-505-4013.
   2. Primary Contact: 

a. Title: Project Manager.
b. Name: Faris Karaghouli.
c. Email: fkaraghouli@reaveley.com.

D. Mechanical Engineering Consultant:
   1. Company Name: WHW Engineering.
      a. Address Line 1: 8619 South Sandy Parkway #101.
      b. City: Sandy.
      c. State: Utah.
      e. Telephone: 801-466-4021.
   2. Primary Contact: .
      a. Title: Project Engineer.
      b. Name: Win Packer, PE.
      c. Email: winp@whw-engineering.com.

E. Electrical Engineering Consultant:
   1. Company Name: Spectrum Engineers.
      a. Address Line 1: 324 South State Stret, Suite 400.
      b. City: Salt Lake City.
      c. State: Utah.
      e. Telephone: 801-401-8419.
   2. Primary Contact: .
      a. Title: Project Engineer.
      b. Name: Chris Kobayashi, PE.
      c. Email: ckk@spectrum-engineers.com.

PART 2 PRODUCTS - NOT USED
PART 3 EXECUTION - NOT USED

END OF SECTION
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END OF SECTION
SECTION 01 21 00
ALLOWANCES

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Exterior building signage.

1.02 ALLOWANCES
   A. Costs Included in Allowances: Cost of product to Contractor or subcontractor, less applicable trade discounts.
   B. Contractor Responsibilities:
      2. Arrange for and process shop drawings, product data, and samples. Arrange for delivery.
   C. Differences in costs will be adjusted by Change Order.

1.03 ALLOWANCES SCHEDULE
   A. Section ______ - ____________: Include the stipulated sum of $7,500.00 for design, purchase, delivery, and installation of building signage.

PART 2 PRODUCTS - NOT USED
PART 3 EXECUTION - NOT USED

END OF SECTION
SECTION 01 30 00
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL
1.01 SECTION INCLUDES
A. General administrative requirements.
B. Construction progress schedule.
C. Submittals for review and project closeout.
D. Number of copies of submittals.
E. Requests for Information (RFI) procedures.
F. Submittal procedures.

1.02 GENERAL ADMINISTRATIVE REQUIREMENTS
A. Comply with requirements of Section 01 70 00 - Execution and Closeout Requirements for coordination of execution of administrative tasks with timing of construction activities.
B. Make the following types of submittals to Architect:
   1. Requests for Information (RFI).
   2. Requests for substitution.
   3. Shop drawings, product data, and samples.
   4. Test and inspection reports.
   5. Design data.
   6. Manufacturer's instructions and field reports.
   7. Applications for payment and change order requests.
   8. Progress schedules.
   9. Coordination drawings.
   10. Correction Punch List and Final Correction Punch List for Substantial Completion.
   11. Closeout submittals.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION
3.01 CONSTRUCTION PROGRESS SCHEDULE
A. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
B. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
   1. Include written certification that major contractors have reviewed and accepted proposed schedule.
C. Within 10 days after joint review, submit complete schedule.
D. Submit updated schedule with each Application for Payment.

3.02 REQUESTS FOR INFORMATION (RFI)
A. Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
   1. Prepare a separate RFI for each specific item.
   2. Prepare in a format and with content acceptable to Owner.
B. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.
C. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.
D. Review Time: Architect will respond and return RFIs to Contractor within seven calendar days of receipt. For the purpose of establishing the start of the mandated response period, RFIs
received after 12:00 noon will be considered as having been received on the following regular working day.

3.03 SUBMITTAL SCHEDULE

3.04 SUBMITTALS FOR REVIEW

A. When the following are specified in individual sections, submit them for review:
   1. Product data.
   2. Shop drawings.
   3. Samples for selection.
   4. Samples for verification.

B. Submit to Architect for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.

C. Samples will be reviewed for aesthetic, color, or finish selection.

D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 01 78 00 - Closeout Submittals.

3.05 SUBMITTALS FOR INFORMATION

A. When the following are specified in individual sections, submit them for information:
   1. Design data.
   2. Certificates.
   3. Test reports.
   4. Inspection reports.
   5. Manufacturer's instructions.
   6. Manufacturer's field reports.
   7. Other types indicated.

B. Submit for Architect's knowledge as contract administrator or for Owner.

3.06 SUBMITTALS FOR PROJECT CLOSEOUT

A. Submit Correction Punch List for Substantial Completion.

B. Submit Final Correction Punch List for Substantial Completion.

C. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 01 78 00 - Closeout Submittals:
   1. Project record documents.
   2. Operation and maintenance data.
   3. Warranties.
   5. Other types as indicated.

D. Submit for Owner's benefit during and after project completion.

3.07 NUMBER OF COPIES OF SUBMITTALS

A. Electronic Documents: Submit one electronic copy in PDF format; an electronically-marked up file will be returned. Create PDFs at native size and right-side up; illegible files will be rejected.

B. Samples: Submit the number specified in individual specification sections; one of which will be retained by Architect.
   1. After review, produce duplicates.
   2. Retained samples will not be returned to Contractor unless specifically so stated.

3.08 SUBMITTAL PROCEDURES

A. General Requirements:
   1. Use a separate transmittal for each item.
   2. Sequentially identify each item. For revised submittals use original number and a sequential numerical suffix.
3. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.

4. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.

B. Shop Drawing Procedures:
   1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting Contract Documents and coordinating related work.
   2. Do not reproduce Contract Documents to create shop drawings.
   3. Generic, non-project-specific information submitted as shop drawings do not meet the requirements for shop drawings.

3.09 SUBMITTAL REVIEW

A. Submittals for Review: Architect will review each submittal, and approve, or take other appropriate action.

B. Submittals for Information: Architect will acknowledge receipt and review. See below for actions to be taken.

C. Architect's actions will be reflected by marking each returned submittal using virtual stamp on electronic submittals.

D. Architect's and consultants' actions on items submitted for review:
   1. Authorizing purchasing, fabrication, delivery, and installation:
      a. "Approved", or language with same legal meaning.
      b. "Approved as Noted, Resubmission not required", or language with same legal meaning.
         1) At Contractor's option, submit corrected item, with review notations acknowledged and incorporated.
      c. "Approved as Noted, Resubmit for Record", or language with same legal meaning.
   2. Not Authorizing fabrication, delivery, and installation:

E. Architect's and consultants' actions on items submitted for information:
   1. Items for which no action was taken:
      a. "Received" - to notify the Contractor that the submittal has been received for record only.
   2. Items for which action was taken:
      a. "Reviewed" - no further action is required from Contractor.

END OF SECTION
SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Preliminary schedule.
   B. Construction progress schedule, bar chart type.

1.02 SUBMITTALS
   A. Within 10 days after date of Agreement, submit preliminary schedule.
   B. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION
3.01 PRELIMINARY SCHEDULE
   A. Prepare preliminary schedule in the form of a horizontal bar chart.

3.02 BAR CHARTS
   A. Include a separate bar for each major portion of Work or operation.
   B. Identify the first work day of each week.

3.03 UPDATING SCHEDULE
   A. Maintain schedules to record actual start and finish dates of completed activities.
   B. Indicate progress of each activity to date of revision, with projected completion date of each activity.
   C. Annotate diagrams to graphically depict current status of Work.
   D. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.
   E. Indicate changes required to maintain Date of Substantial Completion.
   F. Submit reports required to support recommended changes.

END OF SECTION
SECTION 01 40 00
QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Submittals.
B. Quality assurance.
C. Testing and inspection agencies and services.
D. Contractor's construction-related professional design services.
E. Contractor's design-related professional design services.
F. Control of installation.
G. Manufacturers' field services.
H. Defect Assessment.

1.02 DEFINITIONS
A. Contractor's Quality Control Plan: Contractor's management plan for executing the Contract for Construction.
B. Contractor's Professional Design Services: Design of some aspect or portion of the project by party other than the design professional of record. Provide these services as part of the Contract for Construction.
1. Design Services Types Required:
   a. Design-Related: Design services explicitly required to be performed by another design professional due to highly-technical and/or specialized nature of a portion of the project. Services primarily involve engineering analysis, calculations, and design, and are not intended to alter the aesthetic aspects of the design.
      1) Exterior & Interior Stairs.

1.03 CONTRACTOR'S DESIGN-RELATED PROFESSIONAL DESIGN SERVICES
A. Coordination: Contractor's professional design services are subject to requirements of project's Conditions for Construction Contract.
B. Base design on performance and/or design criteria indicated in individual specification sections.
C. Scope of Contractor's Professional Design Services: Provide for the following items of work:
   1. Structural Design of Stairs: As described in Section 05 51 00 - Metal Stairs.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.05 QUALITY ASSURANCE
A. Testing Agency Qualifications:

1.06 TESTING AND INSPECTION AGENCIES AND SERVICES
A. Contractor shall employ and pay for services of an independent testing agency to perform other specified testing.
B. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.
C. Contractor Employed Agency:
   1. Laboratory: Authorized to operate in the State in which the Project is located.

PART 3 EXECUTION

2.01 CONTROL OF INSTALLATION
A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.
B. Comply with manufacturers' instructions, including each step in sequence.
C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.
D. Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
E. Have work performed by persons qualified to produce required and specified quality.
F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

2.02 TESTING AND INSPECTION
A. Testing Agency Duties:
   2. Perform specified sampling and testing of products in accordance with specified standards.
   3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
   4. Promptly notify Architect and Contractor of observed irregularities or non-compliance of Work or products.
   5. Perform additional tests and inspections required by Architect.
   6. Submit reports of all tests/inspections specified.
B. Limits on Testing/Inspection Agency Authority:
   1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
   2. Agency may not approve or accept any portion of the Work.
   3. Agency may not assume any duties of Contractor.
   4. Agency has no authority to stop the Work.
C. Contractor Responsibilities:
   1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
   2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturers’ facilities.
   3. Provide incidental labor and facilities:
      a. To provide access to Work to be tested/inspected.
      b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
      c. To facilitate tests/inspections.
      d. To provide storage and curing of test samples.
   4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
   5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
   6. Arrange with Owner’s agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
D. Re-testing required because of non-compliance with specified requirements shall be performed by the same agency on instructions by Architect.
E. Re-testing required because of non-compliance with specified requirements shall be paid for by Contractor.
2.03 MANUFACTURERS’ FIELD SERVICES
   A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance equipment as applicable, and to initiate instructions when necessary.
   B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

2.04 DEFECT ASSESSMENT
   A. Replace Work or portions of the Work not complying with specified requirements.

   END OF SECTION
SECTION 01 45 33
CODE-REQUIRED SPECIAL INSPECTIONS AND PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Information in this Section DO NOT over-ride SE002 and other General Structural notes.
B. Code-required special inspections.
C. Testing services incidental to special inspections.
D. Submittals.

1.02 REFERENCE STANDARDS

A. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2014 (Errata 2018).
G. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. SDI (QA/QC) - Standard for Quality Control and Quality Assurance for Installation of Steel Deck; 2017.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Special Inspection Agency Qualifications: Prior to the start of work, the Special Inspection Agency is required to:
   1. Submit agency name, address, and telephone number, names of full time registered Engineer and responsible officer.
   2. Submit copy of report of laboratory facilities inspection made by NIST Construction Materials Reference Laboratory during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.
   3. Submit certification that Special Inspection Agency is acceptable to AHJ.
C. Fabricator Special Inspection Reports: After each special inspection of fabricated items at the Fabricator's facility, Special Inspector is required to promptly submit at least two copies of report; one to Architect and one to AHJ.
D. Test Reports: After each test or inspection, promptly submit at least two copies of report; one to Architect and one to AHJ.
E. Certificates: When specified in individual special inspection requirements, Special Inspector shall submit certification by the manufacturer, fabricator, and installation subcontractor to Architect and AHJ, in quantities specified for Product Data.
   1. Indicate material or product complies with or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
   2. Certificates may be recent or previous test results on material or product, but must be acceptable to Architect and AHJ.
F. Manufacturer's Field Reports: Submit reports to Architect and AHJ.
1. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in Contract Documents.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 SCHEDULE OF SPECIAL INSPECTIONS, GENERAL

A. Frequency of Special Inspections: Special Inspections are indicated as continuous or periodic.
   1. Continuous Special Inspection: Special Inspection Agency is required to be present in the area where the work is being performed and observe the work at all times the work is in progress.
   2. Periodic Special Inspection: Special Inspection Agency is required to be present in the area where work is being performed and observe the work part-time or intermittently and at the completion of the work.

3.02 SPECIAL INSPECTIONS FOR STEEL CONSTRUCTION

A. Structural Steel: Comply with quality assurance inspection requirements of ICC (IBC).
B. Cold-Formed Steel Deck: Comply with quality assurance inspection requirements of SDI (QA/QC).
C. Open-Web Joists and Joist Girders: Comply with requirements of ICC (IBC), Table 1705.2.3.
D. Welding:
   1. Structural Steel and Cold Formed Steel Deck:
      b. Multipass Fillet Welds: Verify compliance with AWS D1.1/D1.1M; continuous.
      d. Plug and Slot Welds: Verify compliance with AWS D1.1/D1.1M; continuous.
      e. Single Pass Fillet Welds 5/16 inch or Greater: Verify compliance with AWS D1.1/D1.1M; continuous.
      f. Floor and Roof Deck Welds: Verify compliance with AWS D1.3/D1.3M; continuous.
   2. Reinforcing Steel: Verify items listed below comply with AWS D1.4/D1.4M and ACI 318, Section 3.5.2.
      a. Verification of weldability; periodic.
      b. Reinforcing steel resisting flexural and axial forces in intermediate and special moment frames as well as boundary elements of special structural walls of concrete and shear reinforcement; continuous.
      c. Shear reinforcement; continuous.
      d. Other reinforcing steel; periodic.

3.03 SPECIAL INSPECTIONS FOR CONCRETE CONSTRUCTION

A. Reinforcing Steel, Including Prestressing of Tendons and Placement: Verify compliance with approved Contract Documents and ACI 318, Sections 3.5 and 7.1 through 7.7; periodic.
B. Reinforcing Steel Welding: Verify compliance with AWS D1.4/D1.4M and ACI 318, Section 3.5.2; periodic.
C. Design Mix: Verify plastic concrete complies with the design mix in approved Contract Documents and with ACI 318, Chapter 4 and 5.2; periodic.
D. Specified Curing Temperature and Techniques: Verify compliance with approved Contract Documents and ACI 318, Sections 5.11 through 5.13; periodic.
E. Concrete Strength in Situ: Verify concrete strength complies with approved Contract Documents and ACI 318, Section 6.2, for the following.
F. Formwork Shape, Location and Dimensions: Verify compliance with approved Contract Documents and ACI 318, Section 6.1.1; periodic.
3.04 SPECIAL INSPECTIONS FOR SOILS

A. Materials and Placement: Verify each item below complies with approved construction documents and approved geotechnical report.
   1. Design bearing capacity of material below shallow foundations; periodic.
   2. Design depth of excavations and suitability of material at bottom of excavations; periodic.
   4. Subgrade, prior to placement of compacted fill verify proper preparation; periodic.

B. Testing: Classify and test excavated material; periodic.

END OF SECTION
SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Dewatering
B. Temporary utilities.
C. Temporary telecommunications services.
D. Temporary sanitary facilities.
E. Temporary Controls: Barriers, enclosures, and fencing.
F. Security requirements.
G. Waste removal facilities and services.
H. Project identification sign.
I. Field offices.

1.02 DEWATERING
A. Provide temporary means and methods for dewatering all temporary facilities and controls.
B. See civil drawings for additional information.

1.03 TEMPORARY UTILITIES
A. Provide and pay for all electrical power, lighting, water, heating and cooling, and ventilation required for construction purposes.

1.04 TELECOMMUNICATIONS SERVICES
A. Provide, maintain, and pay for telecommunications services to field office at time of project mobilization.

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

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

1.07 FENCING
A. Provide 6 foot high fence around construction site; equip with vehicular and pedestrian gates with locks.

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

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

1.10 PROJECT IDENTIFICATION
A. Provide project identification sign of design and construction indicated in Section 01 58 13.
B. Erect on site at location indicated.
C. No other signs are allowed without Owner permission except those required by law.

1.11 FIELD OFFICES
A. Office: Weathertight, with lighting, electrical outlets, heating, cooling equipment, and equipped with sturdy furniture, drawing rack, and drawing display table.
B. Provide space for Project meetings, with table and chairs to accommodate 6 persons.
C. Locate offices a minimum distance of 30 feet from existing and new structures.

PART 2 PRODUCTS - NOT USED
PART 3 EXECUTION - NOT USED

END OF SECTION
SECTION 01 58 13
TEMPORARY PROJECT SIGNAGE

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Project identification sign.

1.02 REFERENCE STANDARDS
   A. FHWA (SHS) - Standard Highway Signs and Markings; 2004, with Supplement (2012).

1.03 QUALITY ASSURANCE
   A. Design sign and structure to withstand 50 miles/hr wind velocity.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
   B. Shop Drawing: Show content, layout, lettering, color, foundation, structure, sizes and grades of members.

PART 2 PRODUCTS
2.01 SIGN MATERIALS
   A. Structure and Framing: New, wood, structurally adequate.
   B. Sign Surfaces: Exterior grade plywood with medium density overlay, minimum 3/4 inch thick, standard large sizes to minimize joints.

2.02 PROJECT IDENTIFICATION SIGN
   A. One painted sign, 48 sq ft area, bottom 6 feet above ground.
   B. Content:
      1. Project number, title, logo and name of Owner as indicated on Contract Documents.
      2. Names and titles of authorities.
      4. Name of Contractor.
   C. Lettering: Standard Alphabet Series C, as specified in FHWA (SHS).
   D. Submit rendering of sign for architect approval.

PART 3 EXECUTION
3.01 INSTALLATION
   A. Install project identification sign within 15 days after date fixed by Notice to Proceed.
   B. Erect at location designated.
   C. Erect supports and framing on secure foundation, rigidly braced and framed to resist wind loadings.
   D. Install sign surface plumb and level, with butt joints. Anchor securely.

3.02 MAINTENANCE
   A. Maintain signs and supports clean, repair deterioration and damage.

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

END OF SECTION
SECTION 01 78 00
CLOSEOUT SUBMITTALS

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Project Record Documents.
B. Operation and Maintenance Data.
C. Warranties and bonds.

1.02 RELATED REQUIREMENTS
A. Section 01 30 00 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
B. Individual Product Sections: Specific requirements for operation and maintenance data.
C. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS
A. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.
B. Operation and Maintenance Data:
   1. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
   2. Submit one copy of completed documents 15 days prior to final inspection. This copy will be reviewed and returned after final inspection, with Architect comments. Revise content of all document sets as required prior to final submission.
   3. Submit two sets of revised final documents in final form within 10 days after final inspection.
C. Warranties and Bonds:
   1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
   2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
   3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

PART 2 PRODUCTS - NOT USED
PART 3 EXECUTION
3.01 PROJECT RECORD DOCUMENTS
A. Maintain on site one set of the following record documents; record actual revisions to the Work:
   1. Drawings.
   2. Addenda.
   3. Change Orders and other modifications to the Contract.
B. Ensure entries are complete and accurate, enabling future reference by Owner.
C. Store record documents separate from documents used for construction.
D. Record information concurrent with construction progress.
E. Record Drawings: Legibly mark each item to record actual construction including:
   1. Field changes of dimension and detail.
   2. Details not on original Contract drawings.

3.02 OPERATION AND MAINTENANCE DATA
A. Source Data: For each product or system, list names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.

C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.

D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.03 WARRANTIES AND BONDS

A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.

B. Verify that documents are in proper form, contain full information, and are notarized.

C. Co-execute submittals when required.

D. Retain warranties and bonds until time specified for submittal.

END OF SECTION
SECTION 03 11 00
CONCRETE FORMWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED SECTIONS

   A. Section 03 20 00 - Concrete Reinforcement.
   B. Section 03 30 40 - Portland Cement Concrete.
   C. Section 03 30 00- Concrete Work

1.3 REFERENCES

   A. ACI 301 - Structural Concrete for Buildings.
   B. ACI 318 - Building Code Requirements for Reinforced Concrete.
   C. ACI 347 - Recommended Practice for Concrete Formwork.
   D. PS 1 - Construction and Industrial Plywood.

1.4 DESIGN REQUIREMENTS

   A. Design, engineer and construct formwork, shoring and bracing to conform to design and
code requirements; resultant concrete to conform to required shape, line and dimension.

1.5 QUALITY ASSURANCE

   A. Perform Work in accordance with ACI 301 standards.

1.6 REGULATORY REQUIREMENTS

   A. Conform to applicable code for design, fabrication, erection and removal of formwork.

PART 2 - PRODUCTS

2.1 WOOD FORM MATERIALS

   A. Form Materials: At the discretion of the Contractor.
2.2 PREFABRICATED FORMS

A. Preformed Steel Forms: Minimum 16 gage matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

B. Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.

C. Void Forms: Moisture resistant treated paper faces, biodegradable, structurally sufficient to support weight of wet concrete mix until initial set; 2 inches thick.

2.3 FORMWORK ACCESSORIES

A. Form Ties: Snap-off type, galvanized metal adjustable length, with waterproofing washer, free of defects that could leave holes larger than 1 inch in concrete surface.

B. Form Release Agent: Colorless mineral oil which will not stain concrete, or absorb moisture.

C. Corners: Chamfered, 2 inch size; maximum possible lengths. Chamfer all exposed corners

D. Nails, Spikes, Lag Bolts, Through Bolts, and Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.

E. Waterstops: Polyvinyl chloride, minimum 2,000 psi tensile strength, minimum 50 degrees F (46 degrees C) to plus 175 degrees F working temperature range, 1 inch wide, maximum possible lengths, ribbed profile, preformed corner sections, heat welded jointing.

2.4 WATERSTOP

A. Manufacturer: Greenstreak Plastic Products

B. Model: Ribbed with Centerbulb.

C. Waterstop shall be installed in concrete joints where indicated on the Plans and on the Typical Details.

D. Waterstop shall be installed in concrete joints where indicated on the Plans and on the Typical Details.

E. Waterstop shall be made of polyvinyl chloride (PVC).

F. All vertical joints in waterbearing structures shall have waterstops, whether indicated on the Plans or not.

G. All waterstops shall be continuous.
H. Waterstops in the walls shall be carried into lower slabs and shall join the waterstops in the slabs with appropriate types of fittings.

I. Waterstops shall meet or exceed the requirements in the following table:

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHOD</th>
<th>RECOMMENDED LIMITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Absorption</td>
<td>ASTM D 570</td>
<td>5% max</td>
</tr>
<tr>
<td>Tear Resistance</td>
<td>ASTM D 624</td>
<td>285 l/f/in</td>
</tr>
<tr>
<td>Ultimate Elongation</td>
<td>ASTM D 638</td>
<td>360%</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>ASTM D 638</td>
<td>2,000 psi min</td>
</tr>
<tr>
<td>Low Temperature Brittleness</td>
<td>ASTM D 746</td>
<td>No Failure @-35°F/-37°C</td>
</tr>
<tr>
<td>Stiffness in Flexure</td>
<td>ASTM D 747</td>
<td>600 psi min</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>ASTM D 792</td>
<td>1.4 max</td>
</tr>
<tr>
<td>Ozone Resistance</td>
<td>ASTM D 1149</td>
<td>No failure</td>
</tr>
<tr>
<td>Volatile Loss</td>
<td>ASTM D 1203</td>
<td>0.50% max</td>
</tr>
<tr>
<td>Hardness, Shore A/15</td>
<td>ASTM D 2240</td>
<td>65 to 80</td>
</tr>
<tr>
<td>Tensile Strength After Accelerated Elongation</td>
<td>CRD-C 572</td>
<td>1,600 psi min</td>
</tr>
<tr>
<td>Elongation After Accelerated Extraction</td>
<td>CRD-C 572</td>
<td>300% min</td>
</tr>
<tr>
<td>Effect on Alkali After 7 Days</td>
<td>CRD-C 572</td>
<td>-0.1% to 0.25%</td>
</tr>
</tbody>
</table>

2.5 NEOPRENE BEARING PAD

A. Neoprene pads shall be of dimensions and hardness shown on the drawings and shall be made by approved manufacturer.

B. The material for 40 durometer neoprene pads shall conform to ASTM D-200 M2BC414A14C12F17 and the material for the 30 durometer neoprene pads shall conform to ASTM D-200 M2BC10A14C12F17.

C. Unless otherwise specified on the drawings, neoprene pads shall be 40 durometer.

2.6 CLOSED CELL NEOPRENE PAD
A. Closed cell neoprene pads, shall be used as a filler material in the flexible joints between the wall and wall-footing and between the wall and roof connection in the areas not taken up by the solid neoprene bearing pads and waterstops.

B. The material shall be medium grade closed cell neoprene conforming to 2A3 of ASTM D 1056-85.

C. Rubatex R431N or R423N, or Cypress Sponge 431N or 423N, or approved equal.

2.7 SOFT MASTIC

A. Soft mastic shall be installed in all voids and cavities around the bearing pads, waterstop and seismic cable sleeves. Such material shall be installed with a consistency that will not adversely affect the quality of PVC and neoprene materials.

B. Sikaflex 1A, or Select Seal U-230, or approved equal.

2.8 INSTALLATION OF BEARING AND FILLER PADS

A. Bearing and filler pads shall be installed as indicated on the drawings.

B. Bearing and filler pads shall be glued to the concrete with an approved rubber cement material to prevent uplift of the pads during concrete pouring.

C. All pads shall be held down with approved plastic shim plates placed under reinforcing steel.

C. Nailing down pads will not be permitted.

D. All voids and cavities between bearing and filler pads, waterstop and seismic cable sleeves shall be filled with soft mastic.

E. Contractor’s workmanship shall be such that no cement grout or concrete seepage will occur through the bearing and filler pad area resulting in a restraint of radial wall movements.

F. A continuous neoprene pad and one or more filler pads are required between the top of the wall and the underside of the roof. Any void area between such pads shall be caulked and sealed to prevent any cement from the roof pour to come in contact with the wall top.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 EARTH FORMS

A. Earth forms are not permitted.
3.3 ERECTION - FORMWORK

A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.

B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.

C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.

D. Align joints and make watertight. Keep form joints to a minimum.

E. Obtain approval before framing openings in structural members which are not indicated on Drawings.

F. Provide chamfer strips on external corners.

G. Install void forms in accordance with manufacturer’s recommendations. Protect forms from moisture or crushing.

H. Coordinate this section with other sections of work which require attachment of components to formwork.

I. If formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement before proceeding, request instructions from Engineer.

3.4 APPLICATION - FORM RELEASE AGENT

A. Apply form release agent on formwork in accordance with manufacturer's recommendations.

B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

C. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings which are effected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

3.5 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Provide formed openings where required for items to be embedded in passing through concrete work.

B. Locate and set in place items which will be cast directly into concrete.

C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.

D. Install accessories in accordance with manufacturer's instructions, straight, level, and plumb. Ensure items are not disturbed during concrete placement.

E. Install waterstops in accordance with manufacturer's instructions, continuous without displacing reinforcement.
F. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

G. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.6 FORM CLEANING

A. Clean forms as erection proceeds, to remove foreign matter within forms.

B. Clean formed cavities of debris prior to placing concrete.

C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

D. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

3.7 FORMWORK TOLERANCES

A. Construct formwork to maintain tolerances required by ACI 301.

3.8 FIELD QUALITY CONTROL

A. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure.

B. Do not reuse wood formwork more than 2 times for concrete surfaces to be exposed to view. Do not patch formwork.

3.9 FORM REMOVAL

A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads (minimum of seven days).

B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

C. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

END OF SECTION 03 11 00
SECTION 03 20 00
CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES


1.2 RELATED SECTIONS

A. Section 03 11 00 - Concrete Formwork.
B. Section 03 30 40 - Portland Cement Concrete.
C. Section 03 30 00 - Concrete Work

1.3 REFERENCES

A. ACI 301 - Structural Concrete for Buildings.
B. ACI 318 - Building Code Requirements for Reinforced Concrete.
C. ACI SP-66 - American Concrete Institute - Detailing Manual.
D. CRSI - Concrete Reinforcing Steel Institute - Manual of Practice.
E. CRSI 63 - Recommended Practice For Placing Reinforcing Bars.
F. CRSI 65 - Recommended Practice For Placing Bar Supports, Specifications and Nomenclature.
G. AASHTO M 55: Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.

1.4 SUBMITTALS FOR REVIEW

A. Section 01 33 00 - Submittals Procedures.
B. Shop Drawings: Indicate bar sizes, spacings, locations, and quantities of reinforcing steel bending and cutting schedules, and supporting and spacing devices.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301.

PART 2 - PRODUCTS

2.1 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.
1. Epoxy-Coated Reinforcing Bars:
   a. Steel Bars: ASTM A615/A615M, Grade 60 [ASTM A706/A706M], deformed bars.
   b. Epoxy Coating: [ASTM A775/A775M] [or] [ASTM A934/A934M] with less than 2 percent damaged coating in each 12-inch (305-mm) bar length.

2.2 ACCESSORIES

A. Epoxy-Coated Joint Dowel Bars: ASTM A615/A615M, Grade 60 (Grade 420), plain-steel bars, ASTM A775/A775M epoxy coated.

B. 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 CR SI'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 CR SI Class 1 plastic-protected steel wire, all-plastic bar supports, or CR SI Class 2 stainless steel bar supports.
      b. For epoxy-coated reinforcement, use CR SI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.

C. Mechanical Splice Couplers: ACI 318 (ACI 318M) [Type 1] [Type 2], same material of reinforcing bar being spliced; [tension-compression typedowel-bar type, mechanical-lap type.

D. Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch (1.2908 mm) in diameter.

   1. Finish: ASTM A884/A884M, Class A, Type 1, epoxy coated, with less than 2 percent damaged coating in each 12-inch (305-mm) wire length.

E. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A775/A775M.

2.3 FABRICATION

A. Fabricate concrete reinforcing in accordance with ACI 318.

B. Locate reinforcing splice not indicated on drawing at points of minimum stress. Indicate locations of splices on shop drawings.

PART 3 - EXECUTION

3.1 PREPARATION

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

2. 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 (25 mm), 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 (ACI 318M).

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 (610 mm), whichever is greater.
   2. Stagger splices in accordance with ACI 318 (ACI 318M).
   3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
   4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.

G. Install insulated connection system in accordance with manufacturer's instructions.

H. 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 (305 mm).
   2. Lap edges and ends of adjoining sheets at least one mesh spacing plus 2 inches (50 mm) for plain wire and 8 inches (200 mm) for deformed wire.
   3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
   4. Lace overlaps with wire.
I. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating in accordance with ASTM D3963/D3963M

3.3 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.
   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 special inspector to perform field tests and inspections and prepare test reports.

B. Inspections:
   1. Steel-reinforcement placement.
   2. Steel-reinforcement mechanical splice couplers.
   3. Steel-reinforcement welding.

END OF SECTION 03 20 00
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 cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Footings.
2. Foundation walls.
3. Slabs-on-grade.
4. Suspended slabs.
5. Building walls.

B. Related Sections:

1. Section 03 3300 "Architectural Concrete" for general building applications of specially finished formed concrete.
2. Section 03 3560 "Polished and Sealed Concrete" for finishing of concrete floors
3. Section 31 2000 "Earth Moving" for drainage fill under slabs-on-grade.
4. Section 32 1313 "Concrete Paving" for concrete pavement and walks.
5. Section 32 1316 "Decorative Concrete Paving" for decorative concrete pavement and walks.
6. Section 31 2323 "EPS Geofoam"

1.3 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.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. HPBS Submittals:

1. Product Data for products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Data for liquid floor treatments and curing and sealing compounds, documentation including printed statement of VOC content.
3. Design Mixtures for each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements, and for equivalent concrete mixtures that do not contain portland cement replacements.

C. 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. Provide 30 consecutive 28-day compressive strength histories compliant with ACI 318 requirements.
3. Provide results of drying shrinkage testing for the interior slab on grade mix design.

D. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

1. Show elevations of shear walls with openings for coordination with other trades.
2. Concrete stair cores shall be elevated and steel embed elevations coordinated.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For installer, manufacturer, and testing agency.

B. Welding certificates.

C. 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. Curing compounds.
7. Floor and slab treatments.

D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates.

E. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

F. Field quality-control reports.

G. Minutes of preinstallation conference.
1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests shall be 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. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

G. Mockups: Cast concrete slab-on-grade and formed-surface panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship.

1. Build panel approximately 200 sq. ft. for slab-on-grade and 100 sq. ft. for formed surface in the location indicated or, if not indicated, as directed by Architect.
2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

H. Preinstallation Conference: Conduct conference at Project site.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. 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 special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, forms and form removal limitations, shoring and reshoring procedures, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
   a. High-density overlay, Class 1 or better.
   b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
   c. Structural 1, B-B or better; mill oiled and edge sealed.
   d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.


D. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.


E. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will 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.
2.2 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

C. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

D. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) ASTM A 706/A 706M, deformed bars, epoxy coated, with less than 2 percent damaged coating in each 12-inch (300-mm) bar length.

E. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.

F. Deformed-Steel Wire: ASTM A 496/A 496M.

G. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A, Type 1 coated, as-drawn, plain-steel wire, with less than 2 percent damaged coating in each 12-inch (300-mm) wire length.

H. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.

2.3 REINFORCEMENT ACCESSORIES

A. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, ASTM A 775/A 775M epoxy coated.

B. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: See structural general notes for Cement requirements. Supplement with the following:

   a. Fly Ash: ASTM C 618, Class F or C. Fly ash shall not be used in exterior concrete slabs on grade.
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.

2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
3. Normal Weight Aggregate Concrete to have a minimum density of 145 pcf when fully cured.


2.5 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. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. BASF Construction Chemicals - Building Systems; Rheocrete 222+.
   b. Cortec Corporation; MCI- 2000 2005NS.
   c. Grace Construction Products, W. R. Grace & Co.; DCI-S.
   d. Sika Corporation; FerroGard 901.

D. 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. Coordinate with section 033560 Polished and Sealed Concrete.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ChemMasters.
   b. Davis Colors.
   c. Dayton Superior Corporation.
   d. Hoover Color Corporation.
   e. Lambert Corporation.
   f. QC Construction Products.
   g. Rockwood Pigments NA, Inc.

2.6 FIBER REINFORCEMENT

A. Synthetic Macro-Fiber: Polyolefin macro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, 1 to 2-1/4 inches (25 to 57 mm) long.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. 3M; Scotchcast Polyolefin Fibers.
   b. Euclid Chemical Company (The), an RPM company; Tuf-Strand SF.
   c. FORTA Corporation; FORTA FERRO.
   e. Nycon, Inc.; XL.
   f. Propex Concrete Systems Corp.; Fibermesh 650.
   g. Sika Corporation; Sika Fiber.

2.7 WATERSTOPS

A. Basement and elevator pits, coordinate with drawings.

2.8 FLOOR AND SLAB TREATMENTS

A. Coordinate with section 033560 Polished and Sealed Concrete

2.9 LIQUID FLOOR TREATMENTS

A. VOC Content: Liquid floor treatments shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

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

   a. ChemMasters; Chemisil Plus.
   b. ChemTec Int'l; ChemTec One.
   c. Conspec by Dayton Superior; Intraseal.
   d. Curecrete Distribution Inc.; Ashford Formula.
   e. Dayton Superior Corporation; Day-Chem Sure Hard (J-17).
   f. Edoco by Dayton Superior; Titan Hard.
   g. Euclid Chemical Company (The), an RPM company; Euco Diamond Hard.
   h. Kaufman Products, Inc.; SureHard.
   i. L&M Construction Chemicals, Inc.; Seal Hard.
   j. Meadows, W. R., Inc.; LIQUI-HARD.
   k. Metalcrete Industries; Floorsaver.
i. Nox-Crete Products Group; Duro-Nox.

m. Prosoco

n. Symons by Dayton Superior; Buff Hard.

o. US SPEC, Division of US Mix Products Company; US SPEC Industraseal.


C. Penetrating Liquid Floor Treatments for Polished Concrete Finish: Clear, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and is suitable for polished concrete surfaces.

1. Products: Coordinate with Section 03 3560 polished and sealed Concrete

2.10 CURING MATERIALS

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

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Axim Italcementi Group, Inc.; CATEXOL CimFilm.

b. BASF Construction Chemicals - Building Systems; Confilm.

c. ChemMasters; SprayFilm.

d. Conspec by Dayton Superior; Aquafilm.

e. Dayton Superior Corporation; Sure Film (J-74).

f. Edoco by Dayton Superior; BurkeFilm.

g. Euclid Chemical Company (The), an RPM company; Eucobar.

h. Kaufman Products, Inc.; Vapor-Aid.

i. Lambert Corporation; LAMBCO Skin.

j. L&M Construction Chemicals, Inc.; E-CON.

k. Meadows, W. R., Inc.; EVAPRE.

l. Metalcrete Industries; Waterhold.

m. Nox-Crete Products Group; MONOFILM.

n. Sika Corporation; SikaFilm.

o. SpecChem, LLC; Spec Film.

p. Symons by Dayton Superior; Finishing Aid.

q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.

r. Unitex; PRO-FILM.

s. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) 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.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
b. BASF Construction Chemicals - Building Systems; Kure 200.

c. ChemMasters; Safe-Cure Clear.

d. Conspec by Dayton Superior; W.B. Resin Cure.

e. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).

f. Edoco by Dayton Superior; Res X Cure WB.

g. Euclid Chemical Company (The), an RPM company; Kurez W VOX; TAMMSCURE WB 30C.


i. Lambert Corporation; AQUA KURE - CLEAR.

j. L&M Construction Chemicals, Inc.; L&M Cure R.

k. Meadows, W. R., Inc.; 1100-CLEAR.

l. Nox-Crete Products Group; Resin Cure E.

m. Right Pointe; Clear Water Resin.

n. SpecChem, LLC; Spec Rez Clear.

o. Symons by Dayton Superior; Resi-Chem Clear.

p. TK Products, Division of Sierra Corporation; TK-2519 DC WB.

q. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Anti-Hydro International, Inc.; AH Clear Cure WB.

b. BASF Construction Chemicals - Building Systems; Kure-N-Seal WB.

c. ChemMasters; Safe-Cure & Seal 20.

d. Conspec by Dayton Superior; Cure and Seal WB.

e. Cresset Chemical Company; Crete-Trete 309-VOC Cure & Seal.

f. Dayton Superior Corporation; Safe Cure and Seal (J-18).

g. Edoco by Dayton Superior; Spartan Cote WB II.

h. Euclid Chemical Company (The), an RPM company; Aqua Cure VOX; Clearseal WB 150.


j. Lambert Corporation; Glazecote Sealer-20.

k. L&M Construction Chemicals, Inc.; Dress & Seal WB.


m. Metalcrete Industries; Metcure.

n. Nox-Crete Products Group; Cure & Seal 150E.

o. Symons by Dayton Superior; Cure & Seal 18 Percent E.

p. TK Products, Division of Sierra Corporation; TK-2519 WB.

q. Vexcon Chemicals, Inc.; Starseal 309.

G. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating[, certified by curing compound manufacturer to not interfere with bonding of floor covering].

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. BASF Construction Chemicals - Building Systems; Kure-N-Seal W.

b. ChemMasters; Safe-Cure Clear.

c. Conspec by Dayton Superior; High Seal.

d. Dayton Superior Corporation; Safe Cure and Seal (J-19).

e. Edoco by Dayton Superior; Spartan Cote WB II 20 Percent.
f. Euclid Chemical Company (The), an RPM company; Diamond Clear VOX; Clearseal WB STD.
g. Kaufman Products, Inc.; SureCure Emulsion.
h. Lambert Corporation; Glazecote Sealer-20.
i. L&M Construction Chemicals, Inc.; Dress & Seal WB.
k. Metalcrete Industries; Metcure 0800.
l. Nox-Crete Products Group; Cure & Seal 200E.
m. Symons by Dayton Superior; Cure & Seal 18 Percent E.
n. Vexcon Chemicals, Inc.; Starseal 0800.

H. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound:  ASTM C 1315, Type 1, Class A.

1. Products:  Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. BASF Construction Chemicals - Building Systems; Kure-N-Seal 25 LV.
   b. ChemMasters; Spray-Cure & Seal Plus.
   c. Conspec by Dayton Superior; Sealcure 1315.
   d. Dayton Superior Corporation; Day-Chem Cure and Seal (J-22UV).
   e. Edoco by Dayton Superior; Cureseal 1315.
   f. Euclid Chemical Company (The), an RPM company; Super Diamond Clear; LusterSeal 300.
   g. Kaufman Products, Inc.; Sure Cure 25.
   h. Lambert Corporation; UV Super Seal.
   i. L&M Construction Chemicals, Inc.; Lumiseal Plus.
   k. Metalcrete Industries; Seal N Kure 30.
   l. Right Pointe; Right Sheen 30.
   m. Vexcon Chemicals, Inc.; Certi-Vex AC 1315.
   n. 

2. VOC Content:  Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

I. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound:  ASTM C 1315, Type 1, Class A.

1. Products:  Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. BASF Construction Chemicals - Building Systems; Kure 1315.
   b. ChemMasters; Polyseal WB.
   c. Conspec by Dayton Superior; Sealcure 1315 WB.
   d. Edoco by Dayton Superior; Cureseal 1315 WB.
   e. Euclid Chemical Company (The), an RPM company; Super Diamond Clear VOX; LusterSeal WB 300.
   g. Lambert Corporation; UV Safe Seal.
   h. L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
   j. Metalcrete Industries; Metcure 30.
   k. Right Pointe; Right Sheen WB30.
   l. Symons by Dayton Superior; Cure & Seal 31 Percent E.
2. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.11 RELATED MATERIALS


B. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. 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.

D. 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.

2.12 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 C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
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 4100 psi (29 MPa) at 28 days when tested according to ASTM C 109/C 109M.

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 C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
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 (34.5 MPa) at 28 days when tested according to ASTM C 109/C 109M.
2.13 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, where allowed.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.

D. Admixtures: Use admixtures according to 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, 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.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

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.

2.14 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. See the General Structural Notes for concrete mixture requirements.

2.15 FABRICATING REINFORCEMENT

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

2.16 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
PART 3 - EXECUTION

3.1 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 A, 1/8 inch (3.2 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.

3.2 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. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC’s "Code of Standard Practice for Steel Buildings and Bridges."

2. 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. Install dovetail anchor slots in concrete structures as indicated.

### 3.3 REMOVING AND REUSING FORMS

A. General: 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 (10 deg C) 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 supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength or one week, whichever is last.

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. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

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

### 3.4 VAPOR RETARDERS

A. See under-slab vapor barrier specification

### 3.5 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

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

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

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

E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
3.6 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.
   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.

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

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 (13 mm) or more than 1 inch (25 mm) 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: 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.

F. Acoustic Expansion Joints to be filled using a resilient material. No bridging of the isolation provided by acoustic joints caused by rigid materials in contact with both sides. In particular, no connection via concrete, footings, rebar or conduit.
3.7 WATERSTOPs

A. Basement and elevator pits, coordinate with drawings

3.8 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. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

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 bHPBSwater 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 (4.4 deg C) 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 (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated 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.

3.9 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.

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 and as indicated on drawings.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where 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.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. 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.
3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

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.
3.10 FINISHING FLOORS AND SLABS

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

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.

1. Apply scratch finish to surfaces indicated and to receive concrete floor toppings to receive mortar setting beds for bonded cementitious floor finishes.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces indicated to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces indicated 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.

2. Finish surfaces to the following tolerances, according to ASTM E 1155 (ASTM E 1155M), for a randomly trafficked floor surface:

   a. Dance, Concert Hall, Instrument Ensemble, Choral Ensemble, Proscenium Theater, and all polished concrete areas: Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 21; and of levelness, F(L) 15.

   b. Specified overall values of flatness, F(F) 20; and of levelness, F(L) 15; with minimum local values of flatness, F(F) 12; and of levelness, F(L) 9; for general areas of slabs-on-grade.

   c. Specified overall values of flatness, F(F) 35; with minimum local values of flatness, F(F) 25; for suspended slabs in the Concert Hall and Proscenium Theater and polished concrete suspended slabs

3. 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 1/8 inch.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.

1. 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 elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

G. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:

1. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistant aggregate over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.
2. After broadcasting and tamping, apply float finish.
3. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistant aggregate.

3.11 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:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 6 inches high unless otherwise indicated; and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
3. Minimum Compressive Strength: 3000 psi at 28 days.
4. Install dowel rods to connect concrete base to concrete floor as indicated.
5. Prior to pouring concrete, place and secure anchorage devices where required. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

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

3.12 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 (1 kg/sq. m 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.

3.13 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer’s written instructions.
1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Apply to concrete per manufacturer's recommendation.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

### B. Polished Concrete Floor Treatment

Apply polished concrete finish system to cured and prepared slabs to match accepted mockup. Coordinate with section 033560 Polished and Sealed Concrete.

1. Machine grind floor surfaces to receive polished finishes level and smooth.
2. Apply penetrating liquid floor treatment for polished concrete in polishing sequence and according to manufacturer's written instructions, allowing recommended drying time between successive coats.
3. Continue polishing with progressively finer grit diamond polishing pads to gloss level to match approved mockup.
4. Control and dispose of waste products produced by grinding and polishing operations.
5. Neutralize and clean polished floor surfaces.

### 3.14 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 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.

### 3.15 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 (1.18-mm) 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.

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 receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.

5. 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.

6. 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.

7. 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's approval, using epoxy adhesive and patching mortar. Repair mortars shall be submitted for review.

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

3.16 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

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

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each 150 cu. yd. of each concrete mixture or fraction thereof for each day, but not less than once per 5000 square feet of surface area for walls and slabs.
   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.

5. Compression Test Specimens: ASTM C 31/C 31M.
   a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
   a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
   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.

7. 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.

8. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

9. 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.
10. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.

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

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

D. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within 48 hours of finishing.

3.17 PROTECTION OF LIQUID FLOOR TREATMENTS

A. 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.

END OF SECTION 03 30 00
SECTION 03 30 40
PORTLAND CEMENT CONCRETE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Portland cement concrete material requirements.

B. Mix design requirements.

1.2 REFERENCES

A. AASHTO T 26: Standard Method of Test for Quality of Water to be Used in Concrete.


C. ACI 211.2: Standard Practice for Selecting Proportions for Structural Lightweight Concrete.

D. ACI 211.3: Standard Practice for Selecting Proportions for No-Slump Concrete.

E. ACI 214: Recommended Practice for Evaluation of Strength Test Results of Concrete.

F. ACI 306: Cold Weather Concreting.


H. ASTM C 88: Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.


1.3 DEFINITIONS

A. Average Strength ($f_{c.avg}$): The required average strength for 30 consecutive strength tests which statistically assures no more than the permissible proportions of tests will fall below specified strength.

B. Specified Strength ($f'_c$): The indicated strength.
A.4 SUBMITTALS

A. Mix Design: Submit each proposed mix design 14 days prior to use in the Work. Indicate whether mixes have been designed for pumping. Include in the report of the following information.

1. Water-cement ratio.
2. Proportion of materials in the mix.
3. Source and type of cement.
4. Analysis of water to be used.
5. Type name of admixtures applied. Indicate when accelerating or retarding admixtures are to be used.
6. Slump, air content and temperature of samples.
7. Unit weight of fresh and dry light weight concrete.

B. Pre-Approved Mix Design Data: If supplier has on record, an Owner approved mix design, submit name and address of supplier for each mix design 1 day prior to using concrete mix.

1.5 QUALITY ASSURANCE

A. Use the same source and type of cement, air-entraining agent, water reducing agent, other admixtures, and aggregate.

B. In proportioning material for mixing, use scales certified by the State of Utah. Do not use volume measurement except for water and liquid admixtures.

C. Do not change the quantity of cement per cubic yard.

D. Use of admixtures will not relax hot or cold weather placement requirements.

E. Ready-mixed concrete, in accordance with Alternate No. 3 of ASTM C 94 and requirements in this Section.

F. Testing Concrete: In accordance with ASTM C39.

1.6 PRODUCT STORAGE AND HANDLING

A. Store bagged and bulk cement in weatherproof enclosures to exclude moisture and contaminants.

B. Stockpile aggregate to avoid segregation and prevent contamination.

C. Avoid contamination, evaporation, or damage to admixtures. Protect liquid admixtures from freezing and temperature changes.

PART 2 - PRODUCTS

2.1 CEMENT
A. Type V, in accordance with ASTM C 150.
B. Do not use air entraining cement.

2.2 WATER
A. Clean, non-staining and not detrimental. Comply with AASHTO T 26.

2.3 AGGREGATES - GENERAL
A. Gravel, crushed slag, crushed stone, or other inert materials, composed of hard, strong, durable particles free of injurious coatings.
B. The materials passing the No. 200 sieve shall not exceed 1.75 percent by weight in the combined coarse and fine aggregate.

2.4 COARSE AGGREGATE
A. Sieve Analysis: Graded in accordance with ASTM C 33.
   These limitations may be changed if, in the judgment of the Engineer, workability and methods of consolidation are such that concrete can be placed without honeycomb or voids and the maximum aggregate size does not exceed the following requirements.
   1. 1/5 of narrowest dimension between forms.
   2. 1/3 of depth of slabs.
   3. 3/4 of minimum clear spacing between reinforcing bars.
B. Deleterious Substances: Maximum percentage by weight.
   1. Soft Fragments: 2.0 percent.
   2. Coal and Lignite: 0.3 percent.
   3. Clay Lumps: 0.3 percent.
   4. Other Deleterious Substances: 2.0 percent.

2.5 FINE AGGREGATE
A. Sieve Analysis: Graded in accordance with ASTM C 33, as follows.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing (by weight)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>100</td>
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</tbody>
</table>
B. Deleterious Substances: Maximum percentage by weight.
   1. Coal and Lignite: 0.3 percent.
   2. Clay Lumps: 0.5 percent.
   3. Other Deleterious Substances: 2.0 percent.

2.6 SOUNDNESS AND REACTIVITY OF AGGREGATE

A. Determine suitability of fine and coarse aggregate sources for soundness in accordance with ASTM C 88. Weight loss; not exceeding 16 percent by weight when subject to 5 cycles of sodium sulphate.

B. Determine alkali-silica reactivity in accordance with ASTM C 289. Do not use aggregates determined either potentially or actually deleterious.

2.7 ADMIXTURES

A. Air Entrainment: pH 2.0 maximum type in accordance with ASTM C 260.

   1. Type A: Water reducing.
   2. Type B: Retarding.
   3. Type C: Accelerating.
   4. Type D: Water reducing and water retarding.
   5. Type E: Water reducing and accelerating.
   6. Type F: High range water reducing (super plasticizer). *
   7. Type G: High range water reducing and retarding. *

*The relative durability factor of water reducing admixtures shall not be less than 90 and the chlorides content (as C1-) shall not exceed 1 percent by weight of the admixtures.

C. Calcium Chloride: None allowed.

D. Pozzolan: None allowed.

E. Fly Ash: None allowed.
F. Fiber Mesh: A.G. 0.90, Tensile Strength 70-11 ksi, Lengths of 0.5", 0.75, 1.5", & 2.0".

### 2.8 ENTRAINING AGENT

A. An entraining agent shall be used in all concrete exposed to weather. The agent shall conform to AASHTO designation M-154.

### 2.9 ACI MIX DESIGN

A. The amount by which the average strength of a concrete mix exceeds the specified strength shall be based upon no more than 1 in 100 random individual strength tests falling below the specific strength.

B. Proportion the materials in accordance with ACI 211.1, 211.2 or 211.3 as applicable to produce concrete having the following properties or limitations:

<table>
<thead>
<tr>
<th>CONCRETE MIX PROPERTIES</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Properties</td>
<td>5000</td>
<td>4500</td>
<td>3000</td>
<td>2500</td>
</tr>
<tr>
<td>Specified Compressive Strength $f'_c$ at 28 days, psi</td>
<td>5000</td>
<td>4500</td>
<td>3000</td>
<td>2500</td>
</tr>
<tr>
<td>Compressive Strength at 7 days, psi (a)</td>
<td>3335</td>
<td>3000</td>
<td>2000</td>
<td>1675</td>
</tr>
<tr>
<td>Cement content (94 lb. Sacks of cement per cubic yard of concrete)</td>
<td>7</td>
<td>6.5</td>
<td>5.5</td>
<td>5</td>
</tr>
<tr>
<td>Fiber Mesh</td>
<td>1.5#/CY</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Superplasticizer</td>
<td>12 oz./100# cement</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Water</td>
<td>30 gal/C.Y.</td>
<td>As Reqr</td>
<td>As Reqr</td>
<td>As Reqr</td>
</tr>
<tr>
<td>Crushed Rock</td>
<td>3/4&quot;-#4/60-65%</td>
<td>As Reqr</td>
<td>As Reqr</td>
<td>As Reqr</td>
</tr>
<tr>
<td>Sand</td>
<td>35-40%</td>
<td>As Reqr</td>
<td>As Reqr</td>
<td>As Reqr</td>
</tr>
<tr>
<td>Entrained air content, (% by volume)</td>
<td>6% +/- 1%</td>
<td>4 to 6</td>
<td>4 to 6</td>
<td>4 to 6</td>
</tr>
<tr>
<td>Slump Range, in. (b)</td>
<td>5&quot;</td>
<td>2 to 4</td>
<td>2 to 4</td>
<td>2 to 6</td>
</tr>
</tbody>
</table>
1. Used for monitoring purposes only.

2. Not more than 8" after adding high range water reducer admixture (super-plasticizer) to verified 2" to 3" slump concrete.

C. The use for each class of concrete is as follows:

1. Class A (5000 psi): Concrete Tank
2. Class B (4500 psi): All other reinforced structural concrete
3. Class C (3000 psi): Sidewalks, curb and gutter, cross gutters, pavements and unreinforced footings and foundations.
5. All other concrete, unless specified or otherwise indicated on the Drawing use Class B concrete.

D. Water

1. Sufficient water shall be added to produce concrete with the minimum practicable slump.

2.10 HAND MIXING

A. Do not hand mix batches exceeding 0.5 cubic yards.

B. Hand mix only on watertight platform. Mix cement and aggregate prior to adding water.

C. Ensure all stones are thoroughly covered with mortar and mixture is of uniform color and consistency.

2.11 HEATING, WATER, AND AGGREGATE

A. Do not allow products of fuel combustion to contact the aggregate.

B. Heat aggregate and mixing water to 150 degrees F. maximum. Heat aggregates uniformly.

C. Maintain mixed concrete temperature at time of placement between 60 and 90 degrees F.

D. Do not mix cement with water or with mixtures of water and aggregate greater than 90 degrees F.

PART 3 - EXECUTION

3.1 DELIVERY

A. Slump: Do not transport concrete to the work location if concrete is greater than permissible slump.
B. Discharge: After the introduction of mixing water to the cement and aggregates at the batch plant, discharge concrete from truck mixer within the following air temperatures and time periods.

1. Less than 80 degrees F.: 1-1/2 hours.
2. 80-90 degrees F.: 75 minutes.
3. 90+ degrees F.: 1 hour maximum.

3.2 RE-TEMPERING

A. Adding Water: When concrete arrives at site with slump below specified, water may be added if neither the maximum approved water/cement ratio nor the maximum slump is exceeded provided that:

1. The approved mix design has allowed for on-site addition of water.
2. The amount of water added at the site is accurately measured to ±1 gallon of the desired added amount.
3. That water additions is followed by 3 minutes of mixing at mixing speed prior to discharge.
4. That additional standard cylinder samples are taken from all trucks receiving water after addition of water at no additional cost to Owner.
5. That the person authorized to add water is mutually approved of in writing by Engineer, Contractor, and ready-mix vendor.

B. Super-plasticizers: Premeasure and add high range water reducers (super-plasticizers) in accordance with manufacturer’s instructions. Add super-plasticizers at site using truck-mounted power injection equipment capable of rapidly and uniformly distribution the admixture to the concrete. Mix for a minimum of 3 minutes prior to discharge.

C. Re-tempering after delivery time with super-plasticizer is prohibited.

END OF SECTION 03 30 40
SECTION 03 35 00
CONCRETE FINISHING

PART 1 – GENERAL

1.1 SECTION INCLUDES
A. Application procedure for concrete surface finishes.

1.2 PROJECT CONDITIONS
A. Allow concrete to cure not more than 72 hours before commencing surface finish operations, unless otherwise acceptable to Engineer.
B. Protect adjacent materials and finishes from dust, dirt and other surface or physical damage during finishing operations. Provide protections as required and remove from site at completion of Work.
C. For surfaces to be blast finished, perform abrasive blasting within 24 to 72 hours after casting. Coordinate with form work construction, concrete placement schedule, and form work removal to ensure that surfaces are blasted at same age for uniform results.

PART 2 - EXECUTION

2.1 PATCH FINISHING
A. Repair surface defects immediately after form removal.
B. Make any patches in concrete to closely match color and texture of surrounding surfaces. Determine mix formula for patching mortar by trial and obtain a good color match with concrete when both patch and concrete are cured and dry.
   1. Mix white and gray Portland cement as required to match surrounding concrete to produce grout having consistency of thick paint.
   2. Use a minimum amount of mixing water.
   3. Mix patching mortar in advance and allow to stand without frequent manipulation, without addition of water, until it has reached stiffest placeable consistency.
   4. After initial set, dress surfaces of patches manually to obtain same texture as surrounding surfaces.
C. Repair defective areas.
   1. Remove honeycomb and defective concrete down to sound concrete.
   2. Make edges perpendicular to surface or slightly undercut.
   3. Featheredges are not permitted
   4. Dampen area to be patched and at least 6" surrounding it to prevent absorption of patching mortar water.
5. Prepare bonding grout.
6. Mix to consistency of thick cream.
7. Brush into surface.

D. After surface water has evaporated from patch area, brush bond coat into surface.
   1. When bond coat begins to lose water sheen, apply patching mortar.
   2. Thoroughly consolidate mortar into place and strike-off to leave patch slightly higher than surrounding surface.
   3. Leave undisturbed for at least 1 hour before final finish.
   4. Keep patched area damp for 72 hours or apply curing compound.
   5. Do not use metal tools in finishing an exposed patch.

E. Tie Holes: Unless indicated otherwise, after being cleaned and thoroughly dampened, fill the hole solid with patching mortar.

F. Whereas-cast finishes are indicated, total patched area may not exceed 1 in 500 of as-cast surface. This is in addition to form tie patches, if ties are permitted to fall within as-cast areas.

G. In any finishing process which is intended to expose aggregate on surface, patched areas must show aggregate.
   1. Outer 1" of patch shall contain same aggregates as surrounding concrete.
   2. For aggregate transfer finish, patching mixture shall contain same selected colored aggregates.
   3. After curing, expose aggregates together with aggregates of adjoining surfaces by same process.

2.2 SLAB FINISHING

A. Broom or Belt Finish: After concrete has been placed, consolidated, struck-off, and leveled to the required tolerance, roughen surface transversely with stiff brushes, rakes, or burlap belt before final set.

B. Float Finish: After concrete has been placed, consolidated, struck-off, and leveled, do not work further until ready for floating.
   1. Begin floating when water sheen has disappeared and surface has stiffness sufficient to permit operation.
   2. During or after first floating, check planeness of entire surface with a 10 feet long straightedge applied at 2 or more different angles.
   3. Cut down high spots and fill low spots to the required tolerance.
4. Refloat slab immediately to a uniform sandy texture.

C. Trowel Finish:

1. Float finish surface.
2. Power trowel.
3. Hand trowel as required to provide surface. Do not apply water to retemper concrete in finishing operations.
4. First troweling after power floating shall produce smooth surface relatively free of defects but which may still show some trowel marks.
5. Second trowel by hand after surfaces has hardened.
6. Leave finished surface essentially free of trowel marks, uniform in texture and appearance.
7. On surfaces intended to support floor coverings, grind off defects which would show through floor covering.

2.3 AS-CAST FORMED FINISHING

A. Rough: Patch defects, chip or rub off fins exceeding 1/4" height.
B. Smooth: Patch tie holes and defects and remove fins completely.
   1. When surface texture is impaired and form joints misaligned, grind, bushhammer, or correct affected concrete as directed by Engineer.
   2. Slurry grout areas evidencing minor mortar leakage to match adjacent concrete.
   3. Repair major mortar leakage as a defective area.
   4. When in opinion of Engineer, workmanship is less than acceptable standard, provide one of rubbed finishes at no additional cost to Owner.

2.4 RUBBED FINISHING

A. Produce following finishes on concrete with a smooth form finish.
   1. Smooth Rubbed: Remove forms and perform necessary patching as soon after placement as possible.
   2. Finish newly hardened concrete no later than 24 hours following form removal.
   3. Wet surfaces and rub with carborundum brick or other abrasive until uniform color and texture are produced.

B. Grout Cleaned: Undertake no cleaning operations until all contiguous surfaces are completed and accessible.
1. Wet surface of concrete sufficiently to prevent absorption of water from grout.
2. Apply grout uniformly.
3. Immediately after grouting, scrub surface with cork float or stone to coat surface and fill voids.
4. While grout is still plastic, remove excess grout by working surface with rubber float or sack.
5. After-surface whitens from drying, rub vigorously with clean burlap.
6. Keep damp for at least 36 hours after final rubbing.
7. Cork Floated: Remove forms within 2 to 3 days of placement where possible.
8. Remove ties.
9. Remove all burrs and fins.
10. Dampen wall surface.
11. Apply mortar with firm rubber float or with trowel, filling all surface voids.
12. Compress mortar into voids.
13. If mortar surface dries too rapidly to permit proper compaction and finishing, apply a small amount of water with fog sprayer.
14. Produce final texture with cork float using a swirling motion.

2.5 UNFORMED FINISHING

A. After concrete is placed, strike smooth, tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces.
B. Float to texture which is reasonably consistent with formed surfaces.
C. Continue final treatment on formed surfaces uniformly across uniformed surfaces.

END OF SECTION 03 35 00
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Surface treatments for concrete floors.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's published data on each finishing product, including information on compatibility of different products and limitations.
C. Maintenance Data: Provide data on maintenance and renewal of applied finishes.

1.03 DELIVERY, STORAGE, AND HANDLING
A. Deliver materials in manufacturer's sealed packaging, including application instructions.

1.04 FIELD CONDITIONS
A. Do not finish floors until interior heating system is operational.
B. Maintain ambient temperature of 50 degrees F minimum.

PART 2 PRODUCTS

2.01 CONCRETE FLOOR FINISH APPLICATIONS
A. Unless otherwise indicated, all concrete floors are to be finished using liquid densifier/hardener.
B. Liquid Densifier/Hardener:
C. High Gloss Clear Sealer:
D. Slip Resistant Coating: High gloss clear sealer with plastic aggregate.

2.02 DENSIIFIERS AND HARDENERS
A. Liquid Densifier/Hardener: Penetrating chemical compound that reacts with concrete, filling the pores and dustproofing; for application to concrete after set.

2.03 COATINGS
A. High Gloss Clear Coating: Transparent, non-yellowing, water- or solvent-based coating.
B. Plastic Aggregate: Finely ground polymer for addition to coatings for slip resistance.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that floor surfaces are acceptable to receive the work of this section.
B. Verify that flaws in concrete have been patched and joints filled with methods and materials suitable for further finishes.

3.02 GENERAL
A. Apply materials in accordance with manufacturer's instructions.

3.03 COATING APPLICATION
A. Verify that surface is free of previous coatings, sealers, curing compounds, water repellents, laitance, efflorescence, fats, oils, grease, wax, soluble salts, residues from cleaning agents, and other impediments to adhesion.
B. Verify that water vapor emission from concrete and relative humidity in concrete are within limits established by coating manufacturer.
C. Protect adjacent non-coated areas from drips, overflow, and overspray; immediately remove excess material.

END OF SECTION
SECTION 03 39 00
CONCRETE CURING

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Initial and final curing of horizontal and vertical concrete surfaces.

1.2 RELATED SECTIONS
A. Section 03 30 40 – Portland Cement Concrete.

1.3 REFERENCES
A. ACI 301 - Structural Concrete for Buildings.
B. ACI 302 - Recommended Practice for Concrete Floor and Slab Construction.
C. ACI 308 - Standard Practice for Curing Concrete.
D. ASTM C171 - Sheet Materials for Curing Concrete.
E. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
F. ASTM D2103 - Polyethylene Film and Sheeting.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Membrane Curing Compound Type 1: ASTM C309 Type 1 acrylic type, clear without fugitive dye.
B. Water: Potable, not detrimental to concrete.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Verify substrate conditions under provisions of Section 31 23 27 Soil Compaction.
B. Verify that substrate surfaces are ready to be cured.

3.2 EXECUTION - HORIZONTAL SURFACES
A. Cure floor surfaces in accordance with ACI 308.
B. Ponding: Maintain 100 percent coverage of water over floor slab areas, continuously for 4 days.

*** OR ***
C. Membrane Curing Compound: Apply compound in accordance with manufacturer's instructions in one coat.

3.3 EXECUTION - VERTICAL SURFACES
A. Cure surfaces in accordance with ACI 308.
B. Spraying: Spray water over surfaces and maintain wet for 7 days.
   * * * OR * * *
C. Membrane Curing Compound: Apply compound in accordance with manufacturer's instructions in one coat.

3.4 PROTECTION OF FINISHED WORK
A. Protect finished work under provisions of Section 03 35 00 Concrete Finishing.
B. Do not permit traffic over unprotected floor surface.

END OF SECTION 03 39 00
SECTION 05 12 00 - 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. Grout.

B. Related Sections:
   1. Section 01 4000 "Quality Requirements" for independent testing agency procedures and administrative requirements.
   2. Section 05 1213 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.
   3. Section 05 3100 "Steel Decking" for field installation of shear connectors through deck.
   4. Section 05 5000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame miscellaneous steel fabrications and other metal items not defined as structural steel.
   5. Section 05 5100 "Metal Stairs."
   6. Section 09 9113 "Exterior Painting" and Section 09 9123 "Interior Painting" and Section 09 9600 "High-Performance Coatings" for surface-preparation and priming requirements.

1.3 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

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

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. HPBS Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Laboratory Test Reports for Credit IEQ 4: For primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. 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 with elevations.
   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.

D. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint qualified by testing, including the following:
   1. Power source (constant current or constant voltage).
   2. Electrode manufacturer and trade name.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified installer and 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, 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. Source quality-control reports.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator on the Utah State Division of Facilities Maintenance (DFCM) list of approved fabricators. Fabricators shall indicate, at the time of bidding, any AISC certification and whether in-shop inspections and testing will be required.

B. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."
C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

   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. FCMAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

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

   1. AISC 303.
   2. AISC 341 and AISC 341s1.
   3. AISC 360.
   4. RCSC’s "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

E. Preinstallation Conference: Conduct conference at Project site.

1.7 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 F 1852 fasteners and for retesting fasteners after lubrication.

1.8 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' 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.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.
B. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:

1. W-Shapes: 60 percent.
2. Channels, Angles, M, S-Shapes: 60 percent.
3. Plate and Bar: 25 percent.
4. Cold-Formed Hollow Structural Sections: 25 percent.
5. Steel Pipe: 25 percent.
6. All Other Steel Materials: 25 percent.

C. W-Shapes: ASTM A 992/A 992M.

D. Channels, Angles: ASTM A 36/A 36M or ASTM A 572/A 572M, Grade 50.

E. Plate and Bar: ASTM A 36/A 36M or ASTM A 572/A 572M, Grade 50.

F. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade C structural tubing.

G. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

B. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex or round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: Plain.

C. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

D. Unheaded Anchor Rods: ASTM F 1554, Grade 36 or ASTM F 1554, Grade 55, weldable.

1. Configuration: as indicated.

E. Threaded Rods: ASTM A 36/A 36M.

3. Finish: Plain.

F. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.
2.3 PRIMER

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Primer: SSPC-Paint 25, [Type I] [Type II], zinc oxide, alkyd, linseed oil primer.

C. Primer: SSPC-Paint 25 BCS, [Type I] [Type II], zinc oxide, alkyd, linseed oil primer.

D. Primer: SSPC-Paint 23, latex primer.

E. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

F. Galvanizing Repair Paint: MPI#18, MPI#19, SSPC-Paint 20 or ASTM A 780.

2.4 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.

1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Mark and match-mark materials for field assembly.
4. 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, mechanically thermal cut, 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 according to SSPC-SP 1, "Solvent Cleaning SSPC-SP 2, "Hand Tool Cleaning SSPC-SP 3, "Power Tool Cleaning."

F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.
G. Welded Door Frames: Build up welded door frames attached to structural steel. 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.

H. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
   1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
   2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.

2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

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 will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.7 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.
   3. Surfaces to be high-strength bolted with slip-critical connections.
   4. Surfaces to receive sprayed fire-resistant materials (applied fireproofing).
   5. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
   1. SSPC-SP 2, "Hand Tool Cleaning,"
   2. SSPC-SP 3, "Power Tool Cleaning,"
   3. SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning,"
   4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal,"
   5. SSPC-SP 14/NACE No. 8, "Industrial Blast Cleaning,"
   6. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning,"
   7. SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning,"
   8. SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning,"
   9. SSPC-SP 8, "Pickling."
C. Priming: Immediately after surface preparation, apply primer according to 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.

D. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00:  Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils.

2.8 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.

1. Fill vent and drain holes that will be exposed in the finished Work unless they will 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.

2.9 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

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

C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
4. Radiographic Inspection: ASTM E 94.

E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with 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 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.

1. Do not remove temporary shoring supporting composite deck construction 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 according to AISC 303 and 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 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 shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC’s “Code of Standard Practice for Steel Buildings and Bridges.”

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 will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
1. Level and plumb individual members of structure.
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.

H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
1. Joint Type: as indicated.

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. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
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 will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

B. Bolted Connections: Bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.
1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
   a. Liquid Penetrant Inspection: ASTM E 165.
   b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
   c. Ultrasonic Inspection: ASTM E 164.
d. Radiographic Inspection: ASTM E 94.

D. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.

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

3.6 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.

B. Touchup Painting: 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.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

C. Touchup Painting: Cleaning and touchup painting are specified in Section 09 9113 "Exterior Painting" Section 09 9123 "Interior Painting."

END OF SECTION 05 12 00
SECTION 05 21 00 - STEEL JOIST 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:
      2. LH- and DLH-series long-span steel joists.
   B. Related Requirements:
      1. Section 033000 "Cast-in-Place Concrete" for installing bearing plates in concrete.
      2. Section 042000 "Unit Masonry" for installing bearing plates in unit masonry.

1.3 DEFINITIONS
   A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."
   B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of joist, accessory, and product.
   B. HPBS Submittals:
      1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
      2. Laboratory Test Reports for Credit EQ 4: For primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
   C. Shop Drawings:
      1. Include layout, designation, number, type, location, and spacing of joists.
2. Include joining and anchorage details, bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.

3. Indicate locations and details of bearing plates to be embedded in other construction.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.
B. Welding certificates.
C. Manufacturer certificates.
D. Mill Certificates: For each type of bolt.
E. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."

1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.

B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications."

B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.8 SEQUENCING

A. Deliver steel bearing plates to be built into cast-in-place concrete construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.

1. Use ASD; data are given at service-load level.
2. Design special joists to withstand design loads with live-load deflections as indicated in the General Structural Notes.
B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.2 K-SERIES STEEL JOISTS


B. Provide holes in chord members for connecting and securing other construction to joists.

C. Camber joists according to SJI's "Specifications."

D. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

2.3 LONG-SPAN STEEL JOISTS

A. Manufacture steel joists according to "Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements as follows:

2. End Arrangement: Underslung.
3. Top-Chord Arrangement: Parallel.

B. Provide holes in chord members for connecting and securing other construction to joists.

C. Camber long-span steel joists according to SJI's "Specifications."

D. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

2.4 PRIMERS

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

C. Primer: Provide shop primer that complies with Section 09 9113 "Exterior Painting" and Section 09 9123 "Interior Painting." and Section 09 9600 "High-Performance Coatings."
2.5 JOIST ACCESSORIES

A. Bridging: Fabricate as indicated and according to SJI's "Specifications." Furnish additional erection bridging if required for stability.

B. Fabricate steel bearing plates from ASTM A 36/A 36M steel with integral anchorages of sizes and thicknesses indicated.

C. Furnish ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction. Extend ends to within 1/2 inch of finished wall surface unless otherwise indicated.

D. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.

   1. Finish: Plain, uncoated.

E. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers.

   1. Finish: Plain.

F. Welding Electrodes: Comply with AWS standards.

G. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.6 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.

B. Do not prime paint joists and accessories to receive sprayed fire-resistive materials.

C. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil thick.

D. Shop priming of joists and joist accessories is specified in Section 09 9123 "Interior Painting."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

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

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads are applied.

C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. Bolt joists to supporting steel framework using carbon-steel bolts.


F. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and bolted connections and to perform field tests and inspections and prepare test and inspection reports.

B. Visually inspect field welds according to AWS D1.1/D1.1M.

1. In addition to visual inspection, test field welds according to AWS D1.1/D1.1M and the following procedures, as applicable:

   a. Liquid Penetrant Inspection: ASTM E 165.
   b. Magnetic Particle Inspection: ASTM E 709.

C. Visually inspect bolted connections.

D. Correct deficiencies in Work that test and inspection reports have indicated are not in compliance with specified requirements.

E. Perform additional testing to determine compliance of corrected Work with specified requirements.
3.4 PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates, abutting structural steel, and accessories.

1. Clean and prepare surfaces by hand-tool cleaning according to SSPC-SP 2, or power-tool cleaning according to SSPC-SP 3.
2. Apply a compatible primer of same type as primer used on adjacent surfaces.

C. Touchup Painting: Cleaning and touchup painting are specified in Section 09 9113 "Exterior Painting" and Section 09 9123 "Interior Painting." and Section 09 9600 "High-Performance Coatings."

D. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that joists and accessories are without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 21 00
SECTION 05 31 00 - STEEL 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:

1. Roof deck.
2. Composite floor deck.

B. Related Requirements:

1. Section 03 3000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
2. Section 05 1200 "Structural Steel Framing" for shop- and field-welded shear connectors.
3. Section 05 5000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
4. Section 09 9113 "Exterior Painting" for repair painting of primed deck and finish painting of deck.
5. Section 09 9123 "Interior Painting" for repair painting of primed deck and finish painting of deck.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. HPBS Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Laboratory Test Reports for Credit EQ 4: For primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.
1.4 INFORMATIONAL SUBMITTALS
A. Welding certificates.
B. Product Certificates: For each type of steel deck.
C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
   1. Power-actuated mechanical fasteners.
D. Evaluation Reports: For steel deck.
E. Field quality-control reports.

1.5 QUALITY ASSURANCE
A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

1.6 DELIVERY, STORAGE, AND HANDLING
A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
   1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
2.2 ROOF DECK

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. ASC Profiles, Inc.; a Blue Scope Steel company.
2. Canam United States; Canam Group Inc.
3. CMC Joist & Deck.
5. Cordeck.
6. DACS, Inc.
8. Marlyn Steel Decks, Inc.
9. New Millennium Building Systems, LLC.
11. Roof Deck, Inc.
12. Valley Joist; Subsidiary of EBSCO Industries, Inc.
14. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) zinc coating.
2. Deck Profile: As indicated.
3. Profile Depth: As indicated.
4. Design Uncoated-Steel Thickness: As indicated.
5. Span Condition: As indicated.
6. Side Laps: Interlocking seam or overlapped at Contractor's option to be compatible with chosen deck side lap attachments.

2.3 COMPOSITE FLOOR DECK

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. ASC Profiles, Inc.; a Blue Scope Steel company.
2. Canam United States; Canam Group Inc.
3. CMC Joist & Deck.
5. Cordeck.
6. DACS, Inc.
8. Marlyn Steel Decks, Inc.
9. New Millennium Building Systems, LLC.
B. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:

1. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 33 (230) minimum, with top surface phosphatized and unpainted and underside surface shop primed with manufacturers' standard gray or white baked-on, rust-inhibitive primer.

2. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) zinc coating.

3. Profile Depth: As indicated.

4. Design Uncoated-Steel Thickness: As indicated.

5. Span Condition: As indicated.

2.4 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners.

C. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

D. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth.

E. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

F. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.

G. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.

H. Galvanizing Repair Paint: ASTM A 780, SSPC-Paint 20, or MIL-P-21035B, with dry film containing a minimum of 94 percent zinc dust by weight.

I. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck but must be submitted and approved prior to use. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:

1. Weld Diameter: As indicated.
2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds as indicated.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or as indicated.

1. Fasten with a minimum of 1-1/2-inch-long welds.
C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 2 inches, with end joints as follows:
   1. End Joints: Lapped 4 inches minimum.

D. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.
   1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

3.4 FLOOR-DECK INSTALLATION

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
   1. Weld Diameter: As indicated.
   2. Weld Spacing: Space and locate welds as indicated.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports as indicated.
   1. Fasten with a minimum of 1-1/2-inch-long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 2 inches, with end joints as follows:
   1. End Joints: Lapped or butted at Contractor's option.

D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

3.5 FIELD QUALITY CONTROL

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

B. Field welds will be subject to inspection.

C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

D. Remove and replace work that does not comply with specified requirements.

E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.
3.6 PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation and apply repair paint.

   1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
   2. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 09 9113 "Exterior Painting" and Section 09 9123 "Interior Painting."

C. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 09 9113 "Exterior Painting" and Section 09 9123 "Interior Painting."

D. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 3100
SECTION 05 51 00
METAL STAIRS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Stairs with concrete treads.
B. Stairs with grating treads.
C. Structural steel stair framing and supports.
D. Handrails and guards.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
   1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
   2. Include the design engineer's seal and signature on each sheet of shop drawings.
C. Design Data: As required by authorities having jurisdiction.
D. Designer's Qualification Statement.

1.03 QUALITY ASSURANCE
A. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located, or personnel under direct supervision of such an engineer.

PART 2 PRODUCTS

2.01 METAL STAIRS - GENERAL
A. Metal Stairs: Provide stairs of the design specified, complete with landing platforms, vertical and horizontal supports, railings, and guards, fabricated accurately for anchorage to each other and to building structure.
   1. Regulatory Requirements: Provide stairs and railings complying with the most stringent requirements of local, state, and federal regulations; where requirements of Contract Documents exceed those of regulations, comply with Contract Documents.
   2. Handrails: Comply with applicable accessibility requirements of ADA Standards.
   3. Structural Design: Provide complete stair and railing assemblies complying with the applicable local code.
   4. Dimensions: As indicated on drawings.
   5. Shop assemble components; disassemble into largest practical sections suitable for transport and access to site.
   6. No sharp or rough areas on exposed travel surfaces and surfaces accessible to touch.
   7. Separate dissimilar metals using paint or permanent tape.
B. Metal Jointing and Finish Quality Levels:
   1. Architectural: All joints as inconspicuous as possible, whether welded or mechanical.
      a. Welded Joints: Continuously welded and ground smooth and flush.
      b. Mechanical Joints: Butted tight, flush, and hairline; concealed fastenings only.
      c. Exposed Edges and Corners: Eased to small uniform radius.
      d. Metal Surfaces to be Painted: Sanded or ground smooth, suitable for highest quality gloss finish.
   2. Industrial: All joints made neatly.
      a. Welded Joints: Welded on back side wherever possible.
      b. Welds Exposed to Touch: Ground smooth.
      c. Bolts Exposed to Touch in Travel Area: No nuts or screw threads exposed to touch.

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C. Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.

D. Anchors and Related Components: Same material and finish as item to be anchored, except where specifically indicated otherwise; provide all anchors and fasteners required.

2.02 METAL STAIRS WITH CONCRETE TREADS (BOTH INTERIOR STAIRS)

A. Jointing and Finish Quality Level: Architectural, as defined above.

B. Risers: Closed.

C. Treads: Metal pan with field-installed concrete fill.
   1. Concrete Depth: 1-1/2 inches, minimum.
   2. Precast Concrete Treads: NOT PERMITTED
   3. Tread Pan Material: Steel sheet.
   4. Tread Pan Thickness: As required by design; 14 gage, 0.075 inch minimum.
   5. Concrete Reinforcement: None.
   6. Concrete Finish: Steel troweled.

D. Risers: Same material and thickness as tread pans.
   1. Riser/Nosing Profile: Vertical riser with underside of nosing sloped up from bottom of tread pan at not less than 60 degrees from horizontal, with rounded top of nosing of minimum radius.
   2. Nosing Depth: Not more than 1-1/2 inch overhang.
   3. Nosing Return: Flush with top of concrete fill, not more than 1/2 inch wide.

E. Stringers: Rolled steel channels.
   1. Stringer Depth: 12 inches.
   2. End Closure: Sheet steel of same thickness as risers welded across ends.

F. Landings: Same construction as treads, supported and reinforced as required to achieve design load capacity.

G. Railings: Steel pipe railings.

H. Finish: Shop- or factory-prime painted.

I. Under Side of Stair: Exposed to view, to be finished same as specified for other exposed to view surfaces.

2.03 METAL STAIRS WITH GRATING TREADS (EXTERIOR STAIRS)

A. Jointing and Finish Quality Level: Industrial, as defined above.

B. Risers: Closed.

C. Treads: Steel bar grating.
   1. Grating Type: Welded.
   2. Bearing Bar Depth: 3/4 inch, minimum.
   3. Top Surface: Standard.
   6. Anchorage to Stringers: End plates welded to grating, bolted to stringers.

D. Stringers: Rolled steel channels.
   1. Stringer Depth: 12 inches.
   2. End Closure: Sheet steel, 14 gage, 0.075 inch minimum; welded across ends.

E. Landings: Same construction as treads, supported and reinforced as required to achieve design load capacity.

F. Railings: Steel pipe railings.

G. Finish: Shop- or factory-prime painted.

2.04 HANDRAILS AND GUARDS

A. Wall-Mounted Rails: Round pipe or tube rails unless otherwise indicated.
1. Outside Diameter: 1-1/4 inch, minimum, to 1-1/2 inches, maximum.

B. Guards:
   1. Top Rails: Round pipe or tube rails unless otherwise indicated.
      a. Outside Diameter: 1-1/4 inch, minimum, to 1-1/2 inches, maximum.
   2. Infill at Pipe Railings: Pipe or tube rails sloped parallel to stair.
      a. Outside Diameter: 1 inch.
      b. Material: Steel pipe or tube, round.
      c. Vertical Spacing: Maximum 4 inches on center.
      d. Jointing: Welded and ground smooth and flush.
   3. End and Intermediate Posts: Same material and size as top rails.
      a. Horizontal Spacing: As indicated on drawings.
      b. Mounting: Welded to top surface of stringer.

2.05 MATERIALS
   A. Steel Sections: ASTM A36/A36M.
   B. Steel Tubing: ASTM A500/A500M or ASTM A501/A501M structural tubing, round and shapes as indicated.
   C. Pipe: ASTM A53/A53M, Grade B Schedule 40, black finish.
   D. Gratings: Bar gratings complying with NAAMM MBG 531 or NAAMM MBG 532, whichever applies based on bar sizes.
   E. Concrete Fill: Portland cement Type I, 3000 psi 28 day strength, 2 to 3 inch slump.

2.06 ACCESSORIES
   A. Steel Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, and galvanized to ASTM A153/A153M where connecting galvanized components.
   B. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
   C. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
   D. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.07 SHOP FINISHING
   A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
   B. Do not prime surfaces in direct contact with concrete or where field welding is required.
   C. Prime Painting: Use specified shop- and touch-up primer.
      1. Preparation of Steel: In accordance with SSPC-SP 2, Hand Tool Cleaning.
      2. Number of Coats: One.
   D. Galvanizing: Hot-dip galvanize to minimum requirements of ASTM A123/A123M.
      1. Touch up abraded areas after fabrication using specified touch-up primer for galvanized surfaces.

PART 3 EXECUTION

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

3.02 INSTALLATION
   A. Install components plumb and level, accurately fitted, free from distortion or defects.
   B. Provide anchors, plates, angles, hangers, and struts required for connecting stairs to structure.
   C. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
   D. Provide welded field joints where specifically indicated on drawings. Perform field welding in accordance with AWS D1.1/D1.1M.
E. Other field joints may be either welded or bolted provided the result complies with the limitations specified for jointing quality levels.
F. Obtain approval prior to site cutting or creating adjustments not scheduled.
G. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

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

END OF SECTION
SECTION 06 20 00
FINISH CARPENTRY

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Finish carpentry items.
   B. Hardware and attachment accessories.

1.02 REFERENCE STANDARDS
   A. BHMA A156.9 - American National Standard for Cabinet Hardware; 2015.
   B. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

1.03 ADMINISTRATIVE REQUIREMENTS
   A. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
   B. Product Data:
      1. Provide instructions for attachment hardware and finish hardware.
   C. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. Protect from moisture damage.

PART 2 PRODUCTS
2.01 FINISH CARPENTRY ITEMS
2.02 PLASTIC LAMINATE MATERIALS
   A. Plastic Laminate: NEMA LD 3; color as selected by Architect; finish as selected.

2.03 ACCESSORIES
   A. Adhesive: Type recommended by fabricator to suit application.

2.04 HARDWARE
   A. Hardware: Comply with BHMA A156.9.
   B. Standard Shelf, Countertop, and Workstation Brackets:
      1. Material: Steel.
      2. Finish: Manufacturer's standard, factory-applied, textured powder coat.

2.05 FABRICATION
   A. Shop assemble work for delivery to site, permitting passage through building openings.
   B. Cap exposed plastic laminate finish edges with material of same finish and pattern.
   C. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.
   D. Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify adequacy of backing and support framing.
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. Do not use additional overlay trim to conceal larger gaps.

END OF SECTION
SECTION 06 41 00
ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Specially fabricated cabinet units.
   B. Countertops.
   C. Hardware.

1.02 REFERENCE STANDARDS
   C. BHMA A156.9 - American National Standard for Cabinet Hardware; 2015.
   D. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
   C. Product Data: Provide data for hardware accessories.

1.04 DELIVERY, STORAGE, AND HANDLING
   A. Protect units from moisture damage.

1.05 FIELD CONDITIONS
   A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 PRODUCTS

2.01 CABINETS
   A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
   B. Plastic Laminate Faced Cabinets: Custom grade.
   C. Cabinets at Classrooms:
      2. Finish - Concealed Surfaces: Melamine.
      3. Door and Drawer Front Edge Profiles: Square edge with thin applied band.
      4. Adjustable Shelf Loading: 50 lbs. per sq. ft.
      5. Cabinet Style: Flush overlay.

2.02 WOOD-BASED COMPONENTS
   A. Wood fabricated from old growth timber is not permitted.

2.03 LAMINATE MATERIALS
   A. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications.

2.04 COUNTERTOPS
   A. Plastic Laminate Countertops: Medium density fiberboard substrate covered with HPDL, conventionally fabricated and self-edge banded.
2.05 ACCESSORIES
   A. Adhesive: Type recommended by fabricator to suit application.
   B. Plastic Edge Banding: Extruded PVC, convex shaped; smooth finish; self locking serrated tongue; of width to match component thickness.
      1. Color: As selected by Architect from manufacturer's standard range.
   C. Concealed Joint Fasteners: Threaded steel.
   D. Grommets: Standard plastic grommets for cut-outs, in color to match adjacent surface.

2.06 HARDWARE
   A. Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified.
   B. Drawer and Door Pulls: "U" shaped wire pull, steel with chrome finish, 4 inch centers.
   C. Drawer Slides:
      1. Type: Extension types as indicated.
      2. Static Load Capacity: Commercial grade.
      4. Stops: Integral type.
      5. Features: Provide self closing/stay closed type.
   D. Hinges: European style concealed self-closing type, steel with polished finish.

2.07 FABRICATION
   A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.
   B. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners.

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. Secure cabinets to floor using appropriate angles and anchorages.
   C. Countersink anchorage devices at exposed locations. Conceal 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.

END OF SECTION
SECTION 07 11 13
BITUMINOUS DAMPPROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Bituminous dampproofing.
   B. Protection boards.

1.02 RELATED REQUIREMENTS
   A. Section 07 21 00 - Thermal Insulation: Rigid insulation board used as protection board.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide properties of primer, bitumen, and mastics.

1.05 QUALITY ASSURANCE
   A. Installer Qualifications: Company specializing in performing the work of this section with at least three years of documented experience.

1.06 FIELD CONDITIONS
   A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application until dampproofing has cured.

PART 2 PRODUCTS

2.01 BITUMINOUS DAMPPROOFING
   A. Bituminous Dampproofing: Cold-applied water-based emulsion; asphalt with mineral colloid or chemical emulsifying agent; with or without fiber reinforcement; asbestos-free; suitable for application on vertical and horizontal surfaces.
      1. Composition - Vertical Application: ASTM D1227 Type III or ASTM D1187/D1187M Type I.
      2. Composition - Horizontal and Low-Slope Application: ASTM D1227 Type II or III.
      3. VOC Content: Not more than permitted by local, State, and federal regulations.
      4. Applied Thickness: 1/8 inch, minimum, wet film. Thickness to be verified before covering.
   B. Primers, Mastics, and Related Materials: Type as recommended by dampproofing manufacturer.

2.02 ACCESSORIES
   A. Protection Board: Rigid insulation specified in Section 07 21 00.

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 dampproofing system.
   C. Verify that items penetrating surfaces to receive dampproofing are securely installed.

3.02 PREPARATION
   A. Protect adjacent surfaces not designated to receive dampproofing.
B. Clean and prepare surfaces to receive dampproofing in accordance with manufacturer's instructions.
C. Do not apply dampproofing to surfaces unacceptable to manufacturer.
D. Apply mastic to seal penetrations, small cracks, or minor honeycombs in substrate.

3.03 APPLICATION
A. Foundation Walls: Apply two coats of asphalt dampproofing.
B. Apply bitumen by spray application.
C. Seal items watertight with mastic, that project through dampproofing surface.
D. Immediately backfill against dampproofing to protect from damage.

END OF SECTION
SECTION 07 21 00
THERMAL INSULATION

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Board insulation at perimeter foundation wall.
B. Batt insulation and vapor retarder in exterior wall 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 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.04  FIELD CONDITIONS
A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

PART 2  PRODUCTS

2.01  APPLICATIONS
A. Insulation at Perimeter of Foundation: Expanded polystyrene (EPS) board.
B. Insulation in Metal Framed Walls: Batt insulation with integral vapor retarder.

2.02  FOAM BOARD INSULATION MATERIALS
A. Expanded Polystyrene (EPS) Board Insulation: Complies with ASTM C578.
   1. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
   2. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
   3. Complies with fire resistance requirements indicated on drawings as part of an exterior non-load-bearing exterior wall assembly when tested in accordance with NFPA 285.
   5. Board Thickness: 2 inch.
   7. Type and Compressive Resistance: Type XI, 5 psi (35 kPa), minimum.
   8. Type and Water Absorption: Type XI, 4.0 percent by volume, maximum, by total immersion.
   9. Type and Thermal Resistance, R-value: Type XI, 3.1 (0.55) per 1 inch thickness at 75 degrees F mean temperature.
2.03 BATT INSULATION MATERIALS
   A. Where batt insulation is indicated, either glass fiber or mineral fiber batt insulation may be used, at Contractor's option.
   B. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit.
      1. Flame Spread Index: 75 or less, when tested in accordance with ASTM E84.
      2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
      3. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
      6. Thickness: 5.5 inch.
      7. Facing: Aluminum foil, flame spread 25 rated; one side.

2.04 ACCESSORIES
   A. Flashing Tape: Special reinforced film with high performance adhesive.
      2. Width: As required for application.
   B. Tape: Bright aluminum self-adhering type, mesh reinforced, 2 inch wide.
   C. Nails or Staples: Steel wire; electroplated or galvanized; type and size to suit application.

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 AT FOUNDATION PERIMETER
   A. Install boards vertically on foundation perimeter.
      1. Place boards to maximize adhesive contact.
      2. Butt edges and ends tightly to adjacent boards and to protrusions.
   B. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.03 BATT INSTALLATION
   A. Install insulation and vapor retarder in accordance with manufacturer's instructions.
   B. Install in exterior wall 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.
   E. Staple or nail facing flanges in place at maximum 6 inches on center.
   F. At metal framing, place vapor retarder on warm side of insulation; lap and seal sheet retarder joints over member face.
   G. Tape seal tears or cuts in vapor retarder.
   H. Extend vapor retarder tightly to full perimeter of adjacent window and door frames and other items interrupting the plane of the membrane. Tape seal in place.

3.04 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.
3.05 PROTECTION
A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION
SECTION 07 24 00
EXTERIOR INSULATION AND FINISH SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Composite wall cladding of rigid insulation and reinforced finish coating (Class PB).
B. Drainage and water-resistant barriers behind insulation board.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on system materials, product characteristics, performance criteria, and system limitations.
C. Shop Drawings: Indicate wall joint patterns, joint details, and molding profiles.
D. Selection Samples: Submit manufacturer's standard range of samples illustrating available coating colors and textures.

1.03 QUALITY ASSURANCE
A. Maintain copy of specified installation standard and manufacturer's installation instructions at project site during installation.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Delivery: Deliver materials to project site in manufacturer's original, unopened containers with labels intact. Inspect materials and notify manufacturer of any discrepancies.
B. Storage: Store materials as directed by manufacturer's written instructions.

1.05 FIELD CONDITIONS
A. Do not prepare materials or apply EIFS under conditions other than those described in the manufacturer's written instructions.
B. Do not prepare materials or apply EIFS during inclement weather unless areas of installation are protected. Protect installed EIFS areas from inclement weather until dry.
C. Do not install coatings or sealants when ambient temperature is below 40 degrees F.
D. Do not leave installed insulation board exposed to sunlight for extended periods of time.

1.06 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Provide manufacturer's standard material warranty, covering a period of not less than 5 years.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Basis of Design:
   1. Dryvit Systems, Inc; Dryvit Outsulation Plus MD EIFS, Class PB with Moisture Drainage: www.dryvit.com/#sle.
B. Other Acceptable Exterior Insulation and Finish Systems Manufacturers:
   1. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 EXTERIOR INSULATION AND FINISH SYSTEM
A. Exterior Insulation and Finish System: DRAINAGE type; reinforced finish coating on flat-backed insulation board adhesive-applied directly to water-resistant coating over substrate; provide a complete system that has been tested to show compliance with the following characteristics; include all components of specified system and substrate(s) in tested samples.
B. Fire Characteristics:
   1. Flammability: Pass, when tested in accordance with NFPA 285.
   2. Ignitibility: No sustained flaming when tested in accordance with NFPA 268.
3. Potential Heat of Foam Plastic Insulation Tested Independently of Assembly: No portion of the assembly having potential heat that exceeds that of the insulation sample tested for flammability (above), when tested in accordance with NFPA 259 with results expressed in Btu per square foot.

C. Water Penetration Resistance: No water penetration beyond the plane of the base coat/insulation board interface after 15 minutes, when tested in accordance with ASTM E331 at 6.24 psf differential pressure with tracer dye in the water spray; include in tested sample at least two vertical joints and one horizontal joint of same type to be used in construction; disassemble sample if necessary to determine extent of water penetration.

D. Drainage Efficiency: Average minimum efficiency of 90 percent, when tested in accordance with ASTM E2273 for 75 minutes.

E. Salt Spray Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating after 300 hours exposure in accordance with ASTM B117, using at least three samples matching intended assembly, at least 4 by 6 inches in size.

F. Freeze-Thaw Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating when viewed under 5x magnification after 10 cycles, when tested in accordance with ICC-ES AC219 or ICC-ES AC235.

G. Weathering Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating when viewed under 5x magnification after 2000 hours of accelerated weathering conducted in accordance with ASTM G153 Cycle 1 or ASTM G155 Cycles 1, 5, or 9.

H. Water Degradation Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating after 14 days exposure, when tested in accordance with ASTM D2247.

I. Mildew Resistance: No growth supported on finish coating during 28 day exposure period, when tested in accordance with ASTM D3273.

J. Abrasion Resistance Of Finish: No cracking, checking or loss of film integrity when tested in accordance with ASTM D968 with 113.5 gallons of sand.

K. Impact Resistance: No cracking or denting when tested in accordance with ASTM E695 with a 30 pound impact mass.

2.03 MATERIALS

A. Base Coat: Fiber-reinforced, acrylic or polymer-based product compatible with insulation board and reinforcing mesh, Class PB.

B. Reinforcing Mesh: Balanced, open weave glass fiber fabric, treated for compatibility and improved bond with coating, weight, strength, and number of layers as required to meet required system impact rating.

C. Expanded Polystyrene (EPS) Board Insulation: Complies with ASTM C578.
   1. Board Size: 24 by 48 inches.
   2. Board Size Tolerance: Plus/minus 1/16 inch from square and dimension.
   3. Board Thickness: 3 inches.
   4. Type and Thermal Resistance, R-value (RSI-value): Type XI, 3.1 (0.55) per inch thickness at 75 degrees F mean temperature using ASTM C177 test method.

D. Water-Resistive Barrier Coating: Fluid-applied air and water barrier membrane; applied to sheathing; furnished or approved by EIFS manufacturer.

2.04 ACCESSORY MATERIALS

A. Insulation Fasteners: Fastener and plate system appropriate for substrate and as recommended by EIFS manufacturer.

B. Trim: EIFS manufacturer's standard PVC or galvanized steel trim accessories, as required for a complete project and including starter track and drainage accessories.
C. Sealant Materials: Compatible with EIFS materials and as recommended by EIFS manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate is sound and free of oil, dirt, other surface contaminants, efflorescence, loose materials, or protrusions that could interfere with EIFS installation and is of a type and construction that is acceptable to EIFS manufacturer. Do not begin work until substrate and adjacent materials are complete and thoroughly dry.

B. Verify that substrate surface is flat, with no deviation greater than 1/4 in when tested with a 10 ft straightedge.

3.02 PREPARATION

A. Apply primer to substrate as recommended by EIFS manufacturer for project conditions.

3.03 INSTALLATION - GENERAL

A. Install in accordance with EIFS manufacturer's instructions and ASTM C1397.
   1. Where different requirements appear in either document, comply with the most stringent.
   2. Neither of these documents supersedes provisions of Contract Documents that defines contractual relationships between parties or scope of this work.

3.04 INSTALLATION - WATER-RESISTIVE BARRIER

A. Apply barrier coating as recommended by coating manufacturer; prime substrate as required before application.

B. Seal substrate transitions and intersections with other materials to form continuous water-resistive barrier on exterior of sheathing, using method recommended by manufacturer.

C. At door and window rough openings and other wall penetrations, seal water-resistive barrier and flexible flashings to rough opening before installation of metal flashings, sills, or frames, using method recommended by manufacturer.

D. Lap flexible flashing or flashing tape at least 2 inches on each side of joint or transition.

3.05 INSTALLATION - INSULATION

A. Install in accordance with manufacturer's instructions.

B. Install back wrap reinforcing mesh at all openings and terminations that are not to be protected with trim.

C. On wall surfaces, install boards horizontally. On horizontal surfaces, install boards ________.

D. Place boards in a method to maximize tight joints. Stagger vertical joints and interlock at corners. Butt edges and ends tight to adjacent board and to protrusions. Achieve a continuous flush insulation surface, with no gaps in excess of 1/16 inch.

E. Fill gaps greater than 1/16 inch with strips or shims cut from the same insulation material.

F. Rasp irregularities off surface of installed insulation board.

3.06 INSTALLATION - CLASS PB FINISH

A. Base Coat: Apply in thickness as necessary to fully embed reinforcing mesh, wrinkle free, including back-wrap at terminations of EIFS. Install reinforcing fabric as recommended by EIFS manufacturer.
   1. Lap reinforcing mesh edges and ends a minimum of 2-1/2 inches.
   2. Allow base coat to dry a minimum of 24 hours before next coating application.

B. Apply finish coat after base coat has dried not less than 24 hours, embed finish aggregate, and finish to a uniform texture and color.

C. Finish Coat Thickness: As recommended by manufacturer.

D. Seal control and expansion joints within the field of exterior finish and insulation system, using procedures recommended by sealant and finish system manufacturers.
3.07 CLEANING
   A. Clean EIFS surfaces and work areas of foreign materials resulting from EIFS operations.

3.08 PROTECTION
   A. Protect completed work from damage and soiling by subsequent work.

END OF SECTION
SECTION 07 41 13
METAL ROOF PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Architectural roofing system of preformed steel panels.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Storage and handling requirements and recommendations.
   2. Installation methods.
   3. Specimen warranty.
C. Shop Drawings: Include layouts of roof panels, details of edge and penetration conditions, spacing and type of connections, flashings, underlayments, and special conditions.
   1. Show work to be field-fabricated or field-assembled.
   2. Include structural analysis signed and sealed by qualified structural engineer, indicating compliance of roofing system to specified loading conditions.
D. Selection Samples: For each roofing system specified, submit color chips representing manufacturer's full range of available colors and patterns.
E. Warranty: Submit specified manufacturer's warranty and ensure that forms have been completed in Owner's name and are registered with manufacturer.

1.03 DELIVERY, STORAGE, AND HANDLING
A. Store roofing panels on project site as recommended by manufacturer to minimize damage to panels prior to installation.

1.04 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Finish Warranty: Provide manufacturer's special warranty covering failure of factory-applied exterior finish on metal roof panels and agreeing to repair or replace panels that show evidence of finish degradation, including significant fading, chalking, cracking, or peeling within specified warranty period of five years from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 ARCHITECTURAL METAL ROOF PANELS
A. Architectural Metal Roofing: Provide complete engineered system complying with specified requirements and capable of remaining weathertight while withstanding anticipated movement of substrate and thermally induced movement of roofing system.
B. Metal Panels: Factory-formed panels with factory-applied finish.
   1. Steel Panels:
      b. Steel Thickness: Minimum 24 gage (0.024 inch).
   2. Profile: Standing seam, with minimum 1.0 inch seam height; concealed fastener system for field seaming with special tool.
   3. Texture: Smooth.
   4. Length: Full length of roof slope, without lapped horizontal joints.
   5. Width: Maximum panel coverage of 24 inches.

2.02 ATTACHMENT SYSTEM
A. Concealed System: Provide manufacturer's standard stainless steel or nylon-coated aluminum concealed anchor clips designed for specific roofing system and engineered to meet performance requirements, including anticipated thermal movement.
2.03 SECONDARY FRAMING
   A. Miscellaneous Secondary Framing: Light gage steel framing incidental to structural supports; fabricated from steel sheet.
      1. Profile: Manufacturer's standard cee, zee, asymmetrical zee, hat channel, plain channel, single slope eave strut, double slope eave strut, and angle.
      2. Thickness: 12 gage, 0.1046 inch.

2.04 FINISHES
   A. Fluoropolymer Coil Coating System: Manufacturer's standard multi-coat aluminum coil coating system complying with AAMA 2605, including at least 70 percent polyvinylidene fluoride (PVDF) resin, and at least 80 percent of coil coated aluminum surfaces having minimum total dry film thickness (DFT) of 0.9 mil, 0.0009 inch; color and gloss as selected from manufacturer's standards.

2.05 ACCESSORIES
   A. Miscellaneous Sheet Metal Items: Provide flashings, trim, moldings, closure strips, and caps of the same material, thickness, and finish as used for the roofing panels. Items completely concealed after installation may optionally be made of stainless steel.
   B. Rib and Ridge Closures: Provide prefabricated, close-fitting components of steel with corrosion resistant finish or combination steel and closed-cell foam.
   C. Sealants:
      1. Exposed Sealant: Elastomeric; silicone, polyurethane, or silyl-terminated polyether/polyurethane.
      2. Concealed Sealant: Non-curing butyl sealant or tape sealant.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Do not begin installation of preformed metal roof panels until substrates have been properly prepared.
   B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 INSTALLATION
   A. Overall: Install roofing system in accordance with approved shop drawings and panel manufacturer's instructions and recommendations, as applicable to specific project conditions. Anchor all components of roofing system securely in place while allowing for thermal and structural movement.
      1. Install roofing system with concealed clips and fasteners, except as otherwise recommended by manufacturer for specific circumstances.
      2. Minimize field cutting of panels. Where field cutting is absolutely required, use methods that will not distort panel profiles. Use of torches for field cutting is absolutely prohibited.
   B. Accessories: Install all components required for a complete roofing assembly, including flashings, trim, moldings, closure strips, preformed crickets, caps, rib closures, and ridge closures.
   C. Roof Panels: Install panels in strict accordance with manufacturer's instructions, minimizing transverse joints except at junction with penetrations.

3.03 CLEANING
   A. Clean exposed sheet metal work at completion of installation. Remove grease and oil films, excess joint sealer, handling marks, and debris from installation, leaving the work clean and unmarked, free from dents, creases, waves, scratch marks, or other damage to the finish.
3.04 PROTECTION

A. Do not permit storage of materials or roof traffic on installed roof panels. Provide temporary walkways or planks as necessary to avoid damage to completed work. Protect roofing until completion of project.

B. Touch-up, repair, or replace damaged roof panels or accessories before Date of Substantial Completion.

END OF SECTION
SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Fabricated sheet metal items, including flashings and counterflashings.
B. Sealants for joints within sheet metal fabrications.

1.02 REFERENCE STANDARDS
B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
C. Samples: Submit two samples 6 by 6 inch in size illustrating metal finish color.

1.04 QUALITY ASSURANCE
A. Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.

1.05 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 SHEET MATERIALS
A. Aluminum: ASTM B209 (ASTM B209M); 20 gage, (0.032 inch) thick; anodized finish of color as selected.

2.02 FABRICATION
A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
B. Form pieces in longest possible lengths.
C. Hem exposed edges on underside 1/2 inch; miter and seam corners.
D. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
E. Fabricate corners from one piece with minimum 18 inch long legs; seam for rigidity, seal with sealant.
F. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.

2.03 ACCESSORIES
A. Fasteners: Galvanized steel, with soft neoprene washers.
B. Primer: Zinc chromate type.
C. Concealed Sealants: Non-curing butyl sealant.
D. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.

E. Plastic Cement: ASTM D4586/D4586M, Type I.

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 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.

END OF SECTION
SECTION 07 71 23
MANUFACTURED GUTTERS AND DOWNSPOUTS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Pre-finished aluminum gutters and downspouts.

1.02 ADMINISTRATIVE REQUIREMENTS
   A. Comply with SMACNA (ASMM) for sizing components for rainfall intensity determined by a storm occurrence of 1 in 5 years.

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Shop Drawings: Indicate locations, configurations, jointing methods, fastening methods, locations, and installation details.

1.04 DELIVERY, STORAGE, AND HANDLING
   A. Stack material to prevent twisting, bending, or abrasion, and to provide ventilation. Slope to drain.
   B. Prevent contact with materials that could cause discoloration, staining, or damage.

PART 2 PRODUCTS

2.01 MATERIALS
   A. Pre-Finished Aluminum Sheet: ASTM B209 (ASTM B209M); 0.032 inch thick.
      1. Finish: Plain, shop pre-coated with modified silicone coating.
      2. Color: As selected from manufacturer's standard colors.

2.02 COMPONENTS
   A. Downspouts: 3” x 5” Rectangular profile.
   B. Anchors and Supports: Profiled to suit downspouts.
      1. Downspout Supports: Brackets.
   C. Fasteners: Galvanized steel, with soft neoprene washers.

2.03 FABRICATION
   A. Form downspouts of profiles and size indicated.
   B. Fabricate with required connection pieces.
   C. Form sections square, true, and accurate in size, in maximum possible lengths, free of distortion or defects detrimental to appearance or performance. Allow for expansion at joints.
   D. Hem exposed edges of metal.
   E. Fabricate downspout accessories; seal watertight.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify existing conditions before starting work.
   B. Verify that surfaces are ready to receive work.

3.02 PREPARATION
   A. Paint concealed metal surfaces and surfaces in contact with dissimilar metals with protective backing paint to a minimum dry film thickness of 15 mil.

3.03 INSTALLATION
   A. Install downspouts, and accessories in accordance with manufacturer's instructions.
B. Connect downspouts to storm sewer system. Seal connection watertight.

END OF SECTION
SECTION 07 92 00
JOINT SEALANTS

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Nonsag gunnable joint sealants.
B. Joint backings and accessories.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data for Sealants: Submit manufacturer's technical data sheets for each product to be used, that includes the following.
   1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
   2. List of backing materials approved for use with the specific product.
   3. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
   4. Substrates the product should not be used on.
C. Color Cards for Selection: Where sealant color is not specified, submit manufacturer’s color cards showing standard colors available for selection.
D. Preconstruction Laboratory Test Reports: Submit at least four weeks prior to start of installation.

1.04 QUALITY ASSURANCE
A. Preconstruction Laboratory Testing: Arrange for sealant manufacturer(s) to test each combination of sealant, substrate, backing, and accessories.
   3. Allow sufficient time for testing to avoid delaying the work.
   4. Deliver to manufacturer sufficient samples for testing.
   5. Report manufacturer’s recommended corrective measures, if any, including primers or techniques not indicated in product data submittals.
   6. Testing is not required if sealant manufacturer provides data showing previous testing, not older than 24 months, that shows satisfactory adhesion, lack of staining, and compatibility.

1.05 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Correct defective work within a five year period after Date of Substantial Completion.
C. Warranty: Include coverage for installed sealants and accessories that fail to achieve watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS
2.01 JOINT SEALANT APPLICATIONS
A. Scope:
1. Exterior Joints: Seal open joints, whether or not the joint is indicated on drawings, unless specifically indicated not to be sealed. Exterior joints to be sealed include, but are not limited to, the following items.
   a. Wall expansion and control joints.
   b. Joints between door, window, and other frames and adjacent construction.
   c. Joints between different exposed materials.
   d. Openings below ledge angles in masonry.
   e. Other joints indicated below.
2. Interior Joints: Do not seal interior joints unless specifically indicated to be sealed. Interior joints to be sealed include, but are not limited to, the following items.
   a. Joints between door, window, and other frames and adjacent construction.
   b. Other joints indicated below.
3. Do not seal the following types of joints.
   a. Intentional weepholes in masonry.
   b. Joints indicated to be treated with manufactured expansion joint cover or some other type of sealing device.
   c. Joints where sealant is specified to be provided by manufacturer of product to be sealed.
   d. Joints where installation of sealant is specified in another section.
   e. Joints between suspended panel ceilings/grid and walls.

B. Exterior Joints: Use non-sag non-staining silicone sealant, unless otherwise indicated.
C. Interior Joints: Use non-sag polyurethane sealant, unless otherwise indicated.

2.02 JOIN特 SEALANTS - GENERAL

A. Colors: per Architect.

2.03 NONSAG JOIN特 SEALANTS

A. Non-Staining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
   1. Movement Capability: Plus 100 percent and minus 50 percent, minimum.
   2. Non-Staining To Porous Stone: Non-staining to light-colored natural stone when tested in accordance with ASTM C1248.
   3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
   4. Color: To be selected by Architect from manufacturer's standard range.
B. Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Uses M and A; single component, mildew resistant; not expected to withstand continuous water immersion or traffic.
C. Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single or multi-component; not expected to withstand continuous water immersion or traffic.
   1. Movement Capability: Plus 100 percent, minus 50 percent, minimum.
   2. Color: To be selected by Architect from manufacturer's standard range.
   3. Service Temperature Range: Minus 40 to 180 degrees F.

2.04 ACCESSORIES

A. Backer Rod: Cylindrical cellular foam rod with surface that sealant will not adhere to, compatible with specific sealant used, and recommended by backing and sealant manufacturers for specific application.
B. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that joints are ready to receive work.
B. Verify that backing materials are compatible with sealants.
C. Verify that backer rods are of the correct size.

### 3.02 PREPARATION

A. Remove loose materials and foreign matter that could impair adhesion of sealant.
B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.
C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.
E. Concrete Floor Joints That Will Be Exposed in Completed Work: Test joint filler in inconspicuous area to verify that it does not stain or discolor slab.

### 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. Install bond breaker backing tape where backer rod cannot be used.
D. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
E. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
F. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

**END OF SECTION**
SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Non-fire-rated hollow metal doors and frames.
B. Thermally insulated hollow metal doors with frames.

1.02 RELATED REQUIREMENTS
A. Section 08 71 00 - Door Hardware.
B. Section 08 80 00 - Glazing: Glass for doors and borrowed lites.
C. Section 09 91 13 - Exterior Painting: Field painting.
D. Section 09 91 23 - Interior Painting: Field painting.

1.03 ABBREVIATIONS AND ACRONYMS
A. SDI: Steel Door Institute.

1.04 REFERENCE STANDARDS
C. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2017.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, 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 standards/guidelines.
C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.
D. Installation Instructions: Manufacturer’s published instructions, including any special installation instructions relating to this project.

1.06 QUALITY ASSURANCE
A. Maintain at project site copies of reference standards relating to installation of products specified.
1.07 DELIVERY, STORAGE, AND HANDLING
A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.

B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Requirements for Hollow Metal Doors and Frames:
   1. Steel Sheet: Comply with one or more of the following requirements; galvannealed steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
   2. Accessibility: Comply with ICC A117.1 and ADA Standards.

B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with 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.

2.02 HOLLOW METAL DOORS

A. Exterior Doors: Thermally insulated.
   1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
      a. Level 3 - Extra Heavy-duty.
      b. Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
      c. Model 1 - Full Flush.
      d. Door Face Metal Thickness: 14 gage, 0.067 inch, minimum.
   2. Door Core Material: Polyurethane, 1.8 lbs/cu ft minimum density.
      a. Foam Plastic Insulation: Manufacturer's standard board insulation with maximum flame spread index (FSI) of 75, and maximum smoke developed index (SDI) of 450 in accordance with ASTM E84, and completely enclosed within interior of door.
   4. Weatherstripping: Refer to Section 08 71 00.
   5. Door Finish: Factory primed and field finished.

B. Interior Doors, Non-Fire-Rated:
   1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
      a. Level 1 - Standard-duty.
      b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
      c. Model 1 - Full Flush.
      d. Door Face Metal Thickness: 18 gage, 0.042 inch, minimum.
   2. Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.

2.03 HOLLOW METAL FRAMES

A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.

B. Exterior Door Frames: Full profile/continuously welded type.
   1. Frame Metal Thickness: 14 gage, 0.067 inch, minimum.
   2. Frame Finish: Factory primed and field finished.
   3. Weatherstripping: Separate, see Section 08 71 00.
C. Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.
   1. Frame Metal Thickness: 16 gage, 0.053 inch, minimum.
   2. Frame Finish: Factory primed and field finished.
D. Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.

2.04 FINISHES
A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

2.05 ACCESSORIES
A. Glazing: As specified in Section 08 80 00, factory installed.
B. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.
C. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify existing conditions before starting work.
B. Verify that opening sizes and tolerances are acceptable.
C. Verify that finished walls are in plane to ensure proper door alignment.

3.02 INSTALLATION
A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
B. Coordinate frame anchor placement with wall construction.
C. Install door hardware as specified in Section 08 71 00.

3.03 TOLERANCES
A. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.04 ADJUSTING
A. Adjust for smooth and balanced door movement.

END OF SECTION
SECTION 08 51 23
STEEL WINDOWS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Factory finished steel windows with fixed sash.

1.02 RELATED REQUIREMENTS
   A. Section 07 92 00 - Joint Sealants: Sealing joints between frames and adjacent construction.
   B. Section 08 80 00 - Glazing.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Shop Drawings: Indicate opening dimensions, framed opening tolerances, affected related work; installation requirements.
   C. Test Reports: Prior to submitting shop drawings or starting fabrication, submit test report(s) by independent testing agency showing compliance with performance requirements.

1.05 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing windows specified in this section, with not less than three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Protect factory finished surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond when exposed to sunlight or weather.

1.07 FIELD CONDITIONS
   A. Do not install sealants when ambient temperature is less than 40 degrees F.
   B. Maintain this minimum temperature during and after installation of sealants.

1.08 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 STEEL WINDOWS
   A. Steel Windows: Hot rolled steel sections, factory fabricated, factory finished, with vision glass, related flashings, anchorage and attachment devices.
      1. Grade: Heavy Intermediate design based on SWI (INTRO).

2.02 PERFORMANCE REQUIREMENTS
   A. Wind Loads: Design and size components to withstand wind loads without damage or permanent set, when tested in accordance with ASTM E330/E330M, using pressure equal to 1.5 times specified design pressures, with 10 second duration of maximum load.

END OF SECTION
SECTION 08 71 00

DOOR HARDWARE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes:

1. Mechanical and electrified door hardware for:
   a. Swinging doors.

2. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier's responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.

B. Exclusions: Unless specifically listed in hardware sets, hardware is not specified in this section for:

1. Windows
2. Cabinets (casework), including locks in cabinets
3. Signage
4. Toilet accessories
5. Overhead doors

C. Related Sections:

1. Division 01 Section “Alternates” for alternates affecting this section.
2. Division 07 Section “Joint Sealants” for sealant requirements applicable to threshold installation specified in this section.
3. Division 09 sections for touchup, finishing or refinishing of existing openings modified by this section.
4. Division 13 Section “Radiation Protection” for requirements for lead-lining for door hardware at openings indicated to receive radiation protection.
5. Division 26 sections for connections to electrical power system and for low-voltage wiring.
6. Division 28 sections for coordination with other components of electronic access control system.

1.03 REFERENCES

A. UL - Underwriters Laboratories
   1. UL 10B - Fire Test of Door Assemblies
2. UL 10C - Positive Pressure Test of Fire Door Assemblies
3. UL 1784 - Air Leakage Tests of Door Assemblies
4. UL 305 - Panic Hardware

B. DHI - Door and Hardware Institute

1. Sequence and Format for the Hardware Schedule
2. Recommended Locations for Builders Hardware
3. Key Systems and Nomenclature

C. ANSI - American National Standards Institute

1. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties

1.04 SUBMITTALS

A. General:

1. Submit in accordance with Conditions of Contract and Division 01 requirements.
2. Highlight, encircle, or otherwise specifically identify on submittals deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.
3. Prior to forwarding submittal, comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, "EXAMINATION" article, herein.

B. Action Submittals:

1. Product Data: Technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
2. Riser and Wiring Diagrams: After final approval of hardware schedule, submit details of electrified door hardware, indicating:
   a. Wiring Diagrams: For power, signal, and control wiring and including:
      1) Details of interface of electrified door hardware and building safety and security systems.
      2) Schematic diagram of systems that interface with electrified door hardware.
      3) Point-to-point wiring.
      4) Risers.
   b. Samples for Verification: If requested by Architect, submit production sample of requested door hardware unit in finish indicated, and tagged with full description for coordination with schedule.
      a. Samples will be returned to supplier. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.
   c. Door Hardware Schedule: Submit schedule with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule as published by the Door and Hardware Institute. Indicate complete designations of each item required for each door or opening, include:
      a. Door Index; include door number, heading number, and Architects hardware set number.
      b. Opening Lock Function Spreadsheet: List locking device and function for each opening.
      c. Quantity, type, style, function, size, and finish of each hardware item.
d. Name and manufacturer of each item.
e. Fastenings and other pertinent information.
f. Location of each hardware set cross-referenced to indications on Drawings.
g. Explanation of all abbreviations, symbols, and codes contained in schedule.
h. Mounting locations for hardware.
i. Door and frame sizes and materials.
j. Name and phone number for local manufacturer's representative for each product.
k. Operational Description of openings with any electrified hardware (locks, exits, electromagnetic locks, electric strikes, automatic operators, door position switches, magnetic holders or closer/holder units, and access control components).
Operational description should include operational descriptions for: egress, ingress (access), and fire/smoke alarm connections.

1) Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work that is critical in Project construction schedule.

5. Key Schedule:

a. After Keying Conference, provide keying schedule listing levels of keying as well as explanation of key system's function, key symbols used and door numbers controlled.
b. Use ANSI/BHMA A156.28 “Recommended Practices for Keying Systems” as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion.

1) Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.

6. Templates: After final approval of hardware schedule, provide templates for doors, frames and other work specified to be factory or shop prepared for door hardware installation.

C. Informational Submittals:

1. Qualification Data: For Supplier, Installer and Architectural Hardware Consultant.
2. Product data for electrified door hardware:
   a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
3. Warranty: Special warranty specified in this Section.

D. Closeout Submittals:

1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:
   a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
   b. Catalog pages for each product.
   c. Factory order acknowledgement numbers (for warranty and service)
   d. Name, address, and phone number of local representative for each manufacturer.
e. Parts list for each product.
f. Final approved hardware schedule, edited to reflect conditions as-installed.
g. Final keying schedule
h. Copies of floor plans with keying nomenclature
i. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.
j. Copy of warranties including appropriate reference numbers for manufacturers to identify project.

1.05 QUALITY ASSURANCE

A. Supplier Qualifications and Responsibilities: Recognized architectural hardware supplier with record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that provides certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.

1. Warehousing Facilities: In Project's vicinity.
2. Scheduling Responsibility: Preparation of door hardware and keying schedules.
3. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
4. Coordination Responsibility: Assist in coordinating installation of electronic security hardware with Architect and electrical engineers and provide installation and technical data to Architect and other related subcontractors.

B. Architectural Hardware Consultant Qualifications: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:

1. For door hardware, DHI-certified, Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC).
2. Can provide installation and technical data to Architect and other related subcontractors.
3. Can inspect and verify components are in working order upon completion of installation.
5. Capable of coordinating installation of electrified hardware with Architect and electrical engineers.

C. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.

D. Fire-Rated Door Openings: Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed products tested by Underwriters Laboratories, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.

E. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.

F. Accessibility Requirements: For door hardware on doors in an accessible route, comply with governing accessibility regulations cited in "REFERENCES" article, herein.

G. Keying Conference

1. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
a. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
b. Preliminary key system schematic diagram.
c. Requirements for key control system.
d. Requirements for access control.
e. Address for delivery of keys.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

1. Deliver each article of hardware in manufacturer’s original packaging.

C. Project Conditions:

1. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
2. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.

D. Protection and Damage:

1. Promptly replace products damaged during shipping.
2. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work.
3. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.

1.07 WARRANTY

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

1. Warranty Period: Beginning from date of Substantial Completion, for durations indicated.

a. Closers:
   1) Mechanical: 10 years.
   2) Electrified: 2 years.

b. Automatic Operators: 2 years

c. Exit Devices:
   1) Mechanical: 3 years.
   2) Electrified: 1 year.

d. Locksets:
   1) Mechanical: 10 years.
   2) Electrified: 1 year.

e. Continuous Hinges: Lifetime warranty.

f. Key Blanks: Lifetime
2. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.

1.08 MAINTENANCE

A. Maintenance Tools: Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Approval of manufacturers and/or products other than those listed as “Scheduled Manufacturer” or “Acceptable Manufacturers” in the individual article for the product category shall be in accordance with QUALITY ASSURANCE article, herein.

B. Approval of products from manufacturers indicated in “Acceptable Manufacturers” is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer’s product.

C. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect’s approval.

2.02 MATERIALS

A. Fasteners

1. Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation.

2. Furnish screws for installation with each hardware item. 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 including prepared for paint surfaces to receive painted finish.

3. Provide concealed fasteners for hardware units exposed when door is closed except when 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 thru-bolts are required to fasten hardware securely. Review door specification and advise Architect if thru-bolts are required.

4. Install hardware with fasteners provided by hardware manufacturer.

B. Modification and Preparation of Existing Doors: Where existing door hardware is indicated to be removed and reinstalled.

1. Provide necessary fillers, Dutchmen, reinforcements, and fasteners, compatible with existing materials, as required for mounting new opening hardware and to cover existing door and frame preparations.

2. Use materials which match materials of adjacent modified areas.

3. When modifying existing fire-rated openings, provide materials permitted by NFPA 80 as required to maintain fire-rating.

C. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.

1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.
2.03 HINGES

A. Manufacturers and Products:

B. Requirements:
   1. Provide hinges conforming to ANSI/BHMA A156.1.
   2. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:
      a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
      b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high
   3. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:
      a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
      b. Interior: Heavy weight, steel, 5 inches (127 mm) high
   4. 2 inches or thicker doors:
      a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high
      b. Interior: Heavy weight, steel, 5 inches (127 mm) high
   5. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
   6. Where new hinges are specified for existing doors or existing frames, provide new hinges of identical size to hinge preparation present in existing door or existing frame.
   7. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
      a. Steel Hinges: Steel pins
      b. Non-Ferrous Hinges: Stainless steel pins
      c. Out-Swinging Exterior Doors: Non-removable pins
      d. Out-Swinging Interior Lockable Doors: Non-removable pins
      e. Interior Non-lockable Doors: Non-rising pins
   8. Width of hinges: 4-1/2 inches (114 mm) at 1-3/4 inch (44 mm) thick doors, and 5 inches (127 mm) at 2 inches (51 mm) or thicker doors. Adjust hinge width as required for door, frame, and wall conditions to allow proper degree of opening.
   9. Provide hinges with electrified options as scheduled in the hardware sets. Provide with sufficient number and wire gage to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component.
   10. Provide mortar guard for each electrified hinge specified.
   11. Provide spring hinges where specified. Provide two spring hinges and one bearing hinge per door leaf for doors 90 inches (2286 mm) or less in height. Provide one additional bearing hinge for each 30 inches (762 mm) of additional door height.

2.04 MORTISE LOCKS

A. Manufacturers and Products:

B. Requirements:
1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1, and UL Listed for 3 hour fire doors.
2. Provide locks manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance.
3. Provide lock case that is multi-function and field reversible for handing without opening case. Cylinders: Refer to “KEYING” article, herein.
4. Provide locks with standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1 inch (25 mm) throw, constructed of stainless steel.
5. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
6. Provide electrified options as scheduled in the hardware sets. Where scheduled, provide a request to exit (RX) switch that is actuated with rotation of inside lever.
7. Lever Trim: Solid brass, bronze, or stainless steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.
   a. Lever Design: Falcon Dane/Gala.

2.05 CYLINDRICAL LOCKS – GRADE 1

A. Manufacturers and Products:

B. Requirements:
   1. Provide cylindrical locks conforming to ANSI/BHMA A156.2 Series 4000, Grade 1, and UL Listed for 3 hour fire doors.
   2. Cylinders: Refer to “KEYING” article, herein.
   3. Provide locks with standard 2-3/4 inches (70 mm) backset, unless noted otherwise, with 1/2 inch latch throw. Provide proper latch throw for UL listing at pairs.
   4. Provide locksets with separate anti-rotation thru-bolts, and no exposed screws.
   5. Provide independently operating levers with two external return spring cassettes mounted under roses to prevent lever sag.
   6. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
   7. Provide electrified options as scheduled in the hardware sets.
   8. Lever Trim: Solid cast levers without plastic inserts and wrought roses on both sides.

2.06 EXIT DEVICES

A. Manufacturers and Products:

B. Requirements:
   1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1 and UL listed for Panic Exit or Fire Exit Hardware.
   2. Cylinders: Refer to “KEYING” article, herein.
   3. Provide touchpad type exit devices, fabricated of brass, bronze, stainless steel, or aluminum, plated to standard architectural finishes to match balance of door hardware.
   4. Touchpad must extend a minimum of one half of door width. No plastic inserts are allowed in touchpads.
5. Provide exit devices with deadlatching feature for security and for future addition of alarm kits and/or other electrified requirements.
6. Provide flush end caps for exit devices.
7. Provide exit devices with manufacturer’s approved strikes.
8. Provide exit devices cut to door width and height. Install exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect.
9. Mount mechanism case flush on face of doors, or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass bead kits.
10. Provide cylinder or hex-key dogging as specified at non fire-rated openings.
11. Removable Mullions: 2 inches (51 mm) x 3 inches (76 mm) steel tube. Where scheduled as keyed removable mullion, provide type that can be removed by use of a keyed cylinder, which is self-locking when re-installed.
12. Provide factory drilled weep holes for exit devices used in full exterior application, highly corrosive areas, and where noted in hardware sets.
13. Provide electrified options as scheduled.
14. Provide exit devices with optional trim designs to match other lever and pull designs used on the project.

2.07 CYLINDERS

A. Manufacturers and Products:
   1. Scheduled Manufacturer and Product: Schlage Everest 29 S.

B. Requirements:
   1. Provide cylinders/cores, compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset, manufacturer’s series as indicated. Refer to “KEYING” article, herein.
   2. Provide cylinders in the below-listed configuration(s), distributed throughout the Project as indicated.
      a. Conventional Patented Open: cylinder with interchangeable core with open keyway.

2.08 KEYING

A. Manufacturers:
   1. Scheduled Manufacturer: Medeco.

B. Requirements:
   1. Provide cylinders/cores to match Owner’s existing Medeco system, compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset, manufacturer’s series as indicated. Refer to “KEYING” article, herein.
   2. Provide the following keyway: Verify With Owner.

C. Construction Keying:
   1. Replaceable Construction Cores.
      a. Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
1) 3 construction control keys
2) 12 construction change (day) keys.

b. Owner or Owner’s Representative will replace temporary construction cores with permanent cores.

D. Provide cylinders/cores keyed into Owner’s existing factory registered keying system.

E. Comply with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

F. Requirements:

1. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
   a. Master Keying system as directed by the Owner.

2. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.

3. Provide keys with the following features:
   a. Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
   b. Patent Protection: Keys and blanks protected by one or more utility patent(s).
   c. Geographically Exclusive: Where High Security or Security cylinders/cores are indicated, provide nationwide, geographically exclusive key system complying with the following restrictions.

4. Identification:
   a. Mark permanent cylinders/cores and keys with applicable blind code per DHI publication “Keying Systems and Nomenclature” for identification. Do not provide blind code marks with actual key cuts.
   b. Identification stamping provisions must be approved by the Architect and Owner.
   c. Stamp cylinders/cores and keys with Owner’s unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with “DO NOT DUPLICATE” along with the “PATENTED” or patent number to enforce the patent protection.
   d. Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
   e. Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.

5. Quantity: Furnish in the following quantities.
   a. Change (Day) Keys: 3 per cylinder/core.
   b. Permanent Control Keys: 3. If req.

2.09 KEYING-SCHLAGE CORES

A. Provide a factory registered keying system, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

1. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
   a. Master Keying system as directed by the Owner.
2. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.

3. Provide keys with the following features:

   a. Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
   b. Patent Protection: Keys and blanks protected by one or more utility patent(s)

4. Identification:

   a. Mark permanent cylinders/cores and keys with applicable blind code per DHI publication “Keying Systems and Nomenclature” for identification. Do not provide blind code marks with actual key cuts.
   b. Identification stamping provisions must be approved by the Architect and Owner.
   c. Stamp cylinders/cores and keys with Owner’s unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with “DO NOT DUPLICATE” along with the “PATENTED” or patent number to enforce the patent protection.
   d. Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
   e. Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.

5. Quantity: Furnish in the following quantities.

   a. Change (Day) Keys: 3 per cylinder/core.
   b. Permanent Control Keys: 3.

2.10 DOOR CLOSERS

A. Manufacturers and Products:


B. Requirements:

   1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
   2. Provide door closers with fully hydraulic, full rack and pinion action with aluminum cylinder.
   3. Closer Body: 1-1/2 inch (38 mm) diameter with 5/8 inch (16 mm) diameter heat-treated pinion journal.
   4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
   5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
   6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck.
   7. Pressure Relief Valve (PRV) Technology: Not permitted.
   8. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.
2.11 DOOR CLOSERS

A. Manufacturers and Products:


B. Requirements:

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory.
2. Provide door closers with fully hydraulic, full rack and pinion action with aluminum cylinder.
3. Closer Body: 1-1/4 inch (32 mm) diameter, with 5/8 inch (16 mm) diameter heat-treated pinion journal.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck.
7. Pressure Relief Valve (PRV) Technology: Not permitted.
8. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.12 DOOR TRIM

A. Manufacturers:

1. Scheduled Manufacturer: Ives.

B. Requirements:

1. Provide push plates 4 inches (102 mm) wide by 16 inches (406 mm) high by 0.050 inch (1 mm) thick and beveled 4 edges. Where width of door stile prevents use of 4 inches (102 mm) wide plate, adjust width to fit.
2. Provide push bars of solid bar stock, diameter and length as scheduled. Provide push bars of sufficient length to span from center to center of each stile. Where required, mount back to back with pull.
3. Provide offset pulls of solid bar stock, diameter and length as scheduled. Where required, mount back to back with push bar.
4. Provide flush pulls as scheduled. Where required, provide back-to-back mounted model.
5. Provide pulls of solid bar stock, diameter and length as scheduled. Where required, mount back to back with push bar.
6. Provide pull plates 4 inches (102 mm) wide by 16 inches (406 mm) high by 0.050 inch (1 mm) thick, beveled 4 edges, and prepped for pull. Where width of door stile prevents use of 4 inches (102 mm) wide plate, adjust width to fit.
7. Provide wire pulls of solid bar stock, diameter and length as scheduled.
8. Provide decorative pulls as scheduled. Where required, mount back to back with pull.

2.13 PROTECTION PLATES

A. Manufacturers:

1. Scheduled Manufacturer: Ives.

B. Requirements:

1. Provide kick plates, mop plates, and armor plates minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.

2. Sizes of plates:

   a. Kick Plates: 10 inches (254 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs
   b. Mop Plates: 4 inches (102 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs
   c. Armor Plates: 36 inches (914 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs

2.14 DOOR STOPS AND HOLDERS

A. Manufacturers:

1. Scheduled Manufacturer: Ives.

B. Provide door stops at each door leaf:

1. Provide wall stops wherever possible. Provide convex type where mortise type locks are used and concave type where cylindrical type locks are used.
2. Where a wall stop cannot be used, provide universal floor stops for low or high rise options.
3. Where wall or floor stop cannot be used, provide medium duty surface mounted overhead stop.

2.15 SILENCERS

A. Manufacturers:

1. Scheduled Manufacturer: Ives.

B. Requirements:

1. Provide "push-in" type silencers for hollow metal or wood frames.
2. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
3. Omit where gasketing is specified.

2.16 LATCH PROTECTORS

A. Manufacturers:

1. Scheduled Manufacturer: Ives.

B. Provide stainless steel latch protectors of type required to function with specified lock.
2.17 FINISHES

A. Finish: BHMA 626/652 (US26D); except:
   1. Hinges at Exterior Doors: BHMA 630 (US32D)
   2. Continuous Hinges: BHMA 630 (US32D)
   3. Continuous Hinges: BHMA 628 (US28)
   5. Protection Plates: BHMA 630 (US32D)
   6. Overhead Stops and Holders: BHMA 630 (US32D)
   7. Door Closers: Powder Coat to Match
   8. Wall Stops: BHMA 630 (US32D)
   9. Latch Protectors: BHMA 630 (US32D)
  10. Weatherstripping: Clear Anodized Aluminum
  11. Thresholds: Mill Finish Aluminum

PART 3 - EXECUTION

3.01 EXAMINATION

A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.

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

3.02 INSTALLATION

A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.
   2. Custom Steel Doors and Frames: HMMA 831.

B. Install each hardware item in compliance with manufacturer’s instructions and recommendations, using only fasteners provided by manufacturer.

C. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.

D. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.

E. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

F. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.

G. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
H. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every 30 inches (750 mm) of door height greater than 90 inches (2286 mm).

I. Lock Cylinders: Install construction cores to secure building and areas during construction period.
   1. Replace construction cores with permanent cores as indicated in keying section.

J. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.

K. Closer/holders: Mount closer/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.

L. Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room, or alternate location as directed by Architect.

M. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

N. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.

O. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

P. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

Q. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.03 FIELD QUALITY CONTROL

A. Engage qualified manufacturer trained representative to perform inspections and to prepare inspection reports.
   1. Representative will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.04 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.05 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.
### 3.06 DOOR HARDWARE SCHEDULE

**A.** Hardware items are referenced in the following hardware. Refer to the above-specifications for special features, options, cylinders/keying, and other requirements.

**B.** Hardware Sets:

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END OF SECTION
SECTION 08 80 00
GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Insulating glass units.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data on Insulating Glass Unit Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
C. Samples: Submit two samples 8 by 8 inch in size of glass units.
D. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.04 FIELD CONDITIONS
A. Do not install glazing when ambient temperature is less than 40 degrees F.

1.05 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Insulating Glass Units: Provide a five (5) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS - EXTERIOR GLAZING ASSEMBLIES
A. Provide type and thickness of exterior glazing assemblies to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of glass.
   1. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
   2. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
   3. Glass thicknesses listed are minimum.
B. Vapor Retarder and Air Barrier Seals: Provide completed assemblies that maintain continuity of building enclosure vapor retarder and air barrier.
   1. In conjunction with vapor retarder and joint sealer materials described in other sections.
C. Thermal and Optical Performance: Provide exterior glazing products with performance properties as indicated. Performance properties are in accordance with manufacturer's published data as determined with the following procedures and/or test methods:
1. Center of Glass U-Value: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
2. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.

2.02 GLASS MATERIALS
A. Float Glass: Provide float glass based glazing unless otherwise indicated.
   1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality - Q3.

2.03 INSULATING GLASS UNITS
A. Insulating Glass Units: Types as indicated.
   1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
   2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
   4. Edge Seal:
      a. Color: Black.
   5. Purge interpane space with dry air, hermetically sealed.
B. Insulating Glass Units: Vision glass, double glazed.
   1. Applications: Exterior glazing unless otherwise indicated.
   2. Space between lites filled with air.
   3. Outboard Lite: Annealed float glass, 1/4 inch thick, minimum.
      a. Tint: to be selected from samples of blues, greens, and grays.
      b. Coating: Low-E (passive type), on #2 surface.
   4. Inboard Lite: Annealed float glass, 1/4 inch thick, minimum.
      a. Tint: Clear.
   5. Total Thickness: 1 inch.
   7. Visible Light Transmittance (VLT): .5 percent, nominal.
   9. See A601 for additional information.

PART 3 EXECUTION
3.01 VERIFICATION OF CONDITIONS
A. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.
B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.

3.02 INSTALLATION, GENERAL
A. Install glazing in compliance with written instructions of glass, gaskets, and other glazing material manufacturers, unless more stringent requirements are indicated, including those in glazing referenced standards.
B. Do not exceed edge pressures around perimeter of glass lites as stipulated by glass manufacturer.

3.03 CLEANING
A. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.
B. Remove non-permanent labels immediately after glazing installation is complete.
C. Clean glass and adjacent surfaces after sealants are fully cured.
D. Clean glass on both exposed surfaces not more than 4 days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

3.04 PROTECTION

A. After installation, mark pane with an 'X' by using removable plastic tape or paste.

B. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

END OF SECTION
SECTION 09 05 61
COMMON WORK RESULTS FOR FLOORING PREPARATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section applies to floors identified in Contract Documents that are receiving the following types of floor coverings:
   1. Carpet tile.
B. Preparation of new concrete floor slabs for installation of floor coverings.
C. Testing of concrete floor slabs for moisture and alkalinity (pH).
D. Remediation of concrete floor slabs due to unsatisfactory moisture or alkalinity (pH) conditions.
   1. Contractor shall perform all specified remediation of concrete floor slabs. If such remediation is indicated by testing agency's report and is due to a condition not under Contractor's control or could not have been predicted by examination prior to entering into the contract, a contract modification will be issued.

1.02 REFERENCE STANDARDS


1.03 QUALITY ASSURANCE

A. Moisture and alkalinity (pH) testing shall be performed by an independent testing agency employed and paid by Contractor.
B. Testing Agency Qualifications: Independent testing agency experienced in the types of testing specified.
   1. Submit evidence of experience consisting of at least 3 test reports of the type required, with project Owner's project contact information.
C. Contractor's Responsibility Relating to Independent Agency Testing:
   1. Provide access for and cooperate with testing agency.
   2. Confirm date of start of testing at least 10 days prior to actual start.
   3. Allow at least 4 business days on site for testing agency activities.
   4. Achieve and maintain specified ambient conditions.
   5. Notify Architect when specified ambient conditions have been achieved and when testing will start.

1.04 FIELD CONDITIONS

A. Maintain ambient temperature in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 65 degrees F or more than 85 degrees F.
B. Maintain relative humidity in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 40 percent and not more than 60 percent.

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 CONCRETE SLAB PREPARATION

A. Follow recommendations of testing agency.
B. Perform following operations in the order indicated:
   1. Preliminary cleaning.
   2. Moisture vapor emission tests; 3 tests in the first 1000 square feet and one test in each additional 1000 square feet, unless otherwise indicated or required by flooring manufacturer.
   3. Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
4. Alkalinity (pH) tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
5. Specified remediation, if required.
6. Patching, smoothing, and leveling, as required.
7. Other preparation specified.
9. Protection.

3.02 MOISTURE VAPOR EMISSION TESTING
A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.
B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.
C. Test in accordance with ASTM F1869 and as follows.
D. Plastic sheet test and mat bond test may not be substituted for the specified ASTM test method, as those methods do not quantify the moisture content sufficiently.
E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if test values exceed 3 pounds per 1000 square feet per 24 hours.
F. Report: Report the information required by the test method.

3.03 ALKALINITY TESTING
A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.
B. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if alkalinity (pH) test value is over 10.

3.04 ADHESIVE BOND AND COMPATIBILITY TESTING
A. Comply with requirements and recommendations of floor covering manufacturer.

END OF SECTION
SECTION 09 21 16
GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Metal stud wall framing.
B. Metal channel ceiling framing.
C. Gypsum wallboard.
D. Joint treatment and accessories.

1.02 REFERENCE STANDARDS
E. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2018.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES
A. Provide completed assemblies complying with ASTM C840 and GA-216.

2.02 METAL FRAMING MATERIALS
A. Non-structural Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/120 at 5 psf.
1. Studs: "C" shaped with knurled or embossed faces.
2. Runners: U shaped, sized to match studs.
3. Ceiling Channels: C-shaped.

2.03 BOARD MATERIALS
A. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
2. Glass mat faced gypsum panels as defined in ASTM C1658/C1658M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.
3. Thickness:

B. Backing Board For Wet Areas: One of the following products:
   1. Glass Mat Faced Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178/C1178M.
      a. Regular Type: Thickness 5/8 inch.

C. Ceiling Board: Special sag resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
   1. Application: Ceilings, unless otherwise indicated.
   2. Thickness: 1/2 inch.

2.04 GYPSUM WALLBOARD ACCESSORIES
A. Beads, Joint Accessories, and Other Trim: ASTM C1047, rigid plastic, galvanized steel, or rolled zinc, unless noted otherwise.
   1. Corner Beads: Low profile, for 90 degree outside corners.

B. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
   1. Paper Tape: 2 inch wide, creased paper tape for joints and corners, except as otherwise indicated.

C. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inch in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion resistant.

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. Metal 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 1/1200.

C. Studs: Space studs at 16 inches on center.
   1. Extend partition framing to structure where indicated and to ceiling in other locations.

D. Blocking: Install mechanically fastened steel sheet blocking for support of:
   1. Wall mounted cabinets.
   2. Plumbing fixtures.
   3. Toilet partitions.
   4. Toilet accessories.

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 perpendicular to framing, with ends and edges occurring over firm bearing.

C. Installation on Metal Framing: Use screws for attachment of gypsum board.

3.04 INSTALLATION OF TRIM AND ACCESSORIES
A. Corner Beads: Install at external corners, using longest practical lengths.

3.05 JOINT TREATMENT
A. Glass Mat Faced Gypsum Board and Exterior Glass Mat Faced Sheathing: Use fiberglass joint tape, embed and finish with setting type joint compound.
B. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.

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.

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.

3.06 TOLERANCES
   A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION
SECTION 09 30 00
TILING

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Tile for wall applications.
B. Coated glass mat backer board as tile substrate.
C. Ceramic accessories.
D. Ceramic trim.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.

1.03 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum five years of documented experience.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 TILE
A. Glazed Wall Tile: ANSI A137.1, standard grade.
   1. Moisture Absorption: 7.0 to 20.0 percent as tested in accordance with ASTM C373.
   2. Size: 4 by 8 inch, nominal.
   3. Edges: Cushioned.
   5. Color(s): To be selected by Architect from manufacturer's standard range.
   7. Trim Units: Matching bead, bullnose, cove, and base shapes in sizes coordinated with field tile.

2.02 TRIM AND ACCESSORIES
A. Ceramic Trim: Matching bullnose, double bullnose, cove base, and cove ceramic shapes in sizes coordinated with field tile.
   1. Applications:
      a. Open Edges: Bullnose.
      b. Inside Corners: Jointed.
      c. Floor to Wall Joints: Cove base.
   2. Manufacturers: Same as for tile.

2.03 SETTING MATERIALS

2.04 GROUTS
A. Standard Grout: ANSI A118.6 standard cement grout.
   1. Applications: Use this type of grout where indicated and where no other type of grout is indicated.
   2. Use sanded grout for joints 1/8 inch wide and larger; use unsanded grout for joints less than 1/8 inch wide.
   3. Color(s): As selected by Architect from manufacturer's full line.
B. Epoxy Grout: ANSI A118.3 chemical resistant and water-cleanable epoxy grout.
   1. Applications: wet walls.
2. Color(s): As selected by Architect from manufacturer’s full line.

2.05 ACCESSORY MATERIALS
   A. Backer Board: Coated glass mat type complying with ASTM C1178/C1178M; inorganic fiberglass mat on both surfaces and integral acrylic coating vapor retarder.
   B. Mesh Tape: 2 inch wide self-adhesive fiberglass mesh tape.

PART 3 EXECUTION

3.01 EXAMINATION
   A. 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 tile.

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.
   D. Install backer board in accordance with ANSI A108.11 and board manufacturer's instructions. Tape joints and corners, cover with skim coat of setting material to a feather edge.
   E. Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.

3.03 INSTALLATION - GENERAL
   A. Install tile and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.19, 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.
   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. Sound tile after setting. Replace hollow sounding units.
   G. Keep control and expansion joints free of mortar, grout, and adhesive.
   H. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
   I. Grout tile joints unless otherwise indicated. Use standard grout unless otherwise indicated.
   J. 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 - WALL TILE
   A. Over coated glass mat backer board on studs, install in accordance with TCNA (HB) Method W245.

3.05 CLEANING
   A. Clean tile and grout surfaces.

3.06 PROTECTION
   A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION
SECTION 09 51 00
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Suspended metal grid ceiling system.
B. Acoustical units.

1.02 REFERENCE STANDARDS
C. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2014.

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. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate grid layout and related dimensioning.
C. Product Data: Provide data on suspension system components and acoustical units.
D. Samples: Submit two samples 6 by 6 inch in size illustrating material and finish of acoustical units.
E. Samples: Submit two samples each, 12 inches long, of suspension system main runner, cross runner, and perimeter molding.

1.05 QUALITY ASSURANCE
A. Designer Qualifications for Seismic Design: Perform under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed at the State in which the Project is located.

1.06 FIELD CONDITIONS
A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 PRODUCTS

2.01 ACOUSTICAL UNITS
A. Acoustical Units - General: ASTM E1264, Class A.
B. Acoustical Panels: Painted mineral fiber, with the following characteristics:
   1. Classification: ASTM E1264 Type III.
   2. Size: 24 by 48 inch.
   4. Light Reflectance: .88 percent, determined in accordance with ASTM E1264.
   5. NRC Range: .60 to .70, determined in accordance with ASTM E1264.
   6. Articulation Class (AC): 150+, determined in accordance with ASTM E1264.
   7. Panel Edge: Square.
2.02 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.
   1. Materials:
      a. Steel Grid: ASTM A653/A653M, G30 coating, unless otherwise indicated.
B. Exposed Suspension System: Hot-dipped galvanized steel grid with aluminum cap.
   1. Application(s): Seismic.
   2. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
   3. Profile: Tee; 15/16 inch face width.

2.03 ACCESSORIES
A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
B. Hanger Wire: 12-gage 0.08 inch galvanized steel wire.
C. Hold-Down Clips: Manufacturer's standard clips to suit application. Hold-Down clips shall be installed for all tiles as noted on A171.
D. Perimeter Moldings: Same metal and finish as grid.
   1. Angle Molding: L-shaped, for mounting at same elevation as face of grid.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify existing conditions before starting work.
B. Verify that layout of hangers will not interfere with other work.

3.02 PREPARATION
A. Install after major above-ceiling work is complete.
B. Coordinate the location of hangers with other work.

3.03 INSTALLATION - SUSPENSION SYSTEM
A. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
B. Lay out system to a balanced grid design with edge units no less than 50 percent of acoustical unit size. Refer to Reflected Ceiling Plan.
C. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
   1. Use longest practical lengths.
D. Seismic Suspension System, Seismic Design Categories D, E, F: Hang suspension system with grid ends attached to the perimeter molding on two adjacent walls; on opposite walls, maintain a 3/4 inch clearance between grid ends and wall.
E. 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.
F. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
G. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
H. Do not eccentrically load system or induce rotation of runners.
3.04 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 acoustical units level, in uniform plane, and free from twist, warp, and dents.
   E. Cutting Acoustical Units:
      1. Make field cut edges of same profile as factory edges.
   F. Install hold-down clips on panels within 20 ft of an exterior door.

3.05 TOLERANCES
   A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
   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.
B. Installation accessories.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
C. Selection Samples: Submit manufacturer's complete set of color samples for Architect's initial selection.
D. Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.
E. Installer's Qualification Statement.

1.04 QUALITY ASSURANCE
A. Installer Qualifications: Company specializing in installing specified flooring with minimum three years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.
B. Store all materials off of the floor in an acclimatized, weather-tight space.
C. Maintain temperature in storage area between 55 degrees F and 90 degrees F.
D. Protect roll materials from damage by storing on end.

1.06 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 to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

PART 2 PRODUCTS

2.01 RESILIENT BASE
A. Resilient Base: ASTM F1861, Type TS rubber, vulcanized thermoset; top set Style B, Cove.
   1. Height: 4 inch.
   2. Thickness: 0.125 inch.
   4. Length: Roll.
   5. Color: To be selected by Architect from manufacturer's full range.
   6. Accessories: Premolded external corners and internal corners.

2.02 ACCESSORIES
A. Primers, Adhesives, and Seam Sealer: Waterproof; types recommended by flooring manufacturer.
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 floor substrates as recommended by flooring and adhesive manufacturers.
   B. Clean substrate.

3.03  INSTALLATION - GENERAL
   A. Starting installation constitutes acceptance of subfloor conditions.
   B. Install in accordance with manufacturer's written instructions.

3.04  INSTALLATION - RESILIENT BASE
   A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.
   B. Miter internal corners. At external corners, use premolded units. At exposed ends, use premolded units.
   C. Install base on solid backing. Bond tightly to wall and floor surfaces.
   D. Scribe and fit to door frames and other interruptions.

3.05  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 65 66
RESILIENT ATHLETIC FLOORING

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Rubber sheet flooring, adhesively installed.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Selection Samples: Manufacturer’s color charts for flooring materials specified, indicating full range of colors and textures available.
C. Verification Samples: Actual flooring material specified, not less than 12 inch square, mounted on solid backing.
D. Installer’s Qualification Statement.

1.03 QUALITY ASSURANCE
A. Installer Qualifications: An experienced installer certified in writing by the flooring manufacturer to be qualified for installation of specified flooring system.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Deliver materials to project site in unopened containers clearly labeled with manufacturer’s name and identification of contents.
B. Store materials in dry and clean location until needed for installation. During installation, handle in a manner that will prevent marring and soiling of finished surfaces.

1.05 FIELD CONDITIONS
A. Maintain temperature in spaces to receive adhesively installed resilient flooring within range of 70 to 95 degrees F for not less than 48 hours before the beginning of installation and for not less than 48 hours after installation has been completed. Subsequently, do not allow temperature in installed spaces to drop below 50 degrees F or to go above 100 degrees F.

PART 2 PRODUCTS
2.01 PREFORMED ATHLETIC FLOORING
A. Rubber Sheet Flooring: Two-layer vulcanized rubber.
   2. Sheet Width: Minimum 48 inches.
   5. Color: As selected from manufacturer’s standard range.

2.02 ACCESSORIES
A. Leveling Compound: Latex-modified cement formulation as recommended by flooring manufacturer for substrate conditions.
B. Flooring Adhesive: Waterproof; types recommended by flooring manufacturer.

PART 3 EXECUTION
3.01 EXAMINATION
A. Examine substrates for conditions detrimental to installation of athletic flooring. Proceed with installation only after unsatisfactory conditions have been corrected.
B. 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 athletic flooring to substrate.

3.02 PREPARATION
A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
B. Remove coatings that are incompatible with flooring adhesives, using methods recommended by flooring manufacturer.

C. Broom clean areas to receive athletic flooring immediately before beginning installation.

### 3.03 INSTALLATION

A. Starting installation constitutes acceptance of subfloor conditions.

B. Install in accordance with manufacturer's written instructions.

C. Resilient Sheet Flooring:
   1. Unroll flooring and allow to relax before beginning installation.
   2. Mix adhesive thoroughly and apply to substrate with notched trowel. Roll flooring into fresh adhesive, overlapping end seams and double cutting, butting factory edges and compression fitting.
   3. Roll entire flooring surface with steel roller to assure adhesion to substrate and eliminate air bubbles.
   4. Immediately remove any adhesive from flooring surface, using chemical recommended by flooring manufacturer.
   5. Weld seams using techniques and equipment recommended by manufacturer.
   6. Lay out game lines using tape and taping machine approved by flooring manufacturer. Apply game line paint with roller, and allow to dry before removing tape.
   7. Apply transparent top coat over flooring if recommended by manufacturer, to achieve a uniform finished appearance.

### 3.04 CLEANING

A. Clean flooring using methods recommended by manufacturer.

### 3.05 PROTECTION

A. Protect finished athletic flooring from construction traffic to ensure that it is without damage upon Date of Substantial Completion.

**END OF SECTION**
SECTION 09 68 13
TILE CARPETING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Carpet tile, fully adhered.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
C. Shop Drawings: Indicate layout of joints.
D. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.
E. Submit two, 12 inch long samples of edge strip.
F. Manufacturer's Installation Instructions: Indicate perimeter conditions requiring special attention.
G. Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.
H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Carpet Tiles: Quantity equal to ___ percent of total installed of each color and pattern installed.

1.04 QUALITY ASSURANCE
A. Installer Qualifications: Company specializing in installing carpet tile with minimum three years documented experience and approved by carpet tile manufacturer.

1.05 FIELD CONDITIONS

PART 2 PRODUCTS

2.01 MATERIALS
A. Tile Carpeting: Tufted, manufactured in one color dye lot.
   1. Tile Size: 18 by 18 inch, nominal.
   2. Thickness: 3/8 inch.
   3. Color: to be selected.
   4. Pattern: to be selected.

2.02 ACCESSORIES
A. Subfloor Filler: White premix latex; type recommended by flooring material manufacturer.
B. Edge Strips: Rubber, black color.
C. Adhesives:
   1. Compatible with materials being adhered; maximum VOC content of 50 g/L; CRI (GLP) certified.
D. Carpet Tile Adhesive: Recommended by carpet tile manufacturer; releasable type.
PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.

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 carpet tile.

C. Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to subfloor surfaces.

D. Cementitious Subfloor Surfaces: Verify that substrates are ready for flooring installation by testing for moisture and alkalinity (pH).
   1. Test as Follows:
      b. Internal Relative Humidity: ASTM F2170.
      d. Testing to be completed by General Contractor.
   2. Obtain instructions if test results are not within limits recommended by flooring material manufacturer and adhesive materials manufacturer.

3.02 PREPARATION

A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.

B. Remove subfloor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with subfloor filler.

C. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.

D. Vacuum clean substrate.

3.03 INSTALLATION

A. Starting installation constitutes acceptance of subfloor conditions.

B. Install carpet tile in accordance with manufacturer's instructions.

C. Blend carpet from different cartons to ensure minimal variation in color match.

D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.

E. Lay carpet tile in square pattern, with pile direction parallel to next unit, set parallel to building lines.

F. Fully adhere carpet tile to substrate.

G. Trim carpet tile neatly at walls and around interruptions.

H. Complete installation of edge strips, concealing exposed edges.

3.04 CLEANING

A. Remove excess adhesive without damage, from floor, base, and wall surfaces.

B. Clean and vacuum carpet surfaces.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Surface preparation.
B. Field application of paints.
C. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.
   1. Mechanical and Electrical:
      a. In finished areas, paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment, unless otherwise indicated.
D. Do Not Paint or Finish the Following Items:
   1. Items factory-finished unless otherwise 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, bar code labels, and operating parts of equipment.
   5. Floors, unless specifically indicated.
   7. Concealed pipes, ducts, and conduits.

1.02 REFERENCE STANDARDS
B. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).
C. SSPC-SP 6 - Commercial Blast Cleaning; 2007.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
   1. Where sheen is specified, submit samples in only that sheen.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
B. 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.
C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.05 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. Provide lighting level of 80 ft candles measured mid-height at substrate surface.
PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.
B. Paints:
C. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PAINTS AND FINISHES - GENERAL
A. Paints and Finishes: Ready mixed, unless intended to be a field-catalyzed paint.
   1. Provide paints and finishes 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. Supply each paint material in quantity required to complete entire project's work from a single production run.
   3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
B. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.
C. Colors: To be selected from manufacturer's full range of available colors.
   1. Selection to be made by Architect after award of contract.

2.03 PAINT SYSTEMS - INTERIOR
A. Interior Surfaces to be Painted, Unless Otherwise Indicated: Including gypsum board and shop primed steel.
   1. Two top coats and one coat primer.
   2. Top Coat(s): Interior Latex.
   3. Top Coat Sheen:
      a. Semi-Gloss: MPI gloss level 5; use this sheen at all locations.
   4. Primer: As recommended by top coat manufacturer for specific substrate.
B. Dry Fall: Metals; exposed structure and overhead-mounted services in utilitarian spaces, including shop primed steel deck, structural steel, metal fabrications, galvanized ducts, galvanized conduit, and galvanized piping.
   1. Top Coat: Latex Dry Fall; MPI #118, 155, or 226.
   2. Top Coat Sheen:
      a. Flat: MPI gloss level 1; use this sheen at all locations.
   3. Primer: As recommended by top coat manufacturer for specific substrate.
C. Transparent Finish on Concrete Floors.
   1. Sealer: Water Based Sealer for Concrete Floors; MPI #99.
   2. Sealer Sheen:
      a. Eggshell: MPI gloss level 3; use this sheen at all locations.

2.04 PRIMERS
A. Primers: Provide the following unless other primer is required or recommended by manufacturer of top coats.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially effect proper application.
C. Test shop-applied primer for compatibility with subsequent cover materials.
D. 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. Concrete Floors and Traffic Surfaces: 8 percent.

3.02 PREPARATION
A. Clean surfaces thoroughly and correct defects prior to 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 mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
D. Seal surfaces that might cause bleed through or staining of topcoat.
E. Concrete Floors and Traffic Surfaces: Remove contamination, acid etch, and rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry.
F. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.
G. Galvanized Surfaces:
H. Ferrous Metal:
   1. Solvent clean according to SSPC-SP 1.
   3. Remove rust, loose mill scale, and other foreign substances using using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 "Commercial Blast Cleaning". Protect from corrosion until coated.
I. 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 written instructions and recommendations in "MPI Architectural Painting Specification Manual".
C. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
D. Apply each coat to uniform appearance in thicknesses specified by manufacturer.
E. Sand wood and metal surfaces lightly between coats to achieve required finish.
F. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
G. 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 finishes until completion of project.
B. Touch-up damaged finishes after Substantial Completion.

3.06 COLOR SCHEDULE
A. See Finish Schedule

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Tackboards

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturer's data on chalkboard, markerboard, tackboard, tackboard surface covering, trim, and accessories.
   C. Shop Drawings: Indicate wall elevations, dimensions, joint locations, special anchor details.

PART 2 PRODUCTS

2.01 VISUAL DISPLAY UNITS
   A. Tackboards: Fine-grained, homogeneous natural cork.
      2. Backing: Hardboard, 1/4 inch thick, laminated to tack surface.
      3. Surface Burning Characteristics: Flame spread index of 25, maximum, and smoke developed index of 450, maximum, when tested in accordance with ASTM E84.
      4. Height: 48 inches.
      5. Length: 8 feet, in one piece.
      8. Accessories: Provide map rail.

2.02 ACCESSORIES
   A. Map Rail: Extruded aluminum, manufacturer's standard profile, with cork insert and runners for accessories; 1 inch wide overall, full width of frame.
   B. Map Supports: Formed aluminum sliding hooks and roller brackets to fit map rail.
   C. Mounting Brackets: Concealed.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify that internal wall blocking is ready to receive work and positioning dimensions are as indicated on shop drawings.

3.02 INSTALLATION
   A. Install boards in accordance with manufacturer's instructions.
   B. Secure units level and plumb.

END OF SECTION
SECTION 10 14 00
SIGNAGE

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Room signs.
   B. Building identification signs. (See Allowance)
   C. Plaque.

1.02 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

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 floor or building.
   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 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 Signs:
      1. Sign Type: Flat signs with engraved panel media as specified.
      2. Provide “tactile” signage, with letters raised minimum 1/32 inch and Grade II braille.
      3. Character Height: 1 inch.
      4. Sign Height: 3 inches, unless otherwise indicated.
      5. Classrooms: Identify with as detailed.
      6. Service Rooms: Identify with as detailed.
      7. Rest Rooms: Identify with pictograms, the names "MEN" and "WOMEN", and braille.
   C. Building Identification Signs:
      1. Use individual raised letters. Stainless steel back. Curved lettering. UDC and FBI logo’s.
      2. Mount on outside wall in location indicated on drawings.
   D. Other Dimensional Letter Signs: Wall-mounted.
      1. Exterior: Allow for total of 50 letters, 6 inches high, metal.
   E. See Allowance for details.

2.02 ROOM SIGN TYPES
   A. Flat Signs: Signage media without frame.
      1. Edges: Bevelled.
      2. Corners: Radiused.
   B. Color and Font: Unless otherwise indicated:
      1. Character Font: Helvetica, Arial, or other sans serif font.
      2. Character Case: Upper case only.
      3. Background Color: as selected.

2.03 TACTILE SIGNAGE MEDIA
   A. Engraved Panels: Laminated colored plastic; engraved through face to expose core as background color:
      1. Total Thickness: 1/16 inch.

2.04 DIMENSIONAL LETTERS
   A. Metal Letters:
      1. Metal: Aluminum casting.
      3. Text and Typeface:
         a. Character Font: Helvetica, Arial, or other sans serif font.
         b. Character Case: Upper case only.
      5. Mounting: Concealed screws.

2.05 ACCESSORIES
   A. Concealed Screws: Stainless steel, galvanized steel, chrome plated, or other non-corroding metal.
   B. 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. Locate signs and mount at heights indicated on drawings and in accordance with ADA Standards and ICC A117.1.
   D. Protect from damage until Substantial Completion; repair or replace damaged items.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Metal toilet compartments.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall, floor, and ceiling supports, door swings.
C. Samples: Submit two samples of partition panels, 6 x 6 inch in size illustrating panel finish, color, and sheen.

PART 2 PRODUCTS

2.01 MATERIALS
A. Steel Sheet: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.

2.02 COMPONENTS
A. Toilet Compartments: Powder coated steel, floor-mounted headrail-braced.
B. Doors, Panels, and Pilasters: Sheet steel faces, pressure bonded to sound deadening core, formed and closed edges; corners made with corner clips or mitered, welded, and ground smooth.
   1. Panel Faces: 20 gage, 0.0359 inch.
   2. Door Faces: 22 gage, 0.0299 inch.
   3. Pilaster Faces: 20 gage, 0.0359 inch.
   4. Reinforcement: 12 gage, 0.1046 inch.
   5. Internal Reinforcement: Provide in areas of attached hardware and fittings. Mark locations of reinforcement for partition mounted washroom accessories.
C. Door and Panel Dimensions:
   1. Thickness: 1 inch.
   2. Door Width: 24 inch.
   3. Door Width for Handicapped Use: 36 inch, out-swinging.
   4. Height: 58 inch.
D. Pilasters: 1-1/4 inch thick, of sizes required to suit compartment width and spacing.

2.03 ACCESSORIES
A. Pilaster Shoes: Formed chromed steel with polished finish, 3 inch high, concealing floor fastenings.
   1. Provide adjustment for floor variations with screw jack through steel saddles integral with pilaster.
B. Head Rails: Hollow chrome-plated steel tube, 1 by 1-5/8 inch size, with anti-grip strips and cast socket wall brackets.
C. Brackets: Polished chrome-plated non-ferrous cast metal.
D. Attachments, Screws, and Bolts: Stainless steel, tamper proof type.
E. Hardware: Polished chrome plated non-ferrous cast metal:
   1. Pivot hinges, gravity type, adjustable for door close positioning; two per door.
   2. Thumb turn or sliding door latch with exterior emergency access feature.
3. Door strike and keeper with rubber bumper; mounted on pilaster in alignment with door latch.
4. Coat hook with rubber bumper; one per compartment, mounted on door.
5. Provide door pull for outswinging doors.

2.04 FINISHING
   A. Powder Coated Steel Compartments: Clean, degrease, and neutralize. Follow immediately with a phosphatizing treatment, prime coat and two finish coats powder coat enamel.
   B. Color: as selected.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify existing conditions before starting work.
   B. Verify correct spacing of and between plumbing fixtures.

3.02 INSTALLATION
   A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.
   B. Maintain 3/8 to 1/2 inch 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.

3.03 ADJUSTING
   A. Adjust hinges to position doors in partial opening position when unlatched. Return out swinging doors to closed position.

END OF SECTION
SECTION 10 22 33
ACCORDION FOLDING PARTITIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Accordion folding partitions.
B. Track and operating hardware.
C. Sound-rated construction above ceiling to structure.

1.02 REFERENCE STANDARDS

C. ASTM E413 - Classification for Rating Sound Insulation; 2016.
F. ASTM F793/F793M - Standard Classification of Wall Coverings by Use Characteristics; 2015.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on partition operation, hardware and accessories, electric operating components, track switching components, colors and finishes available.
C. Shop Drawings: Indicate opening sizes, track layout, details of track and required supports, static and dynamic loads, adjacent construction and finish trim, and stacking sizes.
D. Samples: Submit two samples of full manufacturer’s color range for selection of colors.
E. Manufacturer’s Certificate: Certify that partition system meets or exceeds specified acoustic requirements and ________.

1.04 QUALITY ASSURANCE

A. Sound Transmission Class (STC): As indicated, calculated in accordance with ASTM E413, based on tests performed in accordance with ASTM E90, on panel size of 100 sq ft.
B. Noise Isolation Classification (NIC): As indicated, calculated in accordance with ASTM E413, based on tests performed in accordance with ASTM E596.
C. Design Requirements: Design partition track and anchors to support imposed loads with maximum deflection of 1/360 of span, attached to structural members indicated.

PART 2 PRODUCTS

2.01 ACCORDION FOLDING PARTITIONS

A. Partition Construction: Acoustical.
   1. Frame: _____ gage, ____ inch steel pantograph hinge plates; ____ inch diameter vertical rods, galvanized; limiting mechanism; stacking straps and snaps.
   2. Finish: Vinyl coated fabric; color as selected.
   3. Internal air release mechanism.
   4. Acoustic seals at top, meeting mullions, jambs, and bottom.
   5. Sound Transmission Class (STC): _____.
   6. Noise Isolation Class (NIC): _____.
   7. Trim: Jamb mullions.
B. Track: Formed steel; 1-1/4 by 1-1/4 inches size; thickness and profile designed to support loads; steel sub-channel.
C. Carriers: Nylon wheels on trolley carrier at top center of every second fold, with threaded pendant bolt for vertical adjustment.

2.02 FINISH MATERIALS
A. Vinyl Coated Fabric: ASTM F793 Category VI, polyvinyl fluoride finish.
   1. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84.
   2. Color: As selected from manufacturer's standard range.

2.03 COMPONENTS
A. Trim: Aluminum moldings, clear anodized.
B. Hardware: Latching door handles of cast steel, satin chrome finish; master keyed to building keying system; jamb lock and pull bars.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify existing conditions before starting work.
B. Verify that field measurements are as indicated.
C. Verify track supports are laterally braced and will permit track to be leveled within 1/4 inch of required position and parallel to the floor surface.
D. Verify floor flatness of 1/8 in 10 feet, non-cumulative.
E. Verify wall plumbness of 1/8 in 10 feet, non-cumulative.

3.02 INSTALLATION
A. Install partition in accordance with manufacturer's instructions and ASTM E557.
B. Fit and align partition assembly level and plumb.
C. Lubricate moving components.

3.03 ADJUSTING
A. Adjust partition assembly to provide smooth operation from stacked to full open position.
B. Visually inspect partition in full open position for light leaks to identify a potential acoustical leak. Adjust to achieve light tight seal.

END OF SECTION
SECTION 10 26 00
WALL AND DOOR PROTECTION

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Corner guards.

1.02 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Indicate physical dimensions, features, wall mounting brackets with mounted measurements, anchorage details, and rough-in measurements.
   C. Shop Drawings: Include plans, elevation, sections, and attachment details. Show design and spacing of supports for protective corridor handrails, required to withstand structural loads.
   D. Samples: Submit samples illustrating component design, configurations, joinery, color and finish.
      1. Submit two sections of corner guards, 12 inches long.

1.03 DELIVERY, STORAGE, AND HANDLING
   A. Deliver wall protection items in original, undamaged protective packaging. Label items to designate installation locations.
   B. Do not deliver products to project site until areas for storage and installation are fully enclosed, and interior temperature and humidity are in compliance with manufacturer's recommendations for each type of item.

PART 2 PRODUCTS

2.01 PRODUCT TYPES
   A. Corner Guards - Surface Mounted:
      1. Material: Type 304 stainless steel, No. 4 finish, 14 gage, .0747 inch thick.
      2. Width of Wings: 2 inches.
      3. Corner: Square.
      5. Length: One piece.
   B. Adhesives and Primers: As recommended by manufacturer.

2.02 FABRICATION
   A. Fabricate components with tight joints, corners and seams.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.

3.02 INSTALLATION
   A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to supporting construction.
   B. Position corner guard 4 inches above finished floor to 48 inches high.

3.03 CLEANING
   A. Clean wall and door protection items of excess adhesive, dust, dirt, and other contaminants.

END OF SECTION
SECTION 10 28 00
TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Commercial toilet accessories.
B. Under-lavatory pipe supply covers.
C. Utility room accessories.

1.02 REFERENCE STANDARDS

B. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.

1.03 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.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.

PART 2 PRODUCTS

2.01 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. Stainless Steel Sheet: ASTM A666, Type 304.
C. Mirror Glass: Annealed float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.
D. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.

2.02 FINISHES

A. Stainless Steel: Satin finish, unless otherwise noted.

2.03 COMMERCIAL TOILET ACCESSORIES

A. Mirrors: Stainless steel framed, 1/4 inch thick annealed float glass; ASTM C1036.
   1. Annealed Float Glass: Silvering, protective and physical characteristics in compliance with ASTM C1503.
   2. Size: 24” x 36”.
   3. Frame: 0.05 inchangle shapes, with mitered and welded and ground corners, and tamperproof hanging system; satin finish.
B. Seat Cover Dispenser: Stainless steel, surface-mounted, reloading by concealed opening at base, tumbler lock.

C. Grab Bars: Stainless steel, peened surface.
   1. Standard Duty Grab Bars:
      a. Push/Pull Point Load: 250 pound-force, minimum.
      b. Dimensions: 1-1/4 inch outside diameter, minimum 0.05 inch wall thickness, exposed flange mounting, 1-1/2 inch clearance between wall and inside of grab bar.
      c. Finish: Satin.
      d. Length and Configuration: As indicated on drawings.

2.04 UNDER-LAVATORY PIPE AND SUPPLY COVERS
   A. Under-Lavatory Pipe and Supply Covers:
      1. Insulate exposed drainage piping including hot, cold, and tempered water supplies under lavatories or sinks to comply with ADA Standards.
      2. Exterior Surfaces: Smooth non-absorbent, non-abrasive surfaces.
      3. Construction: 1/8 inch flexible PVC.
         a. Surface Burning Characteristics: Flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.

2.05 UTILITY ROOM ACCESSORIES
   A. Combination Utility Shelf/Mop and Broom Holder: 0.05 inch thick stainless steel, Type 304, with 1/2 inch returned edges, 0.06 inch steel wall brackets.
      1. Mop/broom holders: Three spring-loaded rubber cam holders at shelf front.
      2. Length: Manufacturer's standard length for number of holders/hooks.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify existing conditions before starting work.
   B. Verify exact location of accessories for installation.
   C. _____ Provide 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 in locations indicated on drawings.
   B. Mounting Heights: As required by accessibility regulations, and as noted on the drawings.

3.04 PROTECTION
   A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION
SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Fire extinguishers.
B. Fire extinguisher cabinets.

1.02 REFERENCE STANDARDS
C. UL (DIR) - Online Certifications Directory; Current Edition.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide extinguisher operational features.
C. Shop Drawings: Indicate locations of cabinets and cabinet physical dimensions.

PART 2 PRODUCTS

2.01 FIRE EXTINGUISHERS
A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
   1. Provide extinguishers labeled by UL (DIR) or FM (AG) for purpose specified and as indicated.
B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
   1. Cartridge Operated: Spun shell.
   2. Class: A:B:C type.
   3. Size: 10 pound.
   4. Finish: Baked polyester powder coat, red color.
   5. Temperature range: Minus 65 degrees F to ___ degrees F.

2.02 FIRE EXTINGUISHER CABINETS
A. Cabinet Construction: Non-fire rated.
   1. Formed primed steel sheet; 0.036 inch thick base metal.
B. Cabinet Configuration: Semi-recessed type.
   1. Size to accommodate accessories.
   2. Trim: Flat rolled edge, with 1 1/2 inch wide face.
C. Door: 0.036 inch metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180 degree opening with two butt hinge.
D. Door Glazing: Float glass, clear, 1/8 inch thick, and set in resilient channel glazing gasket.
E. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.
F. Weld, fill, and grind components smooth.
G. Finish of Cabinet Exterior Trim and Door: Baked enamel, color as selected.
H. Finish of Cabinet Interior: White colored enamel.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify existing conditions before starting work.
B. Verify rough openings for cabinet are correctly sized and located.
3.02 INSTALLATION

A. Install cabinets plumb and level in wall openings, 48 inches from finished floor to unit nozzle height.
B. Secure rigidly in place.
C. Place extinguishers in cabinets.

END OF SECTION
SECTION 10 56 13
METAL STORAGE SHELVING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Four post shelving.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Rated uniform shelf loads.
   2. Details of shelving assemblies, including reinforcement.
   3. Accessories.
C. Test Reports: Provide independent agency test reports documenting compliance with specified structural requirements.
D. Shop Drawings: Indicate location, type, and layout of shelving, including lengths, heights, and aisle layout, and relationship to adjacent construction.
E. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.03 DELIVERY, STORAGE, AND HANDLING
A. Inspect for dents, scratches, or other damage. Replace damaged units.
B. Store in manufacturer's unopened packaging until ready for installation.
C. Store under cover and elevated above grade.

1.04 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Provide one year manufacturer warranty covering defects of manufacturing and workmanship and rust and corrosion.

PART 2 PRODUCTS

2.01 SHELVING - GENERAL

2.02 FOUR POST SHELVING
A. Four Post Shelving: Steel post-and-beam type with sway bracing, shelving brackets, shelving surfaces, and accessories as specified.
   1. Unit Width: 60 inches, center to center of posts. Additional posts as suggested by manufacturer.
   2. Shelf Capacity: Uniform distributed load of 50 psf, minimum.
   3. Shelf Depth: 24 inches, minimum.
   5. Finish: stainless steel.
   6. Number of Units: 1.
B. Posts and Beams: Formed sheet members; perforations exposed on face of members are not acceptable.
   1. Metal Thickness: 16 gage, 0.0598 inch.
   2. Post Shape: Tee intermediate posts, angle end posts forming corners.
   3. Post Face Width: 2 inches, maximum.
C. Bracing: Formed sheet members.
   1. Back Sway Bracing: Either strap or panel; at back of each unit.
   2. Side Sway Bracing: Either strap or panel; at each side of each unit.
3. Strap Sway Bracing: One strap installed diagonally, 16 gage, 0.0598 inch; welded, riveted, or bolted to uprights.
4. Panel Sway Bracing: Formed sheet metal panels, 20 gage, 0.0359 inch; welded, riveted, or bolted to uprights.

D. Shelves: Formed stainless steel wire; brushed or satin finish; cut ends concealed or smoothed for safety.
   1. Wire Diameter: 1/8 inch, minimum.
   3. Shelf Edge Profile: Extending 3/4 inch high, maximum, below top surface of shelf.
   4. Shelf Connection to Posts: Manufacturer's standard.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that substrate is level and that clearances are as specified.
   B. Do not begin installation until substrates have been properly prepared.
   C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Install shelving with shelf surfaces level and vertical supports plumb; adjust feet and bases as required.
   C. Out-Of-Square Tolerance - Four Post Shelving: Maximum of 1/8 inch difference in distance between bottom shelf and canopy top, measured along any post in any direction.

3.03 PROTECTION
   A. Protect installed products until completion of project.
   B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION
SECTION 10 73 16.13
METAL CANOPIES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Shop fabricated metal canopies.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit product data sheets, including material descriptions and finishes, and preparation instructions and recommendations.
C. Shop Drawings: Prior to commencement of fabrication, submit detailed shop drawings, showing profiles, sections of components, finishes, and fastening details.
D. Design Data: Submit comprehensive structural analysis of design for the specified loads. Stamp and sign calculations by professional engineer.

1.03 QUALITY ASSURANCE
A. Designer Qualifications: Perform design under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Deliver materials to project site ready for erection.
B. Package using methods that prevent damage during shipping and storage on site.
C. Store materials under cover and elevated above grade.

PART 2 PRODUCTS

2.01 METAL CANOPIES
A. Shop Fabricated Metal Canopy
1. Pre-engineered system complying with ASTM E2950.
2. Design and fabricate metal canopy system to resist wind, snow, live, and seismic loads without failure, damage, or permanent deflection in accordance with ASCE 7:
3. Thermal Movement: Design canopy system to accommodate thermal movement caused by ambient temperature range of 120 degrees F and surface temperature range of 180 degrees F without buckling, failure of joint seals, undue stress on fasteners or other detrimental effects on assembly components.
B. Configuration: Layout, canopy clearance, profile, and roof covering design as indicated on drawings.

2.02 COMPONENTS
A. Structural Steel Framing:
1. Other Structural Steel Members: ASTM A36/A36M.
B. Covering:
1. Sheet Metal Decking:
   a. Material: ASTM A653/A653M, G40 galvanized according to ASTM A924/A924M.
   b. Provide canopy manufacturer's standard clip type fasteners for attaching covering to structural beams.
C. Anchor Bolts: ASTM A307 or ASTM A572/A572M, formed with bent shank, assembled with template for casting into concrete.
1. Minimum exposed thread of 7 inches above footing and 23 inch minimum embedment.
2. Provide nuts and washers as required for column leveling and plumbing.
D. Exposed Gutters: Galvanized steel with baked enamel finish, color to match canopy covering, manufacturer's recommended size for canopy specified. Connect downspouts to canopy.
2.03 SHOP FABRICATION
   A.  Provide a complete system ready for erection at project site.
   B.  Shop fabricate to the greatest extent possible; disassemble if necessary for shipping.
   C.  Perform welding in accordance with AWS D1.1/D1.1M.
   D.  Fabricate connections for bolt, nut, and washer connectors.

2.04 FINISHES
   A.  Structural Steel Framing:
       2.  Finish Coating:  As specified in Section as selected by architect.
   B.  Steel Decking:  Polyester baked enamel finish; color as selected from manufacturer's standard range.

2.05 ACCESSORIES
   A.  Trim, Closure Pieces, and Flashings:  Same material, thickness and finish as sheet metal decking; factory-fabricated to required profiles.

PART 3 EXECUTION
3.01 INSTALLATION - FRAMING
   A.  Provide for erection and wind loads.  Provide temporary bracing to maintain structure plumb and in alignment until completion of erection and installation.
   B.  Set column base plates with non-shrink grout to achieve full plate bearing.
   C.  Fasten columns to anchor bolts.
   D.  Do not field cut or alter structural members without approval.
   E.  After erection, prime welds, abrasions, and surfaces not shop primed.

3.02 INSTALLATION - CANOPY COVERING
   A.  Install in accordance with manufacturer's instructions.
   B.  Fasten metal decking to steel support members, aligned level and plumb.
   C.  Install fascia panels, trim, and flashing.
   D.  Separate dissimilar metals using concealed bituminous paint.
   E.  Touch-up damaged finish coating using material provided by manufacturer to match original coating.

3.03 CLEANING
   A.  Clean surfaces of dust and debris; follow manufacturer's cleaning instructions for the finish used.

3.04 PROTECTION
   A.  Protect canopy after installation to prevent damage due to other work until Date of Substantial Completion.

END OF SECTION
SECTION 10 75 00
FLAGPOLES

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Aluminum Flagpoles.

1.02 SUBMITTALS
A. Product Data: Provide data on pole, accessories, and configurations.
B. Shop Drawings: Indicate detailed dimensions, base details, anchor requirements, and imposed loads.
C. Designer's Qualification Statement.

1.03 QUALITY ASSURANCE
A. Designer Qualifications: Design flagpole foundation under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed the State in which the Project is located.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Spiral wrap flagpole with protective covering and pack in protective shipping tubes or containers.
B. Protect flagpole and accessories from damage or moisture.

PART 2 PRODUCTS
2.01 FLAGPOLES
A. Flagpoles: Designed in accordance with NAAMM FP 1001.
   1. Material: Aluminum.
   2. Design: Straight shaft.
   3. Mounting: Ground mounted type.
   4. Nominal Height: 30 ft; measured from nominal ground elevation.
   5. Halyard: External type.
B. Performance Requirements:
   1. Wind Pressure Loading on Flagpole with Flag: Resistant without permanent deformation to _____ miles/hr wind speed, in accordance with NAAMM FP 1001; the factor of safety used is 2.5.

2.02 ACCESSORIES
A. Flag: solid red design, 5 ft by 8 ft size, nylon fabric, brass grommets, hemmed edges.
B. Cleats: 9 inch size, aluminum with galvanized steel fastenings, two per halyard.
C. Halyard: 5/16 inch diameter polypropylene, braided, white.
D. Provide enclosure box at base of pole for flag storage.

2.03 MOUNTING COMPONENTS
A. Foundation Tube Sleeve: AASHTO M 36, corrugated 16 gage, 0.0598 inch steel, galvanized, depth of as indicated by manufacturer inches.
B. Pole Base Attachment: Flush; steel base with base cover.
C. Lighting Ground Rod: 5 inch long copper rod, 3/4 inch diameter.
D. Lightning Ground Cable: Copper No. 6 AWG, soft drawn.

2.04 FINISHING
A. Metal Surfaces in Contact With Concrete: Asphalitic paint.
B. Aluminum: Mill finish.
PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that concrete foundation is ready to receive work and dimensions are as indicated on shop drawings.

3.02 PREPARATION
   A. Coat metal sleeve surfaces below grade and surfaces in contact with dissimilar materials with asphaltic paint.

3.03 INSTALLATION
   A. Install flagpole, base assembly, and fittings in accordance with manufacturer's instructions.

3.04 ADJUSTING
   A. Adjust operating devices so that halyard and flag function smoothly.

END OF SECTION
1.0 INTRODUCTION. The FBI and certain designated partners require Firing Range enhancements to include a Turning Target System and Knee Walls to be installed at various locations CONUS and OCONUS.

2.0 DESCRIPTION OF ITEMS. The following items are required for performance under this contract. The specifications marked with an asterisk (*) will be reviewed during the technical evaluation. Offerors are required to provide CAD drawings or engineering designs for all requirements. Offeror must provide a bid inclusive of all requirements under the SOW. PARTIAL BIDS OR INCOMPLETE BIDS WILL NOT BE CONSIDERED.

2.1 ***Turning Target System.*** Install programmable electronically automated TTS with a full-length Running Man. Turning target system and Running Man is herein after referred to as TTS. Pneumatic systems are not acceptable. The TTS should be constructed of components able to withstand weather conditions at the designated firearms range complex. The TTS should be constructed of components able to withstand direct and indirect fire from authorized ammunition types fired by the partner and the FBI. The quantity of turning targets will be provided to the Offeror when the quote is requested. FBI and Partner targets will be supplied upon request.

System components will be manufactured to withstand and operate in the environment and weather conditions at the designated location:

1. Minimum 6” x 6” steel main support tube: houses wiring for 90° or 180° turning targets and supports the moving target trolley.

2. Target holder every five (5) feet or as designated. Target holder to be gripper style holder or a gripper style holder with a permanently attached provision for wooden stakes. Grippers are to be removable without the use of tools. *** Target holders MUST default to a facing position when the system is powered down. ***

3. Running Man will utilize a removable steel torso target with an FBI QIT20 or similar silhouette. Running Man track will be located to allow easy pedestrian access to the TTS for scoring. Running Man track located in such a manner as to minimize use as a step. If the geographical location required the Running Man track may need to have the ability to thaw itself and function in temperatures typical for the climate. All Running Man components will be warranted for two (2) years.

4. Covers to protect wiring and electronics from direct and/or indirect fire while providing access.

5. Steel Torso target shall be capable of withstanding authorized ammunition types fired by the FBI and partner. The FBI and partner shall provide caliber and bullet types.

6. Target support will a “C” type holder unless otherwise designated.

8. Front armor plate protection (Bull Nose) for TTS operating mechanisms will be capable of withstanding damage from authorized ammunition types fired by the FBI and the partner.

9. Control System:
   A. TTS and Running Man control system tower installations will be a single touchscreen interface with a wireless and hardwire control mirroring the touchscreen controls. Offeror to provide a full-scale picture of the touchscreen control panel with bid package.
   B. TTS and Running Man control touch screen will be installed in the existing control tower. Two (2) auxiliary control devices (I-Pad or equivalent) and necessary equipment for remotely programming and controlling the TTS and Running Man function will be provided.
   C. The control system is to include preprogrammed courses of fire provided by the FBI and partner. Preprogrammed courses of fire will include at a minimum five (5) FBI courses of fire and a minimum of five (5) partner courses of fire with the capability to add and save additional courses as needed.
   D. The control system software is not required to be password protected.

10. TTS and Running Man will be capable of functioning in temperatures between -15 degrees Fahrenheit and +120 degrees Fahrenheit. If specified, the TTS will have the ability to thaw itself and function within 5 minutes of being turned on in freezing conditions.
2.1.1 All TTS components to include the Running Man shall be designed, built and installed to withstand without any mode of failure the impact of direct fire or indirect fire impacts from the authorized rounds producing the maximum energy. TTS shall be designed, built and installed so that the entire target face is fully displayed when exposed to a prone shooter from 50 yards to 3 yards. TTS shall be fully compatible with the mounting and use of FBI QIT20 cardboard targets or similar silhouette. No additional materials other than one rubber band shall be required to attach FBI QIT20 or similar silhouette cardboard targets to the TTS. Wooden components of any kind are not permitted.

2.1.2 A protective physical barrier “Bull Nose” between the firing line and TTS mechanical componentry shall be provided and installed to protect TTS system mechanical components and to direct rounds and round fragments away from shooters. The physical barrier shall be capable of receiving direct fire from all ammunition types authorized for use on the range without failure.

2.1.3 All TTS components shall be designed, built and installed so that the entire target face is fully displayed when exposed to a prone shooter from 50 yards to 3 yards. TTS shall be fully compatible with the mounting and use of FBI QIT20 cardboard targets or similar silhouette. No additional materials other than one rubber band shall be required to attach FBI QIT20 or similar silhouette cardboard targets to the TTS. Wooden components of any kind are not permitted.

2.1.4 All TTS components shall be designed for and made fully compatible with all identified authorized range uses.

2.1.5 - TTS must be programmed to default to the facing position when powered down or during a loss of power or if powered down by the user (turned off).

2.1.6 Annual Maintenance. Three (3) year annual maintenance plan to include service calls on the TTS and Running Man.

2.1.7 Spare Parts. As part of the annual maintenance plan the Offeror will be responsible for maintaining on site, the necessary spare parts to include at a minimum the following:

A. Spare turning target mechanisms

B. Spare target clamp systems.

2.1.8 110-volt receptacles. Two 110-volt double receptacles will be installed in weather proof boxes. One at each end of the TTS and protected from direct and/or indirect fire. Receptacles will meet state and local electrical/building codes.

2.1.9 TTS and components will be warrantied for two (2) years.

2.2 ***Knee Wall***. If required, install a ballistic knee wall set on/in a concrete pad in front of the TTS, the length of the TTS plus 2 feet on each end to protect targetry components exposed below the "Bull Nose" to include the Running Man components from direct and/or indirect fire from a height of 6.5 feet. Knee wall will be capable withstanding damage and preventing ricochet from authorized ammunition types fired by the FBI and partner.

2.3.1 ***Height of Knee Wall*** Knee Wall height will not obstruct any of the target face when exposed to a prone shooter from 50 yards to 3 yards.

2.3.2 Knee Wall coverings will be designed and installed so as to allow FBI/partner personnel to replace sections damaged by normal use.

2.3.3 Concrete Knee Wall pad will extend 12" in the direction of the 50-yard line the entire length of the TTS. There will be no exposed soil or grass between the rear of the Knee Wall and the TTS.

2.3.4 Knee Wall slab will be designed to not allow standing water on its surface. Concrete installation will meet State and local building codes.

2.3.5 Knee Wall and components will be warrantied for two (2) years, excluding normal wear and tear.

3.0 INSTALLATION REQUIREMENTS.

3.1 The Offeror will be responsible for providing all labor, materials and equipment to properly install the TTS with full-length Running Man and if required, a Knee Wall. As part of the TTS installation the Offeror shall be required to install all associated utility upgrades as necessary to allow for proper operations as required.
3.2 The Offeror’s Project Manager shall be responsible for on-site coordination of all staging and deliveries of their product, to include access to and operation of any equipment needed for unloading and movement of materials or product. The Offeror shall have access to the firing range location and be responsible for delivery of all manufactured equipment to the firearms range complex.

3.3 The Offeror is responsible for post installation cleanup. Which will include removal of all material packaging and all other debris left as a result of installation. General clean-up of material packaging and work areas will be conducted during job progress (at the end of each day as a minimum) to minimize unacceptable appearance of job site. All trash removed from the worksite shall be disposed of in accordance with state laws. Packaging and other recyclable materials shall be recycled wherever possible.

3.4 The Offeror shall be responsible for following all safety and security guidelines within the area in which work is being performed to include securing any Offeror owned tools or equipment and any on site storage being utilized. The FBI or partner on-site representative will provide all safety and security guidelines.

3.5 Offeror shall be liable for any damage to Government or partner property caused by the Offeror or their representatives. Any damages identified by the Offeror shall be immediately reported to the FBI or partner on-site representative.

3.6 The Offeror shall inspect and certify all new targeting systems are operating properly to ensure it is free of operational defects, the installation is complete, and the new equipment is ready for use. In addition a system commissioning to assure that installed system meets the requirements of the contract prior to the Government’s acceptance of system which will be witnessed by the Government and a written commissioning report be provided to the FBI by the Offeror.

3.7 Offeror shall provide all new components, completely assembled, installed and operational.

3.8 Utilities: Information regarding the utility specifications such as location, current available electrical services, and spare electrical capacity available will be provided to potential vendors during the site visit or within ten business days upon request. All new electrical and communication conduits and conductors shall be underground conduits installed per the National Electric Code in which the Offeror will not be authorized to direct bury any power and/or signal conductors.

3.8 Disposal: The Offeror is responsible for the removal and disposal of existing targeting systems and equipment being replaced. Disposal shall meet all Local, State, and Federal requirements. Prior to demolition of the old system and components, a disposal plan to include all required permitting will be presented to the FBI for approval. Also, the Offeror shall remove and dispose of all items relating to the installation of the new target system and equipment, such as (but not limited to) protective shipping containers and boxes.

4.0 TRAINING. The Offeror will be responsible to provide the necessary training to the FBI and partner personnel on the operation of the TTS and preventative maintenance of the system.

5.0 DELIVERY REQUIREMENTS. TTS with full-length Running Man and Knee Wall if required, shall be delivered to the specified location on a day and time approved by the FBI or partner representative.

6.0 WARRANTY.

6.1 The Offeror shall provide a three (3) year parts and labor manufacturer’s warranty in which the Manufacturer warrants products installed the Offeror or manufacturers’ representatives against defects of material and workmanship under normal use and service from the date of installation completion. A seven (7) year corrosion warranty for non-ballistic parts. Running Man components will be warranted for two (2) years.

7.0 OPERATION/MAINTENANCE MANUAL.

7.1 The Offeror shall provide the FBI and partner each with a copy of the manufacturer’s operations manual and maintenance manual electronically on a thumb drive, prior to acceptance. One additional copy is to be provided for tower use in which all pages are laminated and enclosed in a notebook.
8.0 GENERAL INFORMATION.

8.1 All TTS and Running Man components and equipment identified within this SOW must be new. Refurbished items are NOT authorized.

8.2 Certifications: The Offeror must be certified by the manufacturer as an approved and certified installer of the TTS and Running Man. Proof of certification must be provided prior to commencement of work. All certification requirements identified within this SOW shall be maintained throughout the life of this contract, to include the warranty period identified in Section 6.0, Warranty of this SOW.

8.3 Normal Working Hours

8.3.1 Normal working hours for the Offeror at the specified firing range complex shall be between 8 a.m. and 5 p.m., weekdays. It shall be incumbent upon the Offeror when interviewing or otherwise communicating with FBI or partner personnel to recognize their lunch, break, and end-of-day schedule. Offeror must coordinate with the FBI or partner representative to ensure the range will be closed during the installation period.

8.3.2 No work within the specified firing range complex will be permitted on Saturdays, Sundays, or Holidays, except as requested by the Offeror and approved in advance by FBI or partner personnel to minimize disruption to operations and training.

9.0 SECURITY

9.1 The FBI and partner shall provide access, and to make provisions for the Offeror to enter upon the project site as required to perform work under this scope.

9.2 All persons entering the property for the purpose of working under this contract shall comply with the security regulations of the FBI and partner which will be provided and briefed to the Offeror by the FBI or partner prior to the scheduled installation date. The Offeror Administrator shall make it a specific provision of this contract that regulations are accepted and obeyed. The FBI and partner reserve the right to exclude or remove from site any employee or agent of the Offeror or subcontractors that are deemed incompetent, careless, insubordinate, or who are otherwise objectionable, or fails to meet and obey security requirements. Persons who cannot produce acceptable identification will not be allowed to enter the complex.

9.3 The Offeror expressly agrees NOT to publish, disclose, or disseminate in any form findings, recommendations, work products, or information relating to the services with the FBI and partner without written approval of both the FBI and partner. No photography of the project will be authorized.

9.4 All information developed as a result of this contract is for the exclusive use of the FBI and partner. All work product, including but not limited to reports, work papers, internal memoranda, drawings and other documents produced under this contract, and all copies thereof, shall become the property of the FBI and partner.

9.5 The Offeror shall furnish to the FBI and partner name, current address, social security number, and date and location of birth of his/her employees working within the firearms range complex.

9.6 Decisions concerning granting of access are made on a case-by-case basis. The Offeror is cautioned that individuals with criminal histories such as arrest records, felony convictions, misdemeanor convictions, or those addicted to or abusive of alcohol or chemicals are likely to be denied access to the site. The exact nature, extent, and time passed since these problems existed influence all access decisions.

9.7 Illegal or undocumented aliens are subject to exclusion, and their identities may be referred to other law enforcement agencies for appropriate action.

9.8 Clearance to move about within the buildings shall be limited to those areas where work is actually being performed. Individuals wandering from work areas will be subject to revocation of access privileges.

9.9 On-site parking for Offeror vehicles will be designated.
SECTION 114860.1

SHOOTING RANGE EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Commercial, Law Enforcement and Military Range Equipment.

B. Range Safety Products:
   1. Ballistic Granular Rubber Bullet Traps
   2. Ballistic Granular Rubber Materials

1.2 RELATED SECTIONS

A. Section 02300 - Earthwork.

B. Section 03300 - Concrete.

1.3 REFERENCES


D. National Rifle Association (NRA) of America - The NRA Range Source Book.

E. Environmental Protection Agency (EPA) - Best Management Practices for Lead at Outdoor Shooting Ranges.


G. ASTM E90 - Laboratory Sound Transmission Class

1.4 SUBMITTALS

A. LEED Submittals/Requirements.

   1. MrC2- Construction Waste Management – provide certification that construction and demolition waste has been diverted from landfills and incineration via reuse or recycling.

   2. MrC3- Material Re-Use – Provide information on the percentage of construction materials that have been salvaged from other structures.

   3. MrC4- Recycled Content – Provide information on the percentage of materials used on the project that have been made from recycled content materials, both pre-consumer and post-consumer recycled materials.

   4. MrC5- Regional Materials – Provide documentation of materials that are both harvested and manufactured within a 500-mile radius of the construction site.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
1. Preparation instructions and recommendations.
3. Storage and handling requirements and recommendations.
4. Installation methods.

C. Shop Drawings: Submit shop drawings prepared by the manufacturer showing plans, sections, elevations, layouts, profiles, and product component locations, including anchorage, bracing, fasteners, accessories, and finishes.

D. Manufacturer’s Certificates: Certify products meet or exceed specified requirements.

E. Installers Qualifications. Certify installer meet or exceed specified requirements.

F. Closeout Submittals: Provide manufacturer’s maintenance and operation instructions that include recommendations for periodic checking and adjustment of systems and maintenance of all components. One-year warranty on manufacturing defects.

1.5 QUALITY ASSURANCE

A. Qualifications: Range Equipment provider shall have a minimum of 5 years’ experience.

B. Installer Qualifications: Minimum 5 years’ experience installing similar equipment and acceptable to the equipment manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer’s unopened packaging until ready for installation.

B. Store products to allow for inspection and measurement of quantity or counting of units.

C. Protect materials from damage from liquids from freezing.

D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

E. Store materials protected from exposure to rain, snow or other harmful weather conditions

1.7 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer’s absolute limits.

PART 2 PRODUCTS

2.1 SYSTEM DESIGN AND INSTALLATION SERVICES

A. Provide the following services in connection with the delivery of ballistic range systems:
1. Customer Support: Provide knowledgeable customer service familiar with the
requirements of live fire shooting environments.

2. Design: Provide design staff experienced in designing live fire environments, and the products used in those environments.

3. Technical Support: Technical personnel shall have the experience and knowledge to provide equipment installation, on-site technical support, new equipment training, and operations and maintenance guidance.
   a. Installation.
   b. On-site Technical Support.
   c. Maintenance Programs.

2.2 RANGE EQUIPMENT DESIGN CRITERIA:

A. Granular Ballistic Rubber Bullet Traps

1. Pistol and Rifle Rated up to .50 BMG: Dimensions shall be as indicated on the drawings. Armor Piercing Incendiary (API), Incendiary or tracer rounds are not permitted for use with the granular rubber bullet trap.

2. The Granular Ballistic Rubber Bullet Trap must meet the following specifications:
   a. Contain/minimize fragmentation of jacketed, semi-jacketed and non-jacketed bullets, bird shot (7.5 and larger), slug projectiles from shotguns and .50 caliber Browning Machine Gun. All projectiles must have a minimum muzzle velocity of 700 (FPS).

   b. Bullet trap to provide a storm water filtration system as an integrated part of the bullet trap.

   c. Outdoor granular ballistic media must meet the following requirements:

      1. Product must be ground to a size capable of passing a 1” screen but not passing a 3/8” screen.

      2. All rubber must originate from used tires acquired within the United States.

      3. Product must have been tested for ballistic application and rubber pieces must have a ballistic durometer reading supporting ballistic requirements and site conditions.

      4. Products such as vulcanized rubber blocks or chopped conveyer belts containing fluff or products containing pieces larger than ¾” size are not acceptable for use with the granular rubber bullet trap.

      5. Rubber enhancer treatment of fire retardant is required to reduce the risk of friction caused fires.
d. Outdoor/Indoor granular ballistic bullet trap must not include any moving or operational parts requiring maintenance.

e. Bullet trap base must be designed to minimize contact between the granular ballistic rubber and underlying soil.

f. Bullet trap must be designed to incorporate site specific civil and grading requirements to maximize drainage and allow for easy maintenance and recycling of lead.

B. Replacement Granular Ballistic Rubber Media.

1. Product: Granular Ballistic Rubber. Only approved materials should be used to supplement or as replacement for the outdoor granular ballistic bullet trap. Owner/Purchaser should consult with the bullet trap vendor to ensure appropriate depths and quantities of granular ballistic rubber are being provided to meet the training requirements of the range. The granular ballistic rubber must meet the following criteria:

   a. Product must be ground to a size capable of passing a 1” screen but not passing a 3/8” screen. Product must be ambiently ground on an Eldan Rasper or a MAC Saturn Grizzly.

   b. All rubber must originate from used tires acquired within the United States.

   c. Product must have been tested for ballistic application and rubber pieces must have a ballistic durometer reading supporting ballistic requirements and site conditions.

   d. Products such as vulcanized rubber blocks or chopped conveyer belts containing fluff or products containing pieces larger than ¾” size are not acceptable for use with the granular rubber bullet trap.

   e. Rubber enhancer treatment of calcium carbonate powder is required to reduce the risk of friction caused fire.

C. Outdoor Automated Turning Target System

1. Target Assembly

   a. Product will be stand mounted V-nose target system.

   b. Target system will utilize electric motors for turning mechanisms only. Pneumatic systems are not acceptable.

   c. Mounting stand Powder coated grey and made from mild steel

   d. Drive mechanism is protected from damage via integral self-resetting stainless steel overload clutch assembly

   e. Target will provide full 360-degree operation with teasing, random motion, 90,180, 270, and 360 bi-directional movements.

   f. AR 500 plating on components exposed to direct ballistic impact

   g. Housing and motor tray are 304 stainless steel for a long-lasting corrosion free unit

   h. Long life stainless clamp assembly, compression spring and main shaft

   i. 304 Stainless target hoop provides a toolless removal take down design for quick change out or lowering to clear range for Running man or other training

   j. Jaw type clamp assembly holds target material up to ¼” firmly and operated with one hand

   k. Nema-4 electrical enclosures for down range power supply cabinets are protected by metal shrapnel cover.

   l. Class 1 Surge protection both down range and up range cabinets for lightning
mitigation.

m. EMI filter in downrange and up range cabinets.
n. Individual isolated power supply per target turner.
o. Tactical lighting (red/blue flash) and white individual target illumination for low light training

2. Target Control System
a. Multiple control methods for targets
   • Rechargeable tactile remote control with clearly marked buttons and lanyard
   • Range is controlled via touch screen console and provides programming up to 10 users and 100 drills
   • Wi-Fi control allows the use of a smart phone or tablet to control main console
   • Single button, rechargeable, small quick stop remote(s) for range safety officers to put all targets on edge
b. Control screen wall or desk mounted includes 9.7” touch screen for programming, saving, manual operation and direct control of drill operations.
c. Wall mounted charging station for remotes included.
d. Control screen can be accessed with included long range Wi-Fi access point through smart devices such as tablets or smart phone (password protected if needed)
e. Access point (Wi-Fi) includes class 3 surge protection devices.

PART 3-EXECUTION

3.1 EXAMINATION

A. Granular ballistic bullet trap should be inspected upon installation with confirmation of ballistic media depth and material.

B. Granular ballistic rubber media- Inspect materials are free from paper, metal, fluff, dirt, oil and grease.

C. Range equipment vendor to provide training on maintenance of bullet trap and granular ballistic rubber material.

D. Upon each course of fire, granular rubber media should be inspected and maintained with raking. Manufacturer to provide Operations & Maintenance procedures for the Granular Rubber Bullet Trap.

E. Operations Manuals to be provide for the Turning Target System

END OF SECTION
PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Countertops for architectural cabinet work.

1.02 REFERENCE STANDARDS
   B. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.
   C. PS 1 - Structural Plywood; 2009.

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Manufacturer's data sheets on each product to be used, including:
      1. Preparation instructions and recommendations.
      2. Storage and handling requirements and recommendations.
      3. Specimen warranty.
   C. Shop Drawings: Complete details of materials and installation; combine with shop drawings of cabinets and casework specified in other sections.
   D. Selection Samples: For each finish product specified, color chips representing manufacturer's full range of available colors and patterns.

1.04 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.

PART 2 PRODUCTS
2.01 COUNTERTOPS
   A. Plastic Laminate Countertops: High-pressure decorative laminate (HPDL) sheet bonded to substrate.
      1. Laminate Sheet: NEMA LD 3, Grade HGS, 0.048 inch nominal thickness.
         a. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
         b. Finish: Matte or suede, gloss rating of 5 to 20.
         c. Surface Color and Pattern: As selected by Architect from the manufacturer's full line.
      2. Exposed Edge Treatment: Square, substrate built up to minimum 1-1/4 inch thick; covered with matching laminate.

2.02 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.

2.03 FABRICATION
   A. Fabricate tops 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 3" grommet and plastic cover. Location by architect.

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 INSTALLATION
A. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
B. Attach plastic laminate countertops using screws with minimum penetration into substrate board of 5/8 inch.
C. Seal joint between back/end splashes and vertical surfaces.

3.03 CLEANING
A. Clean countertops surfaces thoroughly.

3.04 PROTECTION
A. Protect installed products until completion of project.
B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION
SECTION 12 48 13
ENTRANCE FLOOR MATS AND FRAMES

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Carpet mat.

1.02 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data indicating properties of walk-off surface, component dimensions.
   C. Samples: Submit two samples, 12 by 12 inch in size illustrating pattern, color, finish, and edging.

PART 2 PRODUCTS
2.01 MATS
   A. Carpet Mat: Cut nylon pile permanently bonded to vinyl backing; 60 inch wide by 60 inch long with one inch black matching vinyl border on all edges.
      1. Colors: To be selected by Architect from manufacturer's standard range.

PART 3 EXECUTION
3.01 INSTALLATION
   A. Install walk-off surface after cleaning of finish flooring.

END OF SECTION
PART 1 - GENERAL
1.1 GENERAL
   A. General Conditions and Division 01 apply to this Division.

1.2 SCOPE
   A. Includes -
      1. Furnish all labor, materials, and equipment necessary for the completion of the mechanical and plumbing scope of work.
      2. Furnish and install all motors specified in this Division and be responsible for the proper operation of electrical powered equipment furnished by this Division.
      3. Furnish exact location of electrical connections and information on motor controls to Division 26.
      4. Mechanical Contractor shall obtain the services of independent Test and Balance Agency.
      5. Placing the air conditioning, heating, ventilating, and exhaust systems into full operation and continuing their operation during each working day of testing and balancing.
      6. Making changes in pulleys, belts, and dampers, or adding dampers, as required for the correct balance as recommended by Balancing Contractor at no additional cost to Owner.
      7. Air balance, final adjustment and test run.
      8. The satisfactory performance of the completed systems is a requirement of this specification.
   B. Related Work Specified Elsewhere
      1. Conduit, line voltage wiring, outlets, and disconnect switches specified in Division 26.
      2. Magnetic starters and thermal protective devices (heaters) not a factory mounted integral part of packaged equipment are specified in Division 26.

1.3 SITE OBSERVATION
   A. The Contractor shall examine the site and understand the conditions which may affect the performance of work of this Division before submitting proposals for this work.
   B. No subsequent allowance for time or money will be considered for any consequence related to failure to examine existing site conditions.

1.4 DRAWINGS
   A. Mechanical drawings show general arrangement of piping, ductwork, equipment, etc; however, locations are to be regarded as shown diagrammatically only. Follow as closely as actual building construction and work of other trades will permit.
   B. Because of the small scale of mechanical drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Investigate existing structural and finished conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions.
      If changes in location of piping, equipment, ducts, etc. are required due to lack of coordination of work under this division, such changes shall be made without charge. Contractor shall review drawings with local and state agencies having jurisdiction and any changes required by them shall be brought to the attention of the Engineer prior to bidding or commencement of work. It is understood that while Drawings are to be followed as closely as circumstances permit, this Division will be held responsible for the installation of systems according to the true intent and meaning of the Contract Documents. Anything not clear or in conflict will be explained by making application to the Engineer in writing. Should conditions arise where
certain changes would be advisable, secure Owner's and Engineer approval for these changes before proceeding with work.

1.5 COORDINATION OF WORK:

A. Coordinate work of various trades in installing interrelated work. Before installation of mechanical items, make proper provision to avoid interferences in a manner approved by Engineer. Changes required in work specified in Division 22 and 23 caused by neglect to secure approval shall be made at no cost to Owner.

B. Arrange piping, ductwork, and equipment to permit ready access to valves, unions, starters, motors, control components, and to clear openings of doors and access panels. Contractor shall provide all necessary access doors and/or panels to provide complete access to all mechanical equipment, dampers, or accessories. Doors for dampers, etc. shall be minimum 12” x 12” and doors for mechanical equipment shall be minimum 24” x 24”.

C. Furnish and install inserts and supports required by Division 22 and 23 unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions involved in sufficient time to be built into the construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne by Contractor.

D. Be responsible for required digging, cutting, and patching incident to work of this Division and make required repairs afterwards to satisfaction of Owner and Architect. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.

1. Patch and repair walls, floors and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.

2. This Division shall bear expense of cutting, patching, repairing, and replacing of work of other Divisions because of its fault, error, tardiness, or because of damage done by it.

3. Provide the necessary cutting, patching, repairing, and replacing pavements, sidewalks, etc. to permit installation of work of this Division.

E. Adjust locations of piping, ductwork, equipment, etc. to accommodate work from interferences anticipated and encountered. Determine exact route and location of each pipe and cut prior to fabrication.

1. Make offsets, transitions, and changes in direction of piping, ductwork, and electrical raceways as required to maintain proper head room and pitch of sloping lines whether or not indicated on Drawings.

F. Slots and openings through floors, walls and roofs shall be provided by this Division.

G. This Contractor shall schedule his work, store his equipment and materials, and work in harmony with other Contractors so as to not delay or jeopardize the construction.

H. This Division shall coordinate with electrical contractor to insure that all required components of control work are included and fully understood. Any discrepancies shall be called to the attention of the Engineer before completion of bids. No additional cost shall accrue to the Owner as a result of lack of such coordination.

1.6 EQUIPMENT & MATERIALS:

A. Requests for substitution shall be received in writing a minimum of seven days prior to bidding. Prior acceptance shall be by Manufacturer's name only. Items not listed in this specification or subsequent addendums shall not be considered. No oral approvals will be acceptable. Manufacturers listed in this specification are acceptable only for items listed. All other items manufacturer wishes to bid must be prior approved. All equipment shall be subject to final review in accordance with "Project Submittals".

B. Product Approvals -
1. If approval is received to use other than specified items, responsibility for specified capacities and insuring that items to be furnished will fit space available lies with this Division.

2. In the event other than specified equipment is used and will not fit job site conditions, this Division assumes responsibility for replacement with items named in Specification.

C. Use domestic made pipe, pipe fittings, and motors on Project.

D. Motor and equipment name plates as well as applicable UL labels shall be in place when Project is turned over to Owner.

E. Insure that items to be furnished fit spaces available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents. Do not scale off drawings.

F. All materials shall be of the best commercial quality obtainable, consistent with specified materials and for the purpose or function intended. Materials shall be new unless specifically excepted.

G. Equipment catalog or model numbers shown define the basic equipment types and quality standard only. Catalog numbers shall not be considered as all inclusive and shall be verified to include all devices, controls, operators, and appurtenances necessary for the satisfactory and complete operation of the equipment.

H. Follow manufacturer's directions in delivery, storage, protection, and installation of equipment and materials.
   1. Promptly notify Engineer in writing of conflicts between requirements of Contract Documents and Manufacturer's directions and obtain Engineer's written instructions before proceeding with work. Contractor shall bear all expenses arising from correcting deficiencies of work that does not comply with Manufacturer's directions or such written instructions.

I. Deliver equipment and material to site and tightly cover and protect against dirt, water, and chemical or mechanical injury but have readily accessible for inspection. Store items subject to moisture damage (such as controls) in a dry, heated space.

1.7 PROJECT SUBMITTALS:

A. Furnish complete catalog data for manufactured items of equipment to be used in the Work to for review within 15 days after award of Contract.

B. Submittal shall include, but not be limited to the following:
   1. equipment scheduled
   2. balancing contractor
   3. insulation
   4. grilles, and diffusers
   5. automatic temperature controls
   6. certificates of guarantee
   7. valves
   8. plumbing fixtures, accessories, and specialties
   9. any item for which more than one manufacturer is mentioned

C. Submit a minimum of five copies of data in binders and index in same order and name as they appear in Specification. - Optional: Provide electronic submittals. Electronic submittals shall be in .pdf format, and shall be compiled into a single file, with bookmarks for each piece of equipment.
1. State sizes, capacities, brand names, motor HP, electrical requirements, accessories, materials, gauges, dimensions, and other pertinent information.

2. List on catalog covers page numbers of submitted items.

3. Underline or highlight applicable data.

D. If material or equipment is not as specified or submittal is not complete, it will be rejected.

E. Catalog data or shop drawings for equipment which are noted as approved shall not supersede Contract Documents.

F. Review comments shall not relieve this Division from responsibility for deviations from Contract Documents unless attention has been called to such deviations in writing at time of submission, nor shall they relieve this Division from responsibility for errors in items submitted.

G. Check work described by catalog data with Contract Documents for deviations and errors.

H. All items other than first named specified equipment shall show and state all exceptions and deviations taken and shall include design calculations and drawing layouts.

I. The Contractor shall review the submittals prior to submission to make sure that the submittals are complete in all details. No submittal will be reviewed which does not bear the contractor's notation that such checking has been made.

J. No partial submittals will be considered unless approved by the Engineer.

K. Manufacturers' names shall be mentioned as acceptable prior to bidding.

L. Contractor shall verify equipment dimensions to fit the spaces provided with sufficient clearance for servicing the equipment.

M. Contractor shall review equipment submittals for compliance with schedules, specifications, and drawing plans and details. Equipment submittal shall show the proper arrangements to suit installation and maintenance such as motor location, access doors, filter removal, piping connections, etc.

N. Equipment submittal sheets shall be clearly marked indicating equipment symbol and exact selection of proposed equipment. Submittals shall clearly indicate name of manufacturer of each item.

O. For unacceptable items, the right shall be reserved to require the first named specified items.

P. Where submittals are sent with any of the above listed information missing or are incomplete they will be returned to the contractor unchecked to be completed and resubmitted. No additional time or money shall be allowed for failure to provide complete submittals on the first review.

Q. If an item requiring submittal review is ordered, purchased, shipped, or installed prior to the submittal review the item shall be removed from the job site and replaced with an approved item at contractors expense.

1.8 CLEANING & FINISHING:

A. Contractor shall, at all times, keep the premises free from waste material and rubbish. Upon completion of this Section of the work, Contractor shall remove all surplus materials and rubbish; clean all spots resulting from the mechanical work from hardware, floors, glass, walls, etc.; do all required patching up and repair all work of other trades damaged by Contractor under this Section of the work, and leave the premises in a clean orderly condition. Clean heating and cooling coils, internally and externally, and replace all air filters prior to final mechanical inspection. Remove rust, plaster, dirt, grease and oil before painting, insulating, or exposing to view the equipment, piping, ductwork, etc. in completed structure. Refinish any damaged surfaces and leave in proper working order at final completion.

1.9 EQUIPMENT SERVICING:

A. Prior to starting mechanical equipment, all motors, bearings and moving parts shall be properly oiled, greased and lubricated as required. Full and adequate maintenance service shall be
given and upon completion all equipment shall be cleaned and checked and placed in perfect condition for the Owner.

B. Amount and type of lubricant shall be per manufacturer's specification.

1.10 SUPERVISION:
A. The Contractor shall supervise and direct the work with his best skill and attention. He will be solely responsible for the means, methods, techniques, sequences and procedures of construction. The Contractor will be responsible to see that the finished work complies accurately with the Contract Documents.

1.11 SAFETY REGULATIONS:
A. Contractor shall provide equipment, supervision, construction, procedures, and everything necessary to assure safety of life or property.
B. Refer also to General Condition and Special Conditions for protection clauses.

1.12 LEAK DAMAGE:
A. Contractor shall be responsible for damages to the work of other Contractors or to the building, or to its contents, people, etc., caused by leaks in any of the equipment or piping installed by him through equipment or material failures, leaking joints or disconnected pipes, fittings, or by overflows and shall make at his own expense all repairs to fixtures, building interior, contents, paint, rugs, furniture, ceiling tile, and equipment so damaged.

1.13 TOOLS AND STORAGE OF EQUIPMENT:
A. The Contractor shall furnish all necessary tools, staging and whatever may be necessary for the installation of this work and shall at all times protect this work and others, and the materials to be used therein from damage by the weather, accident and other causes, and shall repair and make good any damage thus occurring.

1.14 WORKMANSHIP:
A. Workmanship shall be the best quality of its kind for respective industries, trades, crafts and practices and shall be acceptable in every respect to the Owner and Engineer. Nothing contained herein shall relieve the Contractor from performing good work, perfect in all details of construction.

1.15 TEMPORARY FACILITIES:
A. Furnishing of temporary water, space heating, sanitary facilities, drainage lines, light and power will be as specified in Division 01 General Conditions. Contractor shall arrange to bring facilities to required location of premises. All expenses involved shall be paid by the Contractor as described in General and Special Conditions.

1.16 PAINTING BY CONTRACTOR:
A. See section 09900 for painting requirements. See also section 22 and 23 for color code requirements.
B. Painting shall be by persons experienced in painting.
C. All exposed, insulated, and bare piping, equipment, metal stands and supports shall be painted as follows:
1. The prime coat on equipment shall be factory applied. The finish coats shall be applied under Section 09900 of these specifications.
2. All equipment which is to be furnished in finished painted condition by Contractor shall be left without mark, scratch or impairment to finish upon completion and acceptance of job. Any necessary refinishing to match original shall be done by Contractor. Do not paint over name plates, serial numbers or other identifying marks.
3. All new piping shall be painted as required in Section 22 and 23. Paint colors shall conform to color code requirements as specified "Identification of Piping and Equipment".
1.17 EQUIPMENT BASES:
A. Provide reinforced concrete bases under boilers, chillers, pumps, air handling units, and other equipment as necessary or as indicated on the drawings. Coordinate work with Division 03.
B. Bases shall be 6" high, above the finish floor. The base shall extend beyond the equipment 6" in all directions, where possible. Inserts and vibration isolation systems shall be provided and installed by the Mechanical Contractor at the time the concrete is poured to accommodate and anchor the equipment used. Coordinate with vibration isolation manufacturer’s requirements and Section 22 and 23. Provide a one inch beveled edge all around.

1.18 BELT GUARDS:
A. Shall be provided, properly enclosing each belt drive system. Guards shall be easily removable, constructed of expanded metal with suitable frames corresponding with SMACNA standard and with tachometer openings. Coordinate with equipment suppliers to avoid duplication of belt guards supplied with equipment. Guards shall comply with OSHA Regulations.

1.19 ELECTRICAL WORK:
A. Power wiring to all electrically driven apparatus shall be done under the electrical contract. See Electrical Specifications.
B. Unless specifically noted otherwise on documents, Electrical Contractor shall furnish and install all magnetic starters including properly sized heaters, and disconnect switches as indicated on drawings or required by code.
C. The Contractor shall verify the proper operation of equipment furnished by him. Costs for repair, replacing, re-wiring and retesting shall be borne by the Contractor without additional costs to the Owner.
D. Motors shall be as specified.

1.20 CONTRACTOR’S USE OF BUILDING EQUIPMENT:
A. The Contractor may use equipment such as electric motors, fans, filters, etc. when permanently installed as part of the project and with the written permission of the Owner. As each piece of equipment is used, maintenance procedures approved by the manufacturer shall be followed, a careful record shall be kept of the time used, maintenance procedure following and of any difficulty experienced with equipment. The Contractor’s records on the equipment shall be submitted to the Owner upon acceptance of project. All fan belts and filter media shall be new at the beginning of the Mechanical System Operating Test Run and System Balancing. Wearing surfaces (such as bearings) shall be carefully inspected just prior to acceptance. Any excessive wear noted shall require replacement.

1.21 INSPECTION NOTICE:
A. The following is a basic list of guideline items so that the Architect, district building inspector/Owner’s representative can be at job site for these inspections as the building progresses. Mechanical Contractor shall inform these people one week in advance of test time.
1. Water tests on all sewer, waste, and rainwater piping prior to piping being concealed.
2. Pressure tests on all water service piping.
3. Pressure tests on hot, chilled, and condenser water supply and return piping.
4. All duct work prior to installation of finished ceilings, including ductwork pressure testing.
5. The initial start-up of mechanical equipment, etc.
6. Any changes or problems occurring at job site.
7. Inspect all vent flashings on roof prior to roofing.
8. Periodic inspection at their discretion will be made to insure compliance to Contract Documents and codes. Contractor shall provide ladders, access and other assistance as requested during inspections.
9. Control piping pressure tests.
10. Final inspection before giving approval for final payment.

1.22 EXCAVATION AND BACKFILLING:
A. Trench for the underground gas pipe line shall be excavated to the required depth. Rocks, trash, or other debris will not be allowed in trench or backfill and shall be removed before pipe is laid in place. After piping has been tested, inspected and approved, piping shall be backfilled. All landscaping, concrete, etc., damaged by this Contractor shall be replaced by him to the satisfaction of Owner's Representative.

1.23 WARRANTY GUARANTEE:
A. The Contractor shall warrant all materials and equipment to be of quality consistent with specifications as represented by manufacturer's published data.
B. The Contractor shall guarantee that the installation and operation of the equipment shall be free from defects for a period of one year beginning at date of substantial completion and acceptance. The Contractor shall replace or repair any part of the installation that is found to be defective or incomplete within the guarantee period.
C. The one year guarantee on equipment and systems shall commence when equipment has been demonstrated to work and has been accepted. (Example: If an equipment item fails to perform and it takes 9 months after substantial completion to correct, then the guarantee shall commence after the item has been demonstrated to perform and has been accepted.)
D. Substantial completion and acceptance in no way relieves the Contractor from providing the systems and equipment as specified.

1.24 COMPLETION SCHEDULE:
A. Start-up and verification of basic equipment items shall be done prior to the date of substantial completion with sufficient time to allow balancing and adjusting to be performed.
B. At the time of the final inspection a date shall be agreed upon for completion of any remaining items. At least double the estimated cost of the work will be withheld from the Contractor's payment.

1.25 CODE REQUIREMENTS, FEES, AND PERMITS
A. The work shall be installed in accordance with the following applicable codes, ordinances and standards unless otherwise specified. The codes and standards shall include but not be limited to and be of the latest and current editions.
1. American Boiler and Affiliated Industries (AB and AI)
2. American Gas Association (AGA)
3. Air Movement and Control Association (AMCA)
4. American National Standards Institute (ANSI)
5. Air Conditioning & Refrigeration Institute (ARI)
6. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) - ASHRAE 90.1-2010
7. American Society of Mechanical Engineers (ASME)
9. American Standards Association (ASA)
10. American Water Works Association (AWWA)
11. American Welding Society (AWS)
12. Associated Air Balance Council (AABC)
13. Heat Exchange Institute (HEI)
14. Hydraulic Institute (HI)
15. BR
16. National Electrical Code (NEC)
17. National Fire Protection Association (NFPA)
18. Sheet Metal and Air Conditioning contractors National Association (SMACNA)
19. Underwriters Laboratories (UL)
21. International Mechanical Code (IMC) 2012 Ed
22. International Plumbing Code (IPC) with Utah Amendments 2012 Ed
24. Utah State Safety Orders (OSHA/UOSH)
25. Utah Fire Rating Bureau
26. Utah Boiler and Pressure Vessel Law
27. Utah Air Conservation Regulations/Waste Disposal regulations.
28. ASHRAE Ventilation STD.62-2010

B. Should drawings conflict with any code, the code shall govern. If drawings and specifications establish a quality exceeding the code, the drawings and specifications shall govern. If conflicts do exist among the drawings, specifications and codes, the same shall be brought to the attention of the Engineer in writing prior to bidding, otherwise Contractor shall comply with applicable codes.

C. The latest edition of all codes shall be used.

D. Contractor shall give all notices, obtain all necessary permits, file necessary plans, prepare documents and obtain approvals, and pay all fees required for completion of the mechanical and plumbing work outlined in this Division of the specifications and shown on the Mechanical Drawings.

1.26 OPERATION AND MAINTENANCE MANUAL FOR MECHANICAL SYSTEMS

A. Upon completion of work and before final payment, Contractor shall furnish and deliver to the Owner, through the Engineer, installation, operation and maintenance manuals with instructions for all new materials and equipment used in the building. The contractor shall provide three (2) hard copies of the manuals, and two (2) electronic copies of the manuals on CD or USB drive. Electronic information shall be .PDF format. The CD’s shall include the same information as the hard copies, and shall be organized in the same manner with a table of contents and electronic bookmarks for each section. CD or USB drive itself shall be labeled the same as the hard copies of the manuals. Manuals may be assembled by the Div 22 or 23 contractor, by the TAB contractor, or by a third party such as Wasatch Manuals at Office: (801) 849-0442, Cell: (801) 674-9926, or Email: wasatchmanuals@gmail.com.

B. Bind Operation and Maintenance Manual for Mechanical Systems in a hard-backed three ring binder with strong sturdy cover. The project name shall be on the spine and the front of the binder. The front of the binder shall include the following information:

OPERATION
AND
MAINTENANCE
MANUAL
for MECHANICAL SYSTEMS of
(Name of Project)
(Location of Project)
C. Introduction
1. Title page including name of project, project number, date awarded and date of substantial completion.
2. Second page shall contain the names, phone numbers and addresses of Architect, Consulting Engineers, Mechanical Contractor, and General Contractor.
3. Third page shall include a Table of Contents for the entire manual.

D. First Section - Summary information including:
1. First page shall contain the contractor’s warranties.
2. Second page shall contain a list of names, addresses and phone numbers of contractors and all sub-contractors and work to which each was assigned.
3. Final page or pages shall contain an equipment list. The list shall contain each item of equipment or material for which a submittal was required giving ID or tag no as contained on the drawings make and model No. Serial No. Identification No. Location in building, function along with the name, address, and phone number of the supplier.

E. Second Section - Mechanical Equipment O&M data including:
1. Mechanical maintenance schedule, including a lubrication list when necessary.
2. Mechanical Equipment Operation and Maintenance Data including:
   a. Equipment descriptions
   b. Detailed installation instruction, operating and maintenance instructions. Instructions include in a step by step manner identifying start-up, operating, shutdown and emergency action sequence sufficiently clear so a person unfamiliar with the equipment could perform its operations.
   c. Equipment drawings, performance curves, operating characteristics, etc.
   d. Name addresses and phone number of manufacturer, fabricator and local vendor clearly printed or stamped on cover.
   e. Complete parts listing which include catalog number, serial number, contract number or other accurate provision for ordering replacement and spare parts.
   f. Certified drawings, where applicable, showing assembly of parts and general dimensions.
3. Approved Mechanical submittals

F. Third Section - Plumbing Equipment O&M data including:
1. Section shall contain general product catalog cuts, as well as exploded view drawings with parts lists for all valves and other items with multiple parts.
2. Approved Plumbing submittals

G. Fourth Section - Controls O&M data including:
1. Sequence of Operation
2. Description of each operating system included location of switches, breakers, thermostats, and control devices. Provide a single line diagram, showing set points, normal operating parameters for all loads, pressures, temperatures and flow check points; Describe all alarms and cautions for operation.
3. Provide schematic control diagrams, panel diagrams, wiring diagrams, etc. for each separate fan system, chilled water system, hot water system, exhaust air system, pumps, etc. Each control diagram shall show a schematic representation of mechanical
equipment and location of start-stop switches, insertion thermostats, thermometers, pressure gauges, automatic valves, etc. The correct reading for each control instrument shall be marked on the diagram.

H. The Fifth Section shall contain a complete air and water test and balance report. The report shall contain the name, address and phone number of the agency. It shall also include:
   1. Floor plans showing all air openings and thermometer locations clearly marked and cross referenced with data sheets. Format may be 8 1/2 x 11 or 11x14 if legible.
   2. Data sheets showing amount of air and water at each setting. See sections 230593.
   3. List of equipment with date of last calibration.

I. Drawings and reproducible masters of drawings as required in individual specification sections, are not to be bound in volumes but are to be delivered separate with the maintenance manuals.

J. See the following checklist for assistance in assembling manual:

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
<th>Y, N, or NA</th>
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<tbody>
<tr>
<td>1.</td>
<td>3 ring heavy duty binder with Project name, number and date on cover and project name on spine.</td>
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<td>2.</td>
<td>O&amp;M manual on CD (with label on CD matching label on manual). Electronic copy shall be a PDF file with bookmarks that match the tabs in the hard copy.</td>
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<td>3.</td>
<td>Title Page [including project name, number, address, date awarded, date of substantial completion]</td>
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<td>4.</td>
<td>Second Page Contact List [including architect (if applicable), mechanical engineer, mechanical contractor, and general contractor (if applicable)]</td>
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<td>5.</td>
<td>Table of Contents</td>
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<td>B. Mechanical’s Sub-contractor List</td>
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<td>C. Vendor List</td>
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<td>D. Equipment List</td>
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<td>A. Maintenance Schedule (including lubrication list)</td>
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<td>B. Mechanical Equipment O&amp;M Data (for each piece of equipment submitted) per specifications</td>
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<td>C. Approved mechanical submittals</td>
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<td>A. Plumbing equipment O&amp;M data</td>
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<td><strong>Section 4 - Controls</strong></td>
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<td>A. Sequence of Operation</td>
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1.27 OPERATION AND MAINTENANCE INSTRUCTIONS

A. Contractor shall instruct building maintenance personnel in the operation and maintenance of the installed mechanical systems utilizing the Operation and Maintenance Manual when so doing.

B. Minimum instruction periods shall be as follows -
   1. Mechanical - Two hours.
   2. Plumbing - Two hours.
   3. Temperature Control - Two hours.

C. Instruction periods shall occur before final site observation when systems are properly working and before final payment is made.

D. None of these instructional periods shall overlap each other.

E. An additional four hours of instruction will be provided by each contractor, after 60 days of system operation by owner to insure proper system operation and answer questions.

1.28 RECORD DRAWINGS

A. Contractor shall keep an up-to-date set of mechanical and plumbing drawings in his custody showing all changes in red, clearly defined and neatly drafted by him. At the end of construction, he shall turn these drawings over to the Engineer. Record drawings must be completed and submitted prior to final site observation.

PART 2 - PRODUCTS
(Not Used)

PART 3 - EXECUTION
(Not Used)

END OF SECTION 22 01 00
SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Sleeves.
   5. Escutcheons.
   6. Mechanical demolition.
   7. Equipment installation requirements common to equipment sections.

1.3 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, crawlspaces, and tunnels.
B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in 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. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS
A. Product Data: For the following:
   1. Dielectric fittings.
   2. Mechanical sleeve seals.
B. Welding certificates.

1.5 QUALITY ASSURANCE
A. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, “Welding and Brazing Qualifications.”
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
B. All materials, piping, etc. shall be new, and domestically made of the best commercial quality obtainable, consistent with specified materials and for the purpose or function intended unless specifically approved in writing prior to bid.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION
A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.
B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

PART 2 - PRODUCTS
2.1 PIPE, TUBE, AND FITTINGS
A. Refer to individual Division 22 and 23 piping Sections for pipe, tube, and fitting materials and joining methods.
B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS
A. Refer to individual Division 22 and 23 piping Sections for special joining materials not listed below.
B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
H. Solvent Cements for Joining Plastic Piping:
   1. ABS Piping: ASTM D 2235.
   2. CPVC Piping: ASTM F 493.
   3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   4. PVC to ABS Piping Transition: ASTM D 3138.

19386100 / UDC_FBI FIRING RANG & TRAINING FACILITY 22 05 00 - 2 COMMON WORK RESULTS FOR PLUMBING
2.3 DIELECTRIC FITTINGS
A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
B. Insulating Material: Suitable for system fluid, pressure, and temperature.
C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
   1. Available Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Eclipse, Inc.
      d. Epco Sales, Inc.
      g. Zurn Industries, Inc.; Wilkins Div.
      h. Prior Approved Equal.

2.4 MECHANICAL SLEEVE SEALS
A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Available Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
      e. Linkseal.
      f. Prior Approved Equal.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Carbon steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES
A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
D. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

2.6 ESCUTCHEONS
A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
B. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
2.7 GROUT
A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION
3.1 MECHANICAL DEMOLITION
A. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
   3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
   4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
   5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
C. Coordinate with controls contractor prior to removal of any control devices.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS
A. Install piping according to the following requirements and Division 22 and 23 Sections specifying piping systems.
B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Drawings do not show every offset, or bend that may be required. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
F. Install piping to permit valve servicing.
G. Install piping at indicated slopes.
H. Install piping free of sags and bends.
I. Install fittings for changes in direction and branch connections.
J. Install piping to allow application of insulation.
K. Select system components with pressure rating equal to or greater than system operating pressure.
L. Install escutcheons for penetrations of walls, ceilings, and floors where indicated on drawings and where penetrating will be visible to public.
M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.
N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
Q. Verify final equipment locations for roughing-in.
R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION
A. Join pipe and fittings according to the following requirements and Division 22 and 23 Sections specifying piping systems.
B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

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

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
   3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   5. PVC Nonpressure Piping: Join according to ASTM D 2855.
   6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install 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.

D. Install equipment to allow right of way for piping installed at required slope.

END OF SECTION 22 05 00
SECTION 22 05 23
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 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following general-duty valves:
   1. Bronze ball valves.
   2. Ferrous-alloy ball valves.
   3. Ferrous-alloy butterfly valves.
   4. Bronze check valves.
   5. Ferrous-alloy wafer check valves.
   6. Chainwheel actuators.
B. Related Sections include the following:
   1. Division 22 and 23 Section "Mechanical Identification" for valve tags and charts.
   2. Division 22 and 23 Section "HVAC Instrumentation and Controls" for control valves and actuators.
   3. Division 22 and 23 piping Sections for specialty valves applicable to those Sections only.

1.3 DEFINITIONS
A. The following are standard abbreviations for valves:
   1. CWP: Cold working pressure.
   2. EPDM: Ethylene-propylene-diene terpolymer rubber.
   3. NRS: Nonrising stem.
   4. OS&Y: Outside screw and yoke.
   5. PTFE: Polytetrafluoroethylene plastic.
   6. SWP: Steam working pressure.
   7. TFE: Tetrafluoroethylene plastic.

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

1.5 QUALITY ASSURANCE
A. ASME Compliance: ASME B31.9 for building services piping valves.
   1. Exceptions: Domestic hot- and cold-water piping valves unless referenced.
B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

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 MANUFACTURERS
   A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
      1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VALVES, GENERAL
   A. Refer to Part 3 "Valve Applications" Article for applications of valves.
   B. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
   C. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.
   D. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.
   E. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
   F. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
   G. Valve Actuators:
      1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
      2. Gear Drive Operator: For quarter-turn valves NPS 8 and larger.
      3. Handwheel: For valves other than quarter-turn types.
      4. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
      5. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.
   H. Valves in Insulated Piping: Valves shall have 2-inch stem extensions and the following features:
      1. Gate Valves: Shall be rising-stem type.
      2. Ball Valves: Shall have extended operating handle of non-thermal-conductive material, protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation, and memory stops that are fully adjustable after insulation is applied.
         a. Manufacturers: NIBCO Nib-seal handle extension or a comparable product by one of the following:
            1) Conbraco Industries, Inc.; Apollo Div.
            2) American.
3) Crane.
4) Grinnel.
5) Kitz.
6) Watts.
7) Prior approved equal.

3. Butterfly Valves: Shall have extended necks.


J. Valve Grooved Ends: AWWA C606.

K. Solder Joint: With sockets according to ASME B16.18.
   1. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.

L. Threaded: With threads according to ASME B1.20.1.

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

2.3 BRONZE BALL VALVES

A. Bronze Ball Valves, General: MSS SP-110 and have bronze body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded or solder ends, and blowout-proof stems.

B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: Chrome-plated bronze ball and bronze stem and; reinforced TFE seats; threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing, solder or threaded ends; and 150 psig SWP 600-psig CWP rating.

1. Manufacturers: NIBCO Model S-585-70 or T-585-70, or a comparable product by one of the following:
   a. NIBCO Model S-585-70 or T-585-70
   b. American Valve, Inc.
   d. Crane Co.; Crane Valve Group; Jenkins Valves.
   e. Crane Co.; Crane Valve Group; Stockham Div.
   f. Grinnell Corporation.
   g. Kitz Corporation of America.
   h. NIBCO INC.
   i. Watts Industries, Inc.; Water Products Div.

C. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel vented ball and stem, reinforced TFE seats, threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing, soldered or threaded ends; 150 psig SWP and 600-psig CWP ratings.

1. Manufacturers: NIBCO Model S-585-70-66 or T-585-70-66, or a comparable product by one of the following:
   b. American Valve, Inc.
   d. Crane Co.; Crane Valve Group; Jenkins Valves.
   e. Crane Co.; Crane Valve Group; Stockham Div.
   f. Grinnell Corporation.
2.4 FERROUS-ALLOY BALL VALVES

A. Ferrous-Alloy Ball Valves, General: MSS SP-72, with ASTM A-216 Type WCB, carbon-steel body; ASTM A-351, Type CF8M vented stainless-steel ball; and ASTM A-276, Type 316 stainless-steel stem; fire rated according to API 607 (4th edition); and having flanged ends and blowout-proof stem.

B. Class 150, Full-Port, Ferrous-Alloy Ball Valves: Split-body construction, carbon-filled TFE seats; 285 psig CWP rating.

1. Manufacturers:
   a. NIBCO Model F-515-CS-F-66-FS.
   b. American Valve, Inc.
   d. Cooper Cameron Corp.; Cooper Cameron Valves Div.
   e. Crane Co.; Crane Valve Group; Stockham Div.
   f. Foster Valve Co.
   g. Hammond Valve.
   h. Jomar International, LTD.
   i. Kitz Corporation of America.
   j. Milwaukee Valve Company.
   k. Watts.

2.5 FERROUS-ALLOY BUTTERFLY VALVES

A. Ferrous-Alloy Butterfly Valves, General: MSS SP-67, for bubble-tight shutoff, extended-neck for insulation, disc and lining suitable for potable water, unless otherwise indicated, and with the following features:

   1. Full lug, grooved and flanged valves shall be suitable for bi-directional dead end service at full rated pressure without the use or need of a downstream flange. Valves NPS 12 and smaller shall not have exposed stem to disc fasteners and no exterior mounted fasteners to hold the liner.

   2. Valve sizes NPS 2 through NPS 6 shall have lever lock operator; valve sizes NPS 8 and larger shall have weatherproof gear operator.

B. Single-Flange, 150-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one- or two-piece Type 416 stainless-steel stem, bronze bushing, aluminum-bronze disc, and phenolic-backed EPDM seat (liner) attached to the body.

1. Manufacturers: NIBCO Model LD-1000-5, or a comparable product by one of the following:
   b. Cooper Cameron Corp.; Cooper Cameron Valves Div.
   c. Crane Co.; Crane Valve Group; Center Line.
   d. Crane Co.; Crane Valve Group; Jenkins Valves.
   e. Crane Co.; Crane Valve Group; Stockham Div.
f. Dover Corp.; Dover Resources Company; Norriseal Div.
g. General Signal; DeZurik Unit.
h. Grinnell Corporation.
i. Hammond Valve.
j. Kitz Corporation of America.
k. Legend Valve & Fitting, Inc.
l. Metraflex Co.
m. Milwaukee Valve Company.
n. Mueller Steam Specialty.
o. Process Development & Control.
p. Red-White Valve Corp.
q. Techno Corp.
r. Tyco International, Ltd.; Tyco Valves & Controls.
s. Watts Industries, Inc.; Water Products Div.

C. Single-Flange, 150-psig CWP Rating, Aluminum-Bronze Disc, BUNA Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one- or two-piece Type 416 stainless-steel stem, bronze bushing, aluminum-bronze disc, and phenolic-backed BUNA seat (liner) attached to the body.

1. Manufacturers: NIBCO Model LD-1100-5, or a comparable product by one of the following:
   b. Cooper Cameron Corp.; Cooper Cameron Valves Div.
   c. Crane Co.; Crane Valve Group; Center Line.
   d. Crane Co.; Crane Valve Group; Jenkins Valves.
   e. Crane Co.; Crane Valve Group; Stockham Div.
   f. Dover Corp.; Dover Resources Company; Norriseal Div.
   g. General Signal; DeZurik Unit.
   h. Grinnell Corporation.
   i. Hammond Valve.
   j. Kitz Corporation of America.
   k. Legend Valve & Fitting, Inc.
   l. Metraflex Co.
   m. Milwaukee Valve Company.
   n. Mueller Steam Specialty.
   o. Process Development & Control.
   p. Red-White Valve Corp.
   q. Techno Corp.
   r. Tyco International, Ltd.; Tyco Valves & Controls.
   s. Watts Industries, Inc.; Water Products Div.

D. Single-Flange, 200-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one-piece Type 416 stainless-steel stem, copper bushing, fasteners and pins shall not be used to attach stem, to disc, no pins or fasteners in waterway, aluminum-bronze disc, and molded-in EPDM seat (liner).
1. Manufacturers: NIBCO Model LD-2000-3/5, or a comparable product by one of the following:
   b. Cooper Cameron Corp.; Cooper Cameron Valves Div.
   c. Crane Co.; Crane Valve Group; Center Line.
   d. Crane Co.; Crane Valve Group; Jenkins Valves.
   e. Crane Co.; Crane Valve Group; Stockham Div.
   f. Dover Corp.; Dover Resources Company; Norriseal Div.
   g. General Signal; DeZurik Unit.
   h. Grinnell Corporation.
   i. Hammond Valve.
   j. Kitz Corporation of America.
   k. Legend Valve & Fitting, Inc.
   l. Metraflex Co.
   m. Milwaukee Valve Company.
   n. Mueller Steam Specialty.
   o. Process Development & Control.
   p. Red-White Valve Corp.
   q. Techno Corp.
   r. Tyco International, Ltd.; Tyco Valves & Controls.
   s. Watts Industries, Inc.; Water Products Div.

E. Single-Flange, 200-psig CWP Rating, Aluminum-Bronze Disc, BUNA Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one-piece Type 416 stainless-steel stem, copper bushing, fasteners and pins shall not be used to attach stem to disc, no pins or fasteners in waterway, aluminum-bronze disc, and molded-in BUNA seat (liner).

1. Manufacturers: NIBCO Model LD-2100-3/5, or a comparable product by one of the following:
   b. Cooper Cameron Corp.; Cooper Cameron Valves Div.
   c. Crane Co.; Crane Valve Group; Center Line.
   d. Crane Co.; Crane Valve Group; Jenkins Valves.
   e. Crane Co.; Crane Valve Group; Stockham Div.
   f. Dover Corp.; Dover Resources Company; Norriseal Div.
   g. General Signal; DeZurik Unit.
   h. Grinnell Corporation.
   i. Hammond Valve.
   j. Kitz Corporation of America.
   k. Legend Valve & Fitting, Inc.
   l. Metraflex Co.
   m. Milwaukee Valve Company.
   n. Mueller Steam Specialty.
   o. Process Development & Control.
   p. Red-White Valve Corp.
q. Techno Corp.
r. Tyco International, Ltd.; Tyco Valves & Controls.
s. Watts Industries, Inc.; Water Products Div.

F. Grooved-End, Ferrous-Alloy Butterfly Valves with EPDM-Encapsulated Ductile-Iron Disc: Ductile-iron with grooved or shouldered ends, polyamide coating inside and outside, two-piece Type 416 stainless-steel stem, PTFE bronze sintered on steel bushing, fasteners and pins shall not be used to attach stem to disc, no pins or fasteners in waterway, and 300-psig CWP Rating for Valves NPS 2 through NPS 8, 200 psig CWP Rating for Valves NPS 10 through NPS 12.

1. Manufacturers: NIBCO Model GD-4765-3/5, or a comparable product by one of the following:
   a. Central Sprinkler Co.; Central Grooved Piping Products.
   b. Grinnell Corporation.
   c. Hammond Valve.
   d. McWane, Inc.; Kennedy Valve Div.
   e. Milwaukee Valve Company.
   f. Mueller Steam Specialty.
   g. Victaulic Co. of America.

G. Grooved-End, Ferrous-Alloy Butterfly Valves with BUNA-Encapsulated Ductile-Iron Disc: Ductile-iron with grooved or shouldered ends, polyamide coating inside and outside, two-piece Type 416 stainless-steel stem, PTFE bronze sintered on steel bushing, fasteners and pins shall not be used to attach stem to disc, no pins or fasteners in waterway, and 300-psig CWP Rating for Valves NPS 2 through NPS 8, 200 psig CWP Rating for Valves NPS 10 through NPS 12.

1. Manufacturers: NIBCO Model GD-4775-3/5, or a comparable product by one of the following:
   a. Central Sprinkler Co.; Central Grooved Piping Products.
   b. Grinnell Corporation.
   c. Hammond Valve.
   d. McWane, Inc.; Kennedy Valve Div.
   e. Milwaukee Valve Company.
   f. Mueller Steam Specialty.
   g. Victaulic Co. of America.

2.6 BRONZE CHECK VALVES

A. Bronze Check Valves, General: MSS SP-80.

B. Class 125, Bronze, Lift Check Valves with TFE Disc: ASTM B-584 bronze body and integral seat with soldered or threaded end connections, and having 250-psig CWP rating.

1. Manufacturers: NIBCO Model S-480-Y or T-480-Y, or a comparable product by one of the following:
   a. Cincinnati Valve Co.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Stockham Div.
   d. Red-White Valve Corp.
   e. Walworth Co.

C. Class 125, Bronze, Lift Check Valves with BUNA Disc: ASTM B-584 bronze body and integral seat with nonmetallic BUNA disc, soldered or threaded end connections, and having 250-psig CWP rating.
1. Manufacturers: NIBCO Model S-480 or T-480, or a comparable product by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Powell, Wm. Co.

D. Class 300, Bronze, Swing Check Valves with Bronze Disc: ASTM B-61 bronze body and seat with regrinding-type bronze disc, Y-pattern design, threaded end connections, and having 600 psig CWP rating.
   1. Manufacturers: NIBCO Model T-473-B, or a comparable product by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Powell, Wm. Co.

E. Class 125, Bronze, Swing Check Valves with TFE Disc: ASTM B-62 bronze body and seat with TFE disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 200 psig CWP rating.
   1. Manufacturers: NIBCO Model S-413-Y or T-413-Y, or a comparable product by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Powell, Wm. Co.

F. Class 125, Bronze, Swing Check Valves with BUNA Disc: ASTM B-62 bronze body and seat with BUNA disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 200 psig CWP rating.
   1. Manufacturers: NIBCO Model S-413-W or T-413-W, or a comparable product by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Powell, Wm. Co.

G. Class 150, Bronze, Swing Check Valves with TFE Disc: ASTM B-62 bronze body and seat with TFE disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 300 psig CWP rating.
   1. Manufacturers: NIBCO Model S-433-Y or T-433-Y, or a comparable product by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Powell, Wm. Co.

2.7 DUAL-PLATE, IRON, WAFER OR GROOVED CHECK VALVES
A. Dual-Plate, Iron, Wafer or Grooved Check Valves, General: ANSI B16.1, spring loaded.
B. Dual-Plate, Iron, Wafer or Grooved Check Valves: Class 125, cast-iron, flangeless body with dual, bronze discs; stainless-steel spring and stop pin; BUNA seat; and having 200 psig CWP rating.
   1. Manufacturers: NIBCO Model W-920-W or G-920-W, or a comparable product by one of the following:
      a. Metraflex Co.
      c. Crane.
      d. Grinnel.
      e. Mueller.
      f. Watts.
2.8 CHAINWHEEL ACTUATORS

A. Available Manufacturers:

B. Manufacturers:
   1. Babbitt Steam Specialty Co.
   2. Roto Hammer Industries, Inc.
   3. Prior approved equal.

C. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
   1. Sprocket Rim with Chain Guides: [Ductile iron] [Cast iron] [Aluminum] [Bronze], of type and size required for valve.[Include zinc coating.]
   2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
   3. Chain: [Hot-dip, galvanized steel] [Brass] [Stainless steel], of size required to fit sprocket rim.

PART 3 - EXECUTION
3.1 EXAMINATION
A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

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

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

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

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

3.2 VALVE APPLICATIONS
A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball or butterfly valves.
   2. Throttling Service: Angle, ball, butterfly, or globe valves.
   3. Pump Discharge: Spring-loaded, lift-disc or dual-plate check valves; lever and weight swing check valves; or lever and spring swing check valves.

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

C. Chilled-Water Piping: Use the following types of valves:
   1. Ball Valves, NPS 2 and Smaller: Two -piece, full port, stainless-steel trim, bronze.
   2. Ball Valves, NPS 2-1/2 and Larger: Class 150, full -port, ferrous alloy.
   5. Dual-Plate Check Valves, NPS 2-1/2 and Larger: Wafer, iron.
D. Domestic Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two-piece, full port, stainless-steel trim, bronze.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, full-port, ferrous alloy.
4. Lift Check Valves, NPS 2 and Smaller: Class 125, bronze with TFE disc.

E. Heating Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two-piece, full port, stainless-steel trim, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, full-port, ferrous alloy.
6. Dual-Plate Check Valves, NPS 2-1/2 and Larger: Wafer, iron.

F. Select valves, except wafer and flangeless types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for heating hot water.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged [soldered or threaded] ends.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.
7. For Grooved-End, [Copper Tubing] [and] [Steel Piping]: Valve ends may be grooved. Do not use for steam or steam condensate piping.

3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

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. Butterfly valves may be installed with stem horizontal to allow support for the disc and the cleaning action of the disc.

E. Install valves in position to allow full stem movement.

F. Install chainwheel operators on valves [NPS 4] <Insert other> and larger and more than [84 inches] <Insert other> above floor. Extend chains to [60 inches] <Insert other> above finished floor elevation.

G. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

H. Butterfly valves shall be installed with stems horizontal.
3.4 JOINT CONSTRUCTION

A. Refer to Division 22 and 23 Section “Basic Mechanical Materials and Methods” for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer’s written instructions.

C. Soldered 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 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 22 05 23
SECTION 22 05 48
VIBRATION AND SEISMIC CONTROLS 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following:
   1. Isolation pads.
   2. Freestanding and restrained spring isolators.
   4. Restraining braces and cables.

1.3 SCOPE
A. Provide letter of design intent.
B. Provide full set of seismic submittals.
C. Provide a minimum of 2 on site observations.
D. Provide final letter of compliance completion.

1.4 DEFINITIONS

1.5 PERFORMANCE REQUIREMENTS
A. Wind-Restraint Loading:
   1. Basic Wind Speed: Per owner’s design standards.
   2. Building Classification Category: As defined in the IBC.
   3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

B. Seismic-Restraint Loading:
   1. Site Class: As defined in the IBC.
   2. Assigned Seismic Use Group or Building Category: As defined in the IBC.
      a. Component Importance Factor: 1.0.

1.6 SUBMITTALS
A. Product Data: For the following:
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.
   3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
B. Letter of Design intent, stating company, design criteria, compliance with specifications and only exceptions that will apply. Letter shall be stamped and signed by a licensed and qualified professional engineer in this jurisdiction.

C. Delegated-Design Submittal: For vibration isolation and seismic-restraint details 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. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
   a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 22 and 23 Sections for equipment mounted outdoors.

2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

4. Seismic- and Wind-Restraint Details:
   a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacing’s. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 and 23 Sections for equipment mounted outdoors.
   d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

D. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

E. Welding certificates.

F. Qualification Data: For professional engineer and testing agency.

G. Field quality-control test reports.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

E. Provide a minimum of 2 site observations, and additional observations if required.

F. Upon project completion provide a final letter of acceptance for seismic restraints system and installation.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amber/Booth Company, Inc.
   2. Vibro-acoustics.
   3. ISAT
   5. Gripple.
   6. Prior approved equal.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
   1. Resilient Material: Oil- and water-resistant neoprene or rubber.

C. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
   1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amber/Booth Company, Inc.
   2. Hilti, Inc.
   3. ISAT
   5. Mason Industries.
7. Gripple.
8. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
   1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
   1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
   2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
   3. Maximum 1/4-inch air gap, and minimum 1/4-inch thick resilient cushion.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Restraint Cables: Steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.

G. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

J. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

K. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
   1. Powder coating on springs and housings.
   2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
   3. Baked enamel or powder coat for metal components on isolators for interior use.
   4. Color-code or otherwise mark vibration isolation and seismic- and wind-control devices to indicate capacity range.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

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

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:
   1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
   2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
   3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Piping Restraints:
   1. Comply with requirements in MSS SP-127.
   2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
   3. Brace a change of direction longer than 12 feet.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

H. Drilled-in Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION
A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL
A. Testing Agency: Leave a qualified testing agency to perform tests and inspections.
B. Perform tests and inspections.
C. Tests and Inspections:
   1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
   2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
   4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
   5. Test to 90 percent of rated proof load of device.
   7. Measure isolator deflection.
   8. Verify snubber minimum clearances.
   9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
D. Remove and replace malfunctioning units and retest as specified above.
E. Prepare test and inspection reports.

3.6 ADJUSTING
A. Adjust isolators after piping system is at operating weight.
B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
C. Adjust air-spring leveling mechanism.
D. Adjust active height of spring isolators.
E. Adjust restraints to permit free movement of equipment within normal mode of operation.
3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 22 05 48
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 signs.
   3. Access panel and door markers.
   4. Pipe markers.
   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. Valve numbering scheme.
D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

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 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, 1/4” or larger 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.

C. Access Panel and Door Markers: 1/16” thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8” center hole for attachment.

1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Bradley.
   b. Kolbi.
   c. Prior approved.

2. Colors: Comply with ASME A13.1, unless otherwise indicated.

3. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.

4. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.

5. 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.

6. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 22 and 23 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, etc.

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 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 black equipment markers with white lettering.

2. Letter Size: Minimum 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.

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, etc.
   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.

C. 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.
   B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed 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 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.
   C. 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.

3.4 ADJUSTING
   A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.5 CLEANING
   A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 22 05 53
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Insulation Materials:
      a. Mineral fiber.
   2. Insulating cements.
   3. Adhesives.
   4. Lagging adhesives.
   5. Factory-applied jackets.
   6. Field-applied jackets.
   7. Tapes.
   8. Securements.
   9. Corner angles.
B. Related Sections:
   1. Division 23 Section "Metal Ducts" for duct liners.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
B. Qualification Data: For qualified Installer.
C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
D. Field quality-control reports.

1.4 QUALITY ASSURANCE
A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
1.6 COORDINATION
A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 and 23 Section "Hangers and Supports."
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.

1.7 SCHEDULING
A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.
B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS
2.1 INSULATION MATERIALS
A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Duct insulation shall have a minimum R value = 5 for installation in an unconditioned space, and a minimum R value = 8 for installation outdoors. Provide a weather protective sheet metal jacket for outdoor installation.
2. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap.
   e. Owens Corning; All-Service Duct Wrap.
   f. Prior approved equal.
G. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Fibrex Insulations Inc.; Coreplus 1200.
      b. Johns Manville; Micro-Lok.
      c. Knauf Insulation; 1000 Pipe Insulation.
      d. Manson Insulation Inc.: Alley-K.
      e. Owens Corning; Fiberglas Pipe Insulation.
      f. Prior approved equal.
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.

2.2 INSULATING CEMENTS
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Insulco, Division of MFS, Inc.; Triple I.
      c. Prior approved equal.

2.3 ADHESIVES
A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-127.
      b. Foster Products Corporation, H. B. Fuller Company; 85-60/ 85-70.
      c. Marathon Industries, Inc.; 225.
      d. Mon-Eco Industries, Inc.; 22-25.
      e. Prior approved equal.

2.4 LAGGING ADHESIVES
A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of H.B. Fuller; CR 50 AHV2.
      b. Foster Products Corporation, H. B. Fuller Company; 30-36.
      c. Vimasco Corporation; 713 and 714.
      d. Prior approved equal.
   2. Service Temperature Range: Minus 50 to plus 180 deg F.

2.5 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.

2.6 TAPES
A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      b. Compac Corp.; 104 and 105.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
e. Prior approved equal.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   b. Compac Corp.; 110 and 111.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
   d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
   e. Prior approved equal.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
10. Tensile Strength: 18 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   b. Compac Corp.; 120.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
   d. Venture Tape; 3520 CW.
   e. Prior approved equal.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.7 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products; Bands.
   b. PABCO Metals Corporation; Bands.
c. RPR Products, Inc.; Bands.
d. Prior approved equal.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide.

3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide.


2.8 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.
B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.
C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
B. Surface Preparation: Clean and prepare surfaces to be insulated.
C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS
A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
E. Install multiple layers of insulation with longitudinal and end seams staggered.
F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
G. Keep insulation materials dry during application and finishing.
H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
I. Install insulation with least number of joints practical.
J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer’s recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   5. Handholes.
   6. Cleanouts.

3.4 GENERAL PIPE INSULATION INSTALLATION
A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word “UNION.” Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer’s recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer’s recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Impale insulation over pins and attach speed washers.
   f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section spaced a maximum of 18 inches o.c.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.7 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed supply and outdoor air.
   3. Indoor, concealed return, Air.
   4. Indoor, exposed return, Air.
   5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
   6. Indoor, concealed exhaust.
   7. Indoor, exposed exhaust.

B. Items Not Insulated:
   1. Fibrous-glass ducts.
   2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
   3. Factory-insulated flexible ducts.
   5. Flexible connectors.
   7. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval duct insulation shall be the following:
   1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

B. Concealed, low pressure, round rectangular, and flat-oval exhaust-air duct insulation shall be the following:
   1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

C. Rectangular, low pressure, supply-air duct insulation shall be lined per Section "Metal Ducts".

D. Rectangular, return-air duct insulation shall be lined per Section "Metal Ducts".

E. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

F. Exposed or medium pressure, round and flat-oval, supply-air, and return air duct insulation shall be a perforated linear. See Section "Metal Ducts".
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. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
   4. Vertical roof drain piping.
C. Piping System insulation:
   2. Domestic Cold Water Piping - Mineral Fiber, ½”
   3. Domestic Hot Water Piping - Mineral Fiber, per chart
   4. Horizontal Roof Drain Piping - Mineral Fiber, 1/2”.
   5. Refrigerant Piping - Flexible elastomeric, 1”.

3.11 INDOOR PIPING INSULATION SCHEDULE
A. Minimum Pipe Insulation Thickness from ANSI/ASHRAE/IESNA Standard 90.1-2016, with modifications per 2018 IECC

<table>
<thead>
<tr>
<th>Fluid Operating Temperature Range and usage (°F)</th>
<th>Insulation Conductivity</th>
<th>Nominal Pipe or Tube Size (inches)</th>
<th>Mean Rating Temp. °F</th>
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<td>Conductivity Btu-in./(h-ft²-°F)</td>
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<td>1 to &lt;1-1/2</td>
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<td>141-200</td>
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<td>105-140</td>
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<td>Cooling Systems (Chilled Water, Brine, and Refrigerant)</td>
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3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE
A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. If more than one material is listed, selection from materials listed is Contractor's option.
C. Piping, Exposed:
   1. PVC: 20 mils thick.
D. Minimum Pipe Insulation Thickness from ANSI/ASHRAE/IESNA Standard 90.1-2016, with modifications per 2018 IECC
3.13 DUCT INSULATION SCHEDULE


<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Exterior</th>
<th>Ventilated Attic</th>
<th>Unvented Attic Above Insulated Ceiling</th>
<th>Unvented Attic with Roof Insulation</th>
<th>Unconditioned Space</th>
<th>Indirectly Conditioned Space</th>
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<td>Combine Heating and Cooling Supply Ducts</td>
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3.14 OUTDOOR, FIELD APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Exterior piping, Exposed:
   1. Aluminum jacket.
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
   2. Flexible connectors.
   3. Escutcheons.
   4. Sleeves and sleeve seals.
   5. Wall penetration systems.

1.3 PERFORMANCE REQUIREMENTS
A. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to 2012 IBC.

1.4 SUBMITTALS
A. Product Data: For the following products:
   1. Specialty valves.
   2. Transition fittings.
   3. Dielectric fittings.
   4. Escutcheons.
   5. Sleeves and sleeve seals.
C. Field quality-control reports.

1.5 QUALITY ASSURANCE
A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
B. Comply with NSF 61 for potable domestic water piping and components.

1.6 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.

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

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 water tube, drawn temper.
      4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.3 PIPING JOINING MATERIALS
   A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
   B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 ESCUTCHEONS
   A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
   B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.
   D. One Piece, Stamped Steel: Chrome-plated finish with setscrew or spring clips.
   E. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.
   F. Split Plate, Stamped Steel: Chrome-plated finish with concealed hinge, setscrew or spring clips.
   G. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
   H. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.5 SLEEVES
   A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
   B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
   C. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
   D. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
   E. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
   F. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.
   G. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
      1. Underdeck Clamp: Clamping ring with setscrews.

2.6 SLEEVE SEALS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Advance Products & Systems, Inc.
      2. Calpico, Inc.
      3. Metraflex, Inc.
      4. Pipeline Seal and Insulator, Inc.
      5. Prior approved equal.
B. 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 material and size of pipe.
   2. Pressure Plates: Carbon steel.
   3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.7 GROUT
B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION
3.1 EARTHWORK
A. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION
A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105.
E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 and 23 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
F. Install shutoff valve immediately upstream of each dielectric fitting.
G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.
H. Install domestic water piping level without pitch and plumb.
I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
J. Install seismic restraints on piping. Comply with requirements in Division 22 and 23 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
K. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
L. 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.
M. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
N. Install piping adjacent to equipment and specialties to allow service and maintenance.
O. Install piping to permit valve servicing.
P. 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.
Q. Install piping free of sags and bends.
R. Install fittings for changes in direction and branch connections.
S. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
T. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.
U. Install thermometers on outlet piping from each water heater. Comply with requirements in Division 22 and 23 Section "Meters and Gages for Plumbing Piping" for thermometers.

3.3 JOINT CONSTRUCTION
A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
F. 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.
G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE INSTALLATION
A. General-Duty Valves: Comply with requirements in Division 22 and 23 Section "General-Duty Valves for Plumbing Piping" for valve installations.
B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.
C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
   1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball
valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.

3.5 TRANSITION FITTING INSTALLATION
A. Install transition couplings at joints of dissimilar piping.
B. Transition Fittings in Underground Domestic Water Piping:
   1. NPS 1-1/2 and Smaller: Fitting-type coupling.
   2. NPS 2 and Larger: Sleeve-type coupling.

3.6 HANGER AND SUPPORT INSTALLATION
A. Comply with requirements in Division 22 and 23 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic restraint devices.
B. Comply with requirements in Division 22 and 23 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.
C. Support vertical piping and tubing at base and at each floor.
D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
   2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
   3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   4. NPS 2-1/2: 108 inches with 1/2-inch rod.
   5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
   6. NPS 6: 10 feet with 5/8-inch rod.
   7. NPS 8: 10 feet with 3/4-inch rod.
F. Install supports for vertical copper tubing every 10 feet.
G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
   2. NPS 1-1/2: 108 inches with 3/8-inch rod.
   3. NPS 2: 10 feet with 3/8-inch rod.
   4. NPS 2-1/2: 11 feet with 1/2-inch rod.
   5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
   6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
   7. NPS 6: 12 feet with 3/4-inch rod.
   8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
H. Install supports for vertical steel piping every 15 feet.
I. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer’s written instructions.

3.7 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 the following:
   1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
   2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 15 plumbing fixture Sections for connection sizes.
   4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 ESCUTCHEON INSTALLATION
A. Install escutcheons for penetrations of walls, ceilings, and floors.
B. Escutcheons for New Piping:
   1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
   2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
   3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
   4. Bare Piping in Unfinished Service Spaces: One piece, stamped steel with set screw or spring clips.
   5. Bare Piping in Equipment Rooms: One piece, stamped steel with set screw or spring clips.
   6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.
C. Escutcheons for Existing Piping:
   2. Insulated Piping: Split plate, stamped steel with concealed or exposed-rivet hinge and spring clips.
   3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
   4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
   5. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with exposed-rivet hinge and set screw or spring clips.
   6. Bare Piping in Equipment Rooms: Split plate, stamped steel with set screw or spring clips.
   7. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.
3.9 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

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

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint.

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint.

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals specified in this Section.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

K. Install sleeve materials according to the following applications:
   1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.
   2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.
      a. Extend sleeves 2 inches above finished floor level.
      b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
   3. Sleeves for Piping Passing through Gypsum-Board Partitions:
      a. PVC pipe sleeves for pipes smaller than NPS 6.
      b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.
      c. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
   4. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe Insert type.
   5. Sleeves for Piping Passing through Exterior Concrete Walls:
      a. Steel pipe sleeves for pipes smaller than NPS 6.
      b. Cast-iron wall pipe sleeves for pipes NPS 6 and larger.
      c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
      d. Do not use sleeves when wall penetration systems are used.
   6. Sleeves for Piping Passing through Interior Concrete Walls:
      a. Steel pipe sleeves for pipes smaller than NPS 6.
      b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.
   L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestop materials and installations.
3.10 SLEEVE SEAL INSTALLATION
A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.11 WALL PENETRATION SYSTEM INSTALLATION
A. Install wall penetration systems in new, exterior concrete walls.
B. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

3.12 IDENTIFICATION
A. Identify system components. Comply with requirements in Division 22 and 23 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
B. Label pressure piping with system operating pressure.

3.13 FIELD QUALITY CONTROL
A. Perform tests and inspections.
B. Piping Inspections:
   1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   3. Reinspection: If authorities having jurisdiction find 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 authorities having jurisdiction.
C. Piping Tests:
   1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
   3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   4. Cap and subject piping to static water pressure of 100 psig, 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.

3.14 ADJUSTING
A. Perform the following adjustments before operation:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open shutoff valves to fully open position.
   3. Open throttling valves to proper setting.
   4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
      a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
      b. Adjust calibrated balancing valves to flows indicated.
   5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
   7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
   8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.15 CLEANING
A. Clean and disinfect potable and non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system according to either of the following:
         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
   B. Clean non-potable domestic water piping as follows:
      1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
      2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
         a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
         b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
   C. Prepare and submit reports of purging and disinfecting activities.
D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.16 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
   1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.

D. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
   1. Hard copper tube, ASTM B 88, Type L; wrought- copper solder-joint fittings; and soldered joints.
   2. Hard copper tube, ASTM B 88, Type L; grooved-joint copper-tube appurtenances; and grooved joints.

3.17 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
   2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 22 11 16
SECTION 22 11 19
DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 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.
   4. Temperature-actuated water mixing valves.
   5. Strainers.
   6. Hose bibbs.
   7. Wall hydrants.
   8. Drain valves.
  10. Air vents.
  11. Trap-seal primer valves.
  12. Trap-seal primer systems.

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 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:
   1. 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. Cash Acme.
c. Conbraco Industries, Inc.
d. FEBCO; SPX Valves & Controls.
e. Rain Bird Corporation.
f. Toro Company (The); Irrigation Div.
g. Watts Industries, Inc.; Water Products Div.
h. Zurn Plumbing Products Group; Wilkins Div.
i. Prior approved equal.


3. Size: NPS 1/4 to NPS 3, as required to match connected piping.


5. Inlet and Outlet Connections: Threaded.


B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Arrowhead Brass Products, Inc.
   b. Cash Acme.
   c. Conbraco Industries, Inc.
   d. Legend Valve.
   e. MIFAB, Inc.
   f. Prier Products, Inc.
   g. Watts Industries, Inc.; Water Products Div.
   h. Woodford Manufacturing Company.
   i. Zurn Plumbing Products Group; Light Commercial Operation.
   j. Zurn Plumbing Products Group; Wilkins Div.
   k. Prior approved equal.


5. Finish: Chrome or nickel plated.

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.
   d. Flomatic Corporation.
   e. Watts Industries, Inc.; Water Products Div.
   f. Zurn Plumbing Products Group; Wilkins Div.
   g. Prior approved equal.

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; steel 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. Hose-Connection Backflow Preventers:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   c. Woodford Manufacturing Company.
   d. Prior approved equal.
4. Operation: Up to 10-foot head of water back pressure.
5. Inlet Size: NPS 1/2 or NPS 3/4.
7. Capacity: At least 3-gpm flow.

2.3 WATER PRESSURE-REDUCING VALVES
A. Water Regulators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cash Acme.
   b. Conbraco Industries, Inc.
   c. Honeywell Water Controls.
   e. Zurn Plumbing Products Group; Wilkins Div.
   f. Prior approved equal.
4. 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.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.4 TEMPERATURE-ACTUATED WATER MIXING VALVES
A. Primary, Thermostatic, Water Mixing 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. Symmons Industries, Inc.
f. Or equal by.

4. Type: Exposed-mounting, 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 (860 kPa) minimum, unless otherwise indicated.
10. Tempered-Water Design Flow Rate: See drawings.
11. Pressure Drop at Design Flow Rate: See Drawings.
13. Piping Finish: Copper.

B. Individual-Fixture, Water Tempering Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Sloan.
   b. Watts.
   c. Prior approved equal.
3. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.
8. Tempered-Water Setting: 110°F.
9. Tempered-Water Design Flow Rate:

2.5 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.
2.6 HOSE BIBBS
A. Hose Bibbs:
   4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
   5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
   8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
   9. Finish for Service Areas: Chrome or nickel plated.
   10. Finish for Finished Rooms: Chrome or nickel plated.
   11. Operation for Equipment Rooms: Wheel handle or operating key.
   14. Include operating key with each operating-key hose bibb.
   15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.7 WALL HYDRANTS
A. Nonfreeze Wall Hydrants:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. MIFAB, Inc.
      c. Prier Products, Inc.
      e. Tyler Pipe; Wade Div.
      f. Watts Drainage Products Inc.
      g. Woodford Manufacturing Company.
      h. Zurn Plumbing Products Group; Light Commercial Operation.
      i. Zurn Plumbing Products Group; Specification Drainage Operation.
      j. Or equal by.
   4. Operation: Loose key.
   5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
   6. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).
   7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
   8. Box: Deep, flush mounting with cover.
   9. Box and Cover Finish: Chrome plated.


12. Operating Keys(s): Two with each wall hydrant.

B. Vacuum Breaker Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Arrowhead Brass Products, Inc.
   b. Mansfield Plumbing Products LLC.
   d. Prier Products, Inc.
   g. Woodford Manufacturing Company.
   h. Zurn Plumbing Products Group; Light Commercial Operation.
   i. Or equal by.

2. Standard: ASSE 1019, Type A or Type B.

3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.

4. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.


7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.

8. Inlet: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).


2.8 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:


2. Pressure Rating: 400-psig minimum CWP.


4. Body: Copper alloy.

5. Ball: Chrome-plated brass.


8. Inlet: Threaded or solder joint.


2.9 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
b. Josam Company.
c. MIFAB, Inc.
d. PPP Inc.
e. Sioux Chief Manufacturing Company, Inc.
g. Tyler Pipe; Wade Div.
h. Watts Drainage Products Inc.
i. Zurn Plumbing Products Group; Specification Drainage Operation.
j. Or equal by.
3. Type: Metal bellows Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.10 AIR VENTS

A. Bolted-Construction Automatic Air Vents:
1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
5. Size: NPS 1/2 minimum inlet.

2.11 TRAP-SEAL PRIMER VALVES

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.
   c. Sioux Chief Manufacturing Company, Inc.
   e. Watts Industries, Inc.; Water Products Div.
   f. Or equal by.
3. Pressure Rating: 125 psig (860 kPa) minimum.
5. Inlet and Outlet Connections: NPS 1/2 (DN 15) threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 (DN 15) 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, Trap-Seal Primer Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Or equal by.

2.12 TRAP-SEAL PRIMER SYSTEMS
A. Trap-Seal Primer Systems:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. PPP Inc.
      b. Or equal by.
   2. Standard: ASSE 1044,
   3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
   5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
   7. Number Outlets: See drawings.

PART 3 - EXECUTION
3.1 INSTALLATION
A. Refer to Division 22 and 23 Section “Common work results” for piping joining materials, joint construction, and basic installation requirements.
B. 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. Do not install bypass piping around backflow preventers.
C. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.
D. Install balancing valves in locations where they can easily be adjusted. Install on hot water recirculating lines where they connect to hot water lines.
E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Install thermometers.
   2. 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.
G. Install water hammer arresters in water piping according to PDI-WH 201.
H. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.
I. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
J. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
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.

3.2 CONNECTIONS
A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping and specialties.
B. Ground equipment according to Division 26 Section "Grounding and Bonding."
C. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 LABELING AND IDENTIFYING
A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Pressure vacuum breakers.
   2. Reduced-pressure-principle backflow preventers.
   5. Primary, thermostatic, water mixing valves.
   7. Trap-seal primer systems.
B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

3.4 FIELD QUALITY CONTROL
A. Perform the following tests and prepare test reports:
   1. Test each reduced-pressure-principle backflow preventer 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.

3.5 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.

END OF SECTION 22 11 19
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.
B. Related Sections:
   1. Division 2 Section "Sanitary Sewerage" for sanitary sewerage piping and structures outside the building.

1.3 PERFORMANCE REQUIREMENTS
A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1.4 SUBMITTALS
A. Product Data: For each type of product indicated.
B. LEED Submittal:
   1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
C. Shop Drawings: For solvent drainage system. Include plans, elevations, sections, and details.
D. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
E. Field quality-control reports.

1.5 QUALITY ASSURANCE
A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 PROJECT CONDITIONS
A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Owner no fewer than 72 hours in advance of proposed interruption of sanitary waste service.
   2. Do not proceed with interruption of sanitary waste 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 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS  
A. Pipe and Fittings: ASTM A 74, Service and Extra Heavy class(es).  
B. Gaskets: ASTM C 564, rubber.  

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS  
A. Pipe and Fittings: ASTM A 888 or CISPI 301.  
B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.  
C. CISPI, Hubless-Piping Couplings:  
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:  
      a. ANACO-Husky.  
      b. Fernco Inc.  
      c. MIFAB, Inc.  
      d. Tyler Pipe.  
      e. Prior approved equal.  
   3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.  
D. Heavy-Duty, Hubless-Piping Couplings:  
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:  
      a. ANACO-Husky.  
      b. MIFAB, Inc.  
      c. Tyler Pipe.  
      d. Prior approved equal.  
   3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.  

2.4 ABS PIPE AND FITTINGS  
A. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.  
B. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.  
C. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.  
D. Solvent Cement: ASTM D 2235.  
   1. Use ABS solvent cement that has a VOC content of 325 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).  

2.5 PVC PIPE AND FITTINGS  
A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.  
B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.  
C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
D. Adhesive Primer: ASTM F 656.
   1. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Solvent Cement: ASTM D 2564.
   1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   3. Unshielded, Nonpressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         2) Fernco Inc.
         3) Mission Rubber Company; a division of MCP Industries, Inc.
         4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
         5) Prior approved equal.
      c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
      d. Sleeve Materials:
         2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
         3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
   4. Shielded, Nonpressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         2) Mission Rubber Company; a division of MCP Industries, Inc.
         3) Prior approved equal.
      c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
   5. Pressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         2) Dresser, Inc.
3) EBAA Iron, Inc.
4) JCM Industries, Inc.
5) Romac Industries, Inc.
6) Smith-Blair, Inc.; a Sensus company.
7) The Ford Meter Box Company, Inc.
8) Viking Johnson.
9) Prior approved equal.

PART 3 - EXECUTION

3.1 EARTH MOVING
A. Comply with requirements for excavating, trenching, and backfilling specified in Division 2 Section "Earthwork."

3.2 PIPING INSTALLATION
A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
E. Install piping to permit valve servicing.
F. Install piping at indicated slopes.
G. Install piping free of sags and bends.
H. Install fittings for changes in direction and branch connections.
I. Install piping to allow application of insulation.
J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 and 23 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
L. 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.
M. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

O. Install aboveground ABS piping according to ASTM D 2661.
P. Install aboveground PVC piping according to ASTM D 2665.
Q. Install underground ABS and PVC piping according to ASTM D 2321.
R. Install engineered soil and waste drainage and vent piping systems as follows:
   2. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.
   3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

S. Plumbing Specialties:
   1. Install backwater valves in sanitary waste gravity-flow piping. Comply with requirements for backwater valves specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."
   2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."
   3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."

T. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 and 23 Section "Sleeves and Sleeve Seals for Plumbing Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 and 23 Section "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 and 23 Section "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION


C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
   3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION
A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD’s.
   2. In Drainage Piping: Shielded, nonpressure transition couplings.
   4. In Underground Force Main Piping:
      a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
      b. NPS 2 and Larger: Pressure transition couplings.

B. Dielectric Fittings:
   1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.5 VALVE INSTALLATION
A. General valve installation requirements are specified in Division 22 and 23 Section "General-Duty Valves for Plumbing Piping."
B. Shutoff Valves:
   1. Install shutoff valve on each sewage pump discharge.
   2. Install gate or full-port ball valve for piping NPS 2 (DN 50) and smaller.
   3. Install gate valve for piping NPS 2-1/2 (DN 65) and larger.
C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
D. Backwater Valves: Install backwater valves in piping subject to backflow.
   1. Horizontal Piping: Horizontal backwater valves.
   2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
   3. Install backwater valves in accessible locations.
   4. Comply with requirements for backwater valve specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION
A. Comply with requirements for seismic-restraint devices specified in Division 22 and 23 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 and 23 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:
3.7 CONSTRUCTIONS

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

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.

3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.

5. Comply with requirements for backwater valves cleanouts and drains specified in Division 22 and 23 Section "Sanitary Waste Piping Specialties."

6. 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 (DN 65) and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION
   A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 and 23 Section "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL
   A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
      1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

   B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

   C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

   D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
      1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
      2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
      3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). 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 (250 Pa). 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.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste and vent piping shall be any of the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
   4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

C. Underground, soil, waste, and vent piping shall be any of the following:
   1. Extra Heavy class, cast-iron soil piping; calking materials; and calked joints.
   2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
   4. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION 22 13 16
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 sanitary drainage piping specialties:
      1. Cleanouts.
      2. Floor drains.
      3. Air-admittance valves.
      4. Trap Guards.
      5. Roof flashing assemblies.
      7. Flashing materials.

1.3 DEFINITIONS
   B. FRP: Fiberglass-reinforced plastic.
   C. HDPE: High-density polyethylene plastic.
   D. PE: Polyethylene plastic.
   E. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS
   A. Product Data: For each type of product indicated. Include manufacturer, rated capacities, operating characteristics, and accessories for the following:
      1. Cleanouts.
      2. Floor drains.
      3. Air admittance valves.

1.5 QUALITY ASSURANCE
   A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
   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.

1.6 COORDINATION
   A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 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.
g. Prior approved equal.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.2 FLOOR DRAINS
A. Cast-Iron Floor Drains:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Commercial Enameling Co.
   b. Josam Company; Josam Div.
   c. MIFAB, Inc.
   d. Prier Products, Inc.
   e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   f. Tyler Pipe; Wade Div.
   g. Watts Drainage Products Inc.
   h. Zurn Plumbing Products Group; Light Commercial Operation.
   i. Zurn Plumbing Products Group; Specification Drainage Operation.
   j. Prior approved equal.
2. Standard: ASME A112.6.3.
5. Clamping Device: Required.
6. Outlet: Bottom.
7. Top or Strainer Material: Chrome plate
8. Top or Strainer Material: Stainless steel for shower drains
10. Top Loading Classification: Medium Duty.
11. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.

2.3 AIR-ADMITTANCE VALVES
A. Wall Box:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.

3. Size: About 9 inches wide by 8 inches high by 4 inches deep.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Acorn Engineering Company; Elmdor/Stoneman Div.
      b. Thaler Metal Industries Ltd.
      c. Prior approved equal.

   B. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch- thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflash fitting.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:
   1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
   2. Size: Same as connected waste piping.
      a. NPS 2: 4-inch- minimum water seal.
      b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

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. Trap Guard
   1. Description: Trap guard shall have flexible elastomeric material open on top, with curl closure on bottom as needed to allow water to flow, but not allow sewer gases to escape.
   2. Trap guards by Proset or prior approved equal.

2.6 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Applications: 12 oz./sq. ft. thickness.
   2. Vent Pipe Flashing: 8 oz./sq. ft. thickness.
**PART 3 - EXECUTION**

3.1 **INSTALLATION**

A. Refer to Division 22 and 23 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil and waste stack.

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 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 the following drainage area radii:
      a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
      b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
      c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
   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 trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

G. Install air-admittance-valve wall boxes recessed in wall where indicated on drawings.

H. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

I. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

J. Install deep-seal traps on all floor drains.
A. Install trap guards at floor drains that require trap-seal.
   1. Size: Same as floor drain inlet.
B. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping
   discharge into sanitary drainage system.
C. Install sleeve flashing device with each riser and stack passing through floors with waterproof
   membrane.
D. 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.

3.2 CONNECTIONS
A. Piping installation requirements are specified in other Division 22 and 23 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. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are
   required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker.
      Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
   2. Copper Sheets: Solder joints of copper sheets.
B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors
   and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and
      skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around
      sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches
      around specialty.
C. Set flashing on floors and roofs in solid coating of bituminous cement.
D. Secure flashing into sleeve and specialty clamping ring or device.
E. Install flashing for piping passing through roofs with counterflashing or commercially made
   flashing fittings, according to Division 7 Section "Sheet Metal Flashing and Trim."
F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing
   into cast-iron sleeve having calking recess.
G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL
A. 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 safety. 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.
SECTION 22 14 13
FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following storm drainage piping inside the building:
   1. Pipe, tube, and fittings.
   2. Special pipe fittings.

1.3 DEFINITIONS
B. LLDPE: Linear, low-density polyethylene plastic.
C. PE: Polyethylene plastic.
D. PVC: Polyvinyl chloride plastic.
E. 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. Storm Drainage Piping: 30-foot head of water.
B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.5 SUBMITTALS
A. Product Data: For pipe, tube, fittings, and couplings.
B. Shop Drawings:
   1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
   2. Controlled-Flow Storm Drainage System: Include calculations, plans, and details.
C. 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
   2. 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 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS
   A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy class(es).
   B. Gaskets: ASTM C 564, rubber.
   C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS
   A. Pipe and Fittings: ASTM A 888 or CISPI 301.
   B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
      1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
         a. Available Manufacturers:
            1) ANACO.
            2) Fernco, Inc.
            3) Ideal Div.; Stant Corp.
            4) Mission Rubber Co.
            5) Tyler Pipe; Soil Pipe Div.
            6) Or equal.
         a. Manufacturers:
            1) ANACO.
            2) Clamp-All Corp.
            3) Ideal Div.; Stant Corp.
            4) Mission Rubber Co.
            5) Tyler Pipe; Soil Pipe Div.
            6) Or equal.
      3. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.
         a. Manufacturers:
            1) MG Piping Products Co.
            2) Or equal.
   C. Rigid, Unshielded Couplings: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
      1. Manufacturers:
         a. ANACO.
         1) Or equal.

2.5 ABS PIPE AND FITTINGS
   A. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
   B. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.
2.6 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
   1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
C. Cellular-Core, Sewer and Drain Series, PVC Pipe: ASTM F 891, Series PS 100.
   1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drain pipe.

2.7 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.
      g. Or equal.
   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. Or equal.
C. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
   1. Manufacturers:
      a. ANACO.
      b. Or equal.
D. 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.
b. Or equal.

E. 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.
      d. Or equal.

F. 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.
      b. Or equal.

PART 3 - EXECUTION

3.1 EXCAVATION
   A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS
   A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
   B. Plastic piping shall not be allowed in ceiling return plenums. Where piping is exposed to ceiling plenums, cast iron shall be used.
   C. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:
      1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
      2. Hubless cast-iron soil pipe and fittings; standard, and heavy-duty shielded, stainless-steel couplings; and coupled joints.
      3. ABS pipe, ABS socket fittings, and solvent-cemented joints.
      4. PVC pipe, PVC socket fittings, and solvent-cemented joints.

3.3 PIPING INSTALLATION
   A. Storm sewer and drainage piping outside the building are specified in Division 2 Section "Storm Drainage."
   B. Basic piping installation requirements are specified in Division 22 and 23 Section "Common Work Results."
   C. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."
   D. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Plumbing Specialties."
   E. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
   F. Install underground, steel, force-main piping.[Install encasement on piping according to ASTM A 674 or AWWA C105.]
   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 Division 22 and 23 Section "Common Work Results."

H. Install wall-penetration fitting system at each service pipe penetration through foundation wall. Make installation watertight.

I. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

J. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
   1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

M. Install engineered controlled-flow storm drainage piping in locations indicated.

N. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

O. Install ABS storm drainage piping according to ASTM D 2661.

P. Install PVC storm drainage piping according to ASTM D 2665.

Q. Install underground ABS and PVC storm drainage piping according to ASTM D 2321.

R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION
A. Basic piping joint construction requirements are specified in Division 22 and 23 Section "Basic Mechanical Materials and Methods."


E. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 VALVE INSTALLATION
A. General valve installation requirements are specified in Division 22 and 23 Section "Valves."

B. Shutoff Valves: Install shutoff valve on each sump pump discharge.
   1. Install gate or full-port ball valve for piping NPS 2 and smaller.
   2. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sump pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.
1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.

2. Install backwater valves in accessible locations.

3. Backwater valve are specified in Division 22 Section "Plumbing Specialties."

### 3.6 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 and 23 Section "Mechanical Vibration Controls and Seismic Restraints."

B. Pipe hangers and supports are specified in Division 22 and 23 Section "Hangers and Supports."

Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.

2. Individual, Straight, Horizontal Piping Runs: According to the following:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 22 and 23 Section "Hangers and Supports."

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6: 60 inches with 3/4-inch rod.
   5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.

6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
   2. NPS 3: 48 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
   4. NPS 6: 48 inches with 3/4-inch rod.
   5. NPS 8 to NPS 12: 48 inches with 7/8-inch rod.

I. Install supports for vertical ABS and PVC piping every 48 inches.

J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

### 3.7 CONNECTIONS

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

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
C. Connect storm drainage piping to roof drains and storm drainage specialties.
D. Connect force-main piping to the following:
   1. Storm Sewer: To exterior force main or storm manhole.
   2. Sump Pumps: To sump pump discharge.

3.8 FIELD QUALITY CONTROL
A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and un Concealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 20-foot head of water. From 4 hours before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   5. Prepare reports for tests and required corrective action.

3.9 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 22 14 13
SECTION 22 14 23
STORM DRAINAGE PIPING SPECIALTIES

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 storm drainage piping specialties:
   1. Cleanouts.
   2. Through-penetration firestop assemblies.
   3. Roof drains.
   4. Miscellaneous storm drainage piping specialties.
   5. Flashing materials.
B. Related Sections include the following:
   1. Division 22 Section "Sanitary Waste Piping Specialties" for backwater valves, floor drains, trench drains and channel drainage systems connected to sanitary sewer, air admittance valves, FOG disposal systems, grease interceptors and removal devices, oil interceptors, and solid interceptors.

1.3 DEFINITIONS
B. FOG: Fats, oils, and greases.
C. FRP: Fiberglass-reinforced plastic.
D. HDPE: High-density polyethylene plastic.
E. PE: Polyethylene plastic.
F. PP: Polypropylene plastic.
G. PUR: Polyurethane plastic.
H. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS
A. Product Data: For each type of product indicated.

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 roof penetrations.

PART 2 - PRODUCTS

2.1 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.

g. Prior approved equal.

2. Standard: ASME A112.36.2M for cast iron for 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, cast-iron 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:
   b. Oatey.
   c. Sioux Chief Manufacturing Company, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Zurn Plumbing Products Group; Light Commercial Operation.
   h. Mifab.
   i. Prior approved equal.

2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.

3. Size: Same as connected branch.

4. Type: Adjustable housing.

5. Body or Ferrule: Cast iron.


7. Outlet Connection: Threaded.

8. Closure: Cast-iron plug.

9. Adjustable Housing Material: Cast iron with.


11. Frame and Cover Shape: Round.

12. Top Loading Classification: Medium Duty.

13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.


15. Size: Same as connected branch.


17. Closure: Stainless steel with seal.

18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Standard: ASME A112.36.2M. Include wall access.

3. Size: Same as connected drainage piping.

4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.

5. Closure: Countersunk or raised-head, cast-iron plug.

6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.


D. Plastic Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Canplas LLC.
   b. IPS Corporation.
   c. NDS Inc.
   d. Plastic Oddities; a division of Diverse Corporate Technologies.
   e. Sioux Chief Manufacturing Company, Inc.
   f. Zurn Plumbing Products Group; Light Commercial Operation.
   g. Prior approved equal.

2. Size: Same as connected branch.

3. Body: PVC.

4. Closure Plug: PVC.

5. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.2 ROOF DRAINS

A. Metal Roof Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Marathon Roofing Products.
   c. MIFAB, Inc.
   d. Portals Plus, Inc.
   e. Prier Products, Inc.
   g. Tyler Pipe; Wade Div.
   h. Watts Drainage Products Inc.
   i. Zurn Plumbing Products Group; Light Commercial Operation.
   j. Zurn Plumbing Products Group; Specification Drainage Operation.
   k. Prior approved equal.

2. Standard: ASME A112.21.2M.
3. Pattern: Roof drain.
6. Combination Flashing Ring and Gravel Stop: Required.
7. Outlet: Coordinate with drawings.
10. Underdeck Clamp: Required.

2.3 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Expansion Joints:
1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected piping.

B. Downspout Boots:
1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
2. Size: Inlet size to match downspout.
3. Description: ASTM A 74, Service class, hub-and-spigot, cast-iron soil pipe.
4. Size: Same as or larger than connected downspout.

C. Conductor Nozzles:
1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

D. Downspout Nozzle:
1. All nickel bronze body with decorative face of wall flange and outlet nozzle.
2. Approved Types -
   a. Zurn Z-199 or equal by
   b. Wade
   c. Smith
   d. Josam

2.4 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft. thickness.
B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
D. Fasteners: Metal compatible with material and substrate being fastened.
E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
F. Solder: ASTM B 32, lead-free alloy.
G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil and waste stack.

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 and cover flush with finished wall.

E. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 7.
   1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Position roof drains for easy access and maintenance.

F. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

G. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

H. Install manufactured, gray-iron downspout boots at grade with top 18 inches above grade. Secure to building wall.

I. Install cast-iron soil pipe downspout boots at grade with top of hub 18 inches above grade.

J. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

K. 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.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
   2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. **Sleeve Flashing**: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.

3. **Embedded Specialty Flashing**: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

### 3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 14 23
SECTION 22 15 13
GENERAL-SERVICE COMPRESSED-AIR 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 piping and related specialties for general-service compressed-air systems operating at 200 psig or less.
B. Related Sections include the following:
   1. Division 22 and 23 Section “Compressed-Air Equipment” for general-service air compressors and accessories.

1.3 DEFINITIONS
A. High-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures between 150 and 200 psig.
B. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 150 psig or less.

1.4 PERFORMANCE REQUIREMENTS
A. Seismic Performance: Compressed-air piping and support and installation shall withstand effects of seismic events determined according to SEI/ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.5 SUBMITTALS
A. Product Data: For the following:
   1. Flexible pipe connectors.
   2. Safety valves.
   3. Pressure regulators. Include rated capacities and operating characteristics.
   4. Filters. Include rated capacities and operating characteristics.
   5. Quick couplings.
B. Brazing and welding certificates.
C. Qualification Data: For Installers.
D. Field quality-control test reports.
E. Operation and Maintenance Data: For general-service compressed-air piping specialties to include in operation, and maintenance manuals.

1.6 QUALITY ASSURANCE
A. Installer Qualifications:
   1. Extruded-Tee Outlet Procedure: Qualify operators according to training provided by T-DRILL Industries Inc., for making branch outlets.
   2. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.
   3. Pressure-Seal Joining Procedure for Steel Piping: Qualify operators according to training provided by Victaulic Company.
B. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or to AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

D. ASME Compliance:

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or L seamless, drawn-temper, water tube.
   1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
   2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
   3. Copper Unions: ASME B16.22 or MSS SP-123.
   4. Press-Type Fittings, NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Viega; Plumbing and Heating Systems.
         2) Prior approved equal.

2.2 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for compressed-air 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.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.

E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 FLEXIBLE PIPE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flex-Hose Co., Inc.
   2. Flexicraft Industries.
   3. Hyspan Precision Products, Inc.
   5. Metraflex, Inc.
   6. Proco Products, Inc.
   7. Unaflex, Inc.
   8. Universal Metal Hose; a Hyspan Company
B. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   2. End Connections, NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
   3. End Connections, NPS 2-1/2 and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   2. End Connections, NPS 2 and Smaller: Threaded steel pipe nipple.
   3. End Connections, NPS 2-1/2 and Larger: Flanged steel nipple.

2.4 SLEEVES
A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
B. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

2.5 ESCUTCHEONS
A. General Requirements: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.

2.6 SPECIALTIES
A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.
   1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.
B. Air-Main Pressure Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 250-psig inlet pressure, unless otherwise indicated.
   1. Type: Pilot operated.
C. Air-Line Pressure Regulators: Diaphragm or pilot operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig minimum inlet pressure, unless otherwise indicated.
D. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded. Include mounting bracket if wall mounting is indicated.
E. Mechanical Filters: Two-stage, mechanical-separation-type, air-line filters. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock. Include mounting bracket if wall mounting is indicated.
F. Air-Line Lubricators: With drip chamber and sight dome for observing oil drop entering air stream; with oil-feed adjustment screw and quick-release collar for easy bowl removal. Include mounting bracket if wall mounting is indicated.
   1. Provide with automatic feed device for supplying oil to lubricator.

2.7 QUICK COUPLINGS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aeroquip Corporation; Eaton Corp.
2. Bowes Manufacturing Inc.
3. Foster Manufacturing, Inc.
5. Parker Hannifin Corp.; Fluid Connectors Group; Quick Coupling Div.
6. Rectus Corp.
7. Schrader-Bridgeport; Amflo Div.
9. Snap-Tite, Inc.; Quick Disconnect & Valve Division.
10. TOMCO Products Inc.
11. Tuthill Corporation; Hansen Coupling Div.
12. Prior approved equal

B. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.

C. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.
1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.

D. Valveless Quick Couplings: Straight-through brass body with stainless-steel or nickel-plated-steel operating parts.
1. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.
2. Plug End: With barbed outlet for attaching hose.

2.8 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Compressed-Air Piping between Air Compressors and Receivers: Use one of the following piping materials for each size range:
1. Type K or L, copper tube; wrought-copper fittings; and brazed joints.

B. Low-Pressure Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:
1. Type K or L, copper tube; wrought-copper fittings; and brazed joints.
2. Type K or L, copper tube; press-type fittings; and pressure-sealed joints.

3.2 VALVE APPLICATIONS

A. General-Duty Valves: Comply with requirements in Division 22 and 23 Section "Valves" for metal general-duty valves. Use metal valves, unless otherwise indicated.
1. Metal General-Duty Valves: Use valve types specified in "Valve Applications" Article in Division 22 and 23 Section "Valves" according to the following:
a. Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.
b. High-Pressure Compressed Air: Valve types specified for medium-pressure compressed air.
c. Equipment Isolation NPS 2 and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.
d. Grooved-end valves may be used with grooved-end piping and grooved joints.

3.3 PIPING INSTALLATION

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

B. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.

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

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.

E. Install piping adjacent to equipment and machines to allow service and maintenance.

F. Install air and drain piping with 1 percent slope downward in direction of flow.

G. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.

H. Equipment and Specialty Flanged Connections:
   1. Use steel companion flange with gasket for connection to steel pipe.
   2. Use cast-copper-alloy companion flange with gasket and brazed joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.

I. Flanged joints may be used instead of specified joint for any piping or tubing system.

J. Extended-tee outlets with brazed branch connection may be used for copper tubing, within extruded-tee connection diameter to run tube diameter ratio for tube type, according to Extruded Tee Connections Sizes and Wall Thickness for Copper Tube (Inches) Table in ASTM F 2014.

K. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

L. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

M. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22 and 23 Section "Meters and Gages."

N. Install piping to permit valve servicing.

O. Install piping free of sags and bends.

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

Q. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."

3.4 JOINT CONSTRUCTION

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

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
D. Welded Joints for Steel Piping: Join according to AWS D10.12/D10.12M.
E. Brazed Joints for Copper Tubing: Join according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
F. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
G. Pressure-Sealed Joints: Join with tools recommended by fitting manufacturer, using operators qualified according to Part 1 "Quality Assurance" Article.
H. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.5 VALVE INSTALLATION
A. General-Duty Valves: Comply with requirements in Division 22 and 23 Section "Valves."
B. Install shutoff valves and unions or flanged joints at compressed-air piping to air compressors.
C. Install shutoff valve at inlet to each automatic drain valve, filter, lubricator, and pressure regulator.
D. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

3.6 DIELECTRIC FITTING INSTALLATION
A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.7 FLEXIBLE PIPE CONNECTOR INSTALLATION
A. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter of each air compressor.
B. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.
C. Install stainless-steel-hose flexible pipe connectors in steel compressed-air piping.

3.8 SPECIALTY INSTALLATION
A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.
B. Install air-main pressure regulators in compressed-air piping at or near air compressors.
C. Install air-line pressure regulators in branch piping to equipment.
D. Install automatic drain valves on aftercoolers, receivers, and dryers. Discharge condensate onto nearest floor drain.
E. Install coalescing filters in compressed-air piping at or near air compressors and upstream from mechanical filters. Mount on wall at locations indicated.
F. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters. Mount on wall at locations indicated.
G. Install quick couplings at piping terminals for hose connections.
H. Install hose assemblies at hose connections.

3.9 CONNECTIONS
A. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.
B. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment and machine.

3.10 SLEEVE INSTALLATION
A. Sleeves are not required for core-drilled holes.
B. Permanent sleeves are not required for holes formed by removable PE sleeves.
C. Install sleeves in new walls and slabs as new walls and slabs are constructed.
D. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
E. Fire-BARRIER Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

3.11 ESCUTCHEON INSTALLATION
A. Install escutcheons for penetrations of walls, ceilings, and floors.

3.12 HANGER AND SUPPORT INSTALLATION
A. Comply with requirements in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls" for seismic-restraint devices.
B. Comply with requirements in Division 22 and 23 Section "Hangers and Supports" for pipe hanger and support devices.
C. Vertical Piping: MSS Type 8 or 42, clamps.
D. Individual, Straight, Horizontal Piping Runs:
   1. 100 Feet or Less: MSS Type 1, adjustable, steel clevis hangers.
   2. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls.
   Support pipe rolls on trapeze.
F. Base of Vertical Piping: MSS Type 52, spring hangers.
G. Support horizontal piping within 12 inches of each fitting and coupling.
H. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1/4: 60 inches with 3/8-inch rod.
   2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
   4. NPS 1: 96 inches with 3/8-inch rod.
   6. NPS 1-1/2: 10 feet with 3/8-inch rod.
   7. NPS 2: 11 feet with 3/8-inch rod.
J. Install supports for vertical copper tubing every 10 feet.

3.13 LABELING AND IDENTIFICATION
A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Division 22 and 23 Section "Mechanical Identification."

3.14 FIELD QUALITY CONTROL
A. Perform field tests and inspections.
B. Tests and Inspections:
1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

2. Repair leaks and retest until no leaks exist.

3. Inspect filters lubricators and pressure regulators for proper operation.

C. Prepare test reports.

END OF SECTION 22 15 13
SECTION 22 15 19
GENERAL-SERVICE PACKAGED AIR COMPRESSORS AND RECEIVERS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
1. Lubricated, reciprocating air compressors.
2. Inlet-air filters.

1.3 DEFINITIONS
A. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in acfm.
B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
C. Standard Air: Free air at 68 deg F and 1 atmosphere (29.92 in. Hg) before compression or expansion and measured in scfm.

1.4 PERFORMANCE REQUIREMENTS
A. Seismic Performance: Compressed-air equipment shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.5 SUBMITTALS
A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   1. Wiring Diagrams: For power, signal, and control wiring.
B. Seismic Qualification Certificates: For compressed-air equipment, accessories, and components, from manufacturers.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
C. Operation and Maintenance Data: For compressed-air equipment to include in operation, and maintenance manuals.

1.6 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

1.7 COORDINATION
A. Coordinate sizes and locations of concrete bases with actual equipment provided.
1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Air-Compressor, Inlet-Air-Filter Elements: Equal to 100 percent of amount installed, but no fewer than 2 units.
   2. Belts: Two for each belt-driven compressor.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS AND RECEIVERS

A. General Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.

B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
   1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
   3. Control Voltage: 120-V ac or less, using integral control power transformer.
   5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
   6. Automatic control switches to air compressors.
   7. Instrumentation: Include discharge-air pressure gage, air-filter maintenance indicator, hour meter, compressor discharge-air and coolant temperature gages, and control transformer.
   8. Alarm Signal Device: For connection to alarm system to indicate when backup air compressor is operating.

C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   1. Pressure Rating: At least as high as highest discharge pressure of connected compressors, and bearing appropriate code symbols.
   2. Interior Finish: Corrosion-resistant coating.
   3. Accessories: Include safety valve, pressure gage, drain, and pressure-reducing valve.

D. Mounting Frame: Fabricate mounting and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

2.2 LUBRICATED, RECIPROCATING AIR COMPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Gardner Denver, Inc.
   3. Ingersoll-Rand; Air Solutions Group.
   4. Quincy Compressor; an EnPro Industries company.
   5. Prior approved equal.
B. Compressor(s): Lubricated, reciprocating-piston type with lubricated compression chamber and crankcase.
   1. Submerged gear-type oil pump.
   2. Oil filter.
   3. Combined high discharge-air temperature and low lubrication-oil pressure switch.
   4. Belt guard totally enclosing pulleys and belts.

C. Capacities and Characteristics:
   1. Air Compressor(s): Two; stage.
      a. Intercooler between stages of two-stage units.
      b. Interior Finish: Epoxy or galvanized coating.
      c. Pressure Rating: 125 psig minimum.

2.3 INLET-AIR FILTERS
   A. Description: Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.
      1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
      2. Capacity: Match capacity of air compressor, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

B. Description: Combination inlet-air filter-silencer, suitable for remote installation, for multiple air compressors.
   1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
   2. Capacity: Match total capacity of connected air compressors, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

2.4 MOTORS
   A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 and 23 Section "Motors."
      1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
      2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION
   A. Equipment Mounting: Install air compressors on concrete bases using elastomeric pads. Comply with requirements for vibration isolation devices specified in Division 22 and 23 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
      2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Arrange equipment so controls and devices are accessible for servicing.

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Install the following devices on compressed-air equipment:
   1. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
   2. Pressure Regulators: Install downstream from air compressors.
   3. Automatic Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

3.2 CONNECTIONS
A. Comply with requirements for piping specified in Division 22 and 23 Section "General-Service Compressed-Air Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

3.3 IDENTIFICATION
A. Identify general-service air compressors and components. Comply with requirements for identification specified in Division 22 and 23 Section "Mechanical Identification."

3.4 STARTUP SERVICE
A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check for lubricating oil in lubricated-type equipment.
   3. Check belt drives for proper tension.
   4. Verify that air-compressor inlet filters and piping are clear.
   5. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
   6. Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure but not higher than rating of system components.
   7. Check for proper seismic restraints.
   8. Drain receiver tanks.
   9. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  10. Test and adjust controls and safeties.

3.5 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air compressors.

END OF SECTION 22 15 19
SECTION 22 33 00
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. Light-commercial electric water heaters.
   2. Compression 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.
B. Shop Drawings: Diagram power, signal, and control wiring.
C. Product Certificates: For each type of commercial and instantaneous electric water heater, signed by product manufacturer.
D. Manufacturer Seismic Qualification Certification: Submit certification that commercial water heaters, accessories, and components will withstand seismic forces defined in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
      b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
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.

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:
   b. Light-Commercial Electric Water Heaters:
      1) Storage Tank: Five years.
      2) Controls and Other Components: Two years.
   c. Compression Tanks: One year.

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 LIGHT-COMMERCIAL ELECTRIC WATER HEATERS

A. Description: Comply with UL 174 for household, storage electric water heaters.

1. Manufacturers:
   c. Electric Heater Company (The); Hubbell Heaters Division.
   d. GSW Water Heating Company.
   e. Heat Transfer Products, Inc.
   f. Lochinvar Corporation.
   i. Smith, A. O. Water Products Company.
   j. State Industries, Inc.
   k. Prior approved equal.

2. Storage-Tank Construction: Steel, vertical arrangement.
   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.

3. Factory-Installed Storage-Tank Appurtenances:
   a. Anode Rod: Replaceable magnesium.
   b. Dip Tube: Provide unless cold-water inlet is near bottom of tank.
   c. Drain Valve: ASSE 1005.
   d. Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2.
   e. Jacket: Steel with enameled finish.
   f. Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
   g. Heating Elements: Two; electric, screw-in immersion type; wired for simultaneous operation, unless otherwise indicated.
   h. Temperature Control: Adjustable thermostat for each element.
   i. Safety Control: High-temperature-limit cutoff device or system.
   j. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

4. Special Requirements: NSF 5 construction with legs for off-floor installation.

5. Capacity and Characteristics:
   a. See drawings for size, capacity, electrical characteristics, etc.

2.3 COMPRESSION TANKS
   A. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
   1. Manufacturers:
      a. AMTROL Inc.
      b. Armstrong Pumps, Inc.
      c. Flexcon Industries.
      d. Honeywell Sparco.
      e. Myers, F. E.; Pentair Pump Group (The).
      f. Smith, A. O.; Aqua-Air Div.
      g. State Industries, Inc.
      h. Taco, Inc.
      i. Watts Regulator Co.
      j. Wessels Co.
      k. Prior approved equal.
   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.
2.4 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. Water Heater Stand and Drain-Pan Units: High-density-polyethylene-plastic, 18-inch high, enclosed-base stand complying with IAPMO PS 103 and IAS No. 2. Include integral or separate drain pan with raised edge and NPS 1 drain outlet with ASME B1.20.1 pipe thread.

D. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches above the floor.

E. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.

F. 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.

G. Piping Manifold Kits: Water heater manufacturer's factory-fabricated inlet and outlet piping arrangement for multiple-unit installation. Include piping and valves for field assembly that are capable of isolating each water heater and of providing balanced flow through each water heater.

H. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

I. Water Regulators: ASSE 1003, water-pressure reducing valve. Set at 25-psig maximum outlet pressure, unless otherwise indicated.

J. Shock Absorbers: ASSE 1010 or PDI WH 201, Size A water hammer arrester.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

A. 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.

B. Install seismic restraints for light-commercial and commercial water heaters. Anchor to substrate.

C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 and 23 Section "Plumbing Specialties" for hose-end drain valves.

F. Install thermometer on outlet piping of water heaters. Refer to Division 22 and 23 Section "Meters and Gages" for thermometers.

G. Install thermometers on inlet and outlet piping of household, collector-to-tank, solar-electric water heaters. Refer to Division 22 and 23 Section "Meters and Gages" for thermometers.
H. Install pressure gage(s) on inlet and outlet of commercial electric water-heater piping. Refer to Division 22 and 23 Section "Meters and Gages" for pressure gages.

I. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve, thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Refer to Division 22 and 23 Section "Valves" for general-duty valves and to Division 22 and 23 Section "Meters and Gages" for thermometers.

J. Install water regulator, with integral bypass relief valve, in booster-heater inlet piping and water hammer arrester in booster-heater outlet piping.

K. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.

L. Fill water heaters with water.

M. Charge compression tanks with air.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. 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.

B. 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 and instantaneous electric water heaters. Refer to Division 1 Section "Closeout Procedures Demonstration and Training."

END OF SECTION 22 33 00
SECTION 22 40 00
PLUMBING FIXTURES

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following conventional plumbing fixtures and related components:
   1. Lavatories.
   2. Lavatory Faucets.
   3. Water closets.
   4. Toilet seats.
   5. Flushometers - Water Closets.
   6. Urinals.
   7. Flushometers - Urinals.
   8. Fixture supports.
  10. Commercial sinks.
  11. Sink Faucets.
  12. Service sinks.
B. Related Sections include the following:
   1. Division 22 Section "Plumbing Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.

1.3 DEFINITIONS
B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.
E. 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.
F. FRP: Fiberglass-reinforced plastic.
G. PMMA: Polymethyl methacrylate (acrylic) plastic.
H. PVC: Polyvinyl chloride plastic.

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. Operation and Maintenance Data: For plumbing fixtures to include in operation, and maintenance manuals.

C. Warranty: Special warranty specified in this Section.

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.


E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

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

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

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
5. Vitreous-China Fixtures: ASME A112.19.2M.

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

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
5. Hose-Connection Vacuum Breakers: ASSE 1011.
I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
   2. Brass and Copper Supplies: ASME A112.18.1.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Disposers: ASSE 1008 and UL 430.
   3. Floor Drains: ASME A112.6.3.
   7. Off-Floor Fixture Supports: ASME A112.6.1M.

1.6 WARRANTY
   A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
      1. Failures include, but are not limited to, the following:
         a. Structural failures of unit shell.
         b. Faulty operation of controls, blowers, pumps, heaters, and timers.
         c. Deterioration of metals, metal finishes, and other materials beyond normal use.
      2. Warranty Period: One year from date 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 Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
      2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
      3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 2 of each type.
      4. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.

PART 2 - PRODUCTS
2.1 LAVATORIES
   A. Lavatories:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Inc.
   b. Commercial Enameling Company.
   c. Eljer.
   d. Kohler Co.
   e. Crane.
   f. Sloan
   g. Zurn.

2. Description: Accessible, wall-mounting, vitreous-china fixture.
   a. Type: With back.
   b. Size: 20 by 18 inches rectangular.
   c. Faucet Hole Punching: Three holes, 4-inch centers.
   e. Supplies: NPS 3/8 chrome-plated copper with stops.
   f. Drain: Grid with offset waste.
      1) Location: Near back of bowl.

B. Mixing valve:
   1. Valve shall be thermostatic and pressure mixing valve with maximum 5 degree approach temperature.
   2. Approved Manufacturers -
      a. Powers hydroguard TP or equal by
      b. Sloan
      c. Prior approved equal

2.2 LAVATORY FAUCETS

A. Lavatory Faucets:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Inc.
      b. Bradley Corporation.
      c. Chicago Faucets.
      d. Delta Faucet Company.
      e. Eljer.
      f. Elkay Manufacturing Co.
      g. Fisher Manufacturing Co.
      h. Just Manufacturing Company.
      i. Kohler Co.
      j. Moen, Inc.
      l. Sayco; a Briggs Plumbing Products, Inc. Company.
      m. Speakman Company.
      n. Sloan
2. Description: Sensor. 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.
   d. Centers: 4 inches.
   e. Mounting: Deck, concealed.
   f. Spout: Rigid type.
   g. Spout Outlet: Aerator.
   h. Drain: Grid.
   i. Tempering Device: Thermostatic.

2.3 WATER CLOSETS
A. Water Closets, Wall Mounted Flush Valve:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Kohler Co. K-4330-ET or equal by
         1) Zurn.
         2) American Standard Companies, Inc. AFT Wall Water Saver 2257.103.
         3) Crane Plumbing, L.L.C./Fiat Products.
         4) Eljer.
         5) Sloan
         6) Prior approved equal.
   2. Description: Accessible, Where indicated on drawings, wall Wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
      a. Style: Flushometer valve.
         1) Bowl Type: Elongated with siphon-jet design.
         2) Design Consumption: 1.6 gal./flush.
      b. Flushometer.

2.4 TOILET SEATS
A. Toilet Seats:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Comfort seats C108SSCAM or equal.
      b. American Standard Companies, Inc.
      c. Bemis Manufacturing Company.
      d. Church Seats.
      e. Eljer.
      f. Kohler Co.
      g. Olsonite Corp.
2. Description: Toilet seat for water-closet-type fixture.
   a. Material: Molded, heavy duty, solid, anti-microbial plastic.
   b. Configuration: Open front without cover.
   c. Hinge Type: Stainless Steel, self-sustaining.
   d. Class: Standard commercial.
   e. Color: White.

2.5 FLUSHOMETERS-WATER CLOSETS

A. Flushometers, Water Closets:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Coyne & Delany Co.
      b. Sloan Valve Company.
      c. Zurn Plumbing Products Group.
   2. Description: Flushometer for water closet 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. Inlet Size: NPS 1".
      d. Trip Mechanism: Battery-operated sensor actuator.
      e. Consumption: 1.6 gal./flush.

2.6 URINALS

A. Urinals:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard Companies, Inc.
      b. Briggs Plumbing Products, Inc.
      c. Crane Plumbing, L.L.C./Fiat Products.
      d. Eljer.
      e. Kohler Co.
      f. Dexter K 5016-T
      g. Sloan
      h. TOTO USA, Inc.
      i. Zurn.
      j. Prior approved equal.
   2. Description: Accessible, where indicated on drawings, Wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
      a. Type: Blowout with extended shields.
      b. Strainer or Trapway: Open trapway with integral trap.
      c. Design Consumption: 1 gal./flush.
f. Outlet Size: NPS 1-1/2.

2.7 FLUSHOMETERS-URINALS

A. Flushometers, Urinals:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Coyne & Delany Co.
   b. Sloan Valve Company.
   c. Zurn Plumbing Products Group.

2. Description: Flushometer for 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.
   d. Trip Mechanism: Battery-operated sensor actuator.
   e. Consumption: 1.0 gal./flush.

2.8 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. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
7. Prior approved equal.

B. Water-Closet Supports:

1. Description: Combination carrier designed for accessible or standard mounting height as required 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.

C. Urinal Supports:

1. Description: Type I, 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.

D. Lavatory Supports:

1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.

E. Sink Supports:
1. Description: Type II, sink carrier with hanger plate, bearing studs, and tie rod for sink-type fixture. Include steel uprights with feet.

2.9 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Piping Enclosures:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. TRUEBRO, Inc.
      b. Plumberex.
      c. McGuire.
      d. Proflo.
      e. Prior approved equal.
   2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

2.10 COMMERCIAL SINKS

A. Commercial Sinks, Single Compartment Break Room Sink:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elkay Manufacturing Co.
      b. Just Manufacturing Company.
      c. Prior approved equal.
   2. Description: One-compartment, counter-mounting, stainless-steel commercial sink with backsplash.
      b. Metal Thickness: 18 Gauge.
      c. Compartment:
         1) Drain: NPS 1-1/2 tailpiece with stopper.
            a) Location: Centered in compartment.
   B. Commercial Sinks, Two Compartment:
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. Elkay Manufacturing Co.
         b. Just Manufacturing Company.
         c. Prior approved equal.
      2. Description: Two-compartment, freestanding, stainless-steel commercial sink with backsplash.
         b. Metal Thickness: 18 Gauge.
         c. Compartment:
            1) Dimensions: See drawings.
            2) Drain: NPS 1-1/2 tailpiece with stopper.
               a) Location: Centered in compartment.

2.11 SINK FAUCETS

A. Sink Faucets One compartment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Inc.
   b. Bradley Corporation.
   c. Chicago Faucets.
   d. Delta Faucet Company.
   e. Eljer.
   f. Elkay Manufacturing Co.
   g. Fisher Manufacturing Co.
   h. Just Manufacturing Company.
   i. Kohler Co.
   j. Moen, Inc.
   k. Sayco; a Briggs Plumbing Products, Inc. Company.
   l. Speakman Company.
   m. T & S Brass and Bronze Works, Inc.
   n. Zurn Plumbing Products Group.

2. Description: Kitchen faucet without spray. 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: 2.5 gpm, unless otherwise indicated.
   d. Mixing Valve: Single control.
   e. Mounting: Deck.
   f. Handle(s): Lever.
   g. Spout Type: Swing, solid brass.
   h. Spout Outlet: Aerator.
   Drain: basket strainer

2.12 SERVICE SINKS

A. Service Sinks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Inc.
   b. Commercial Enameling Company.
   c. Eljer.
   d. Kohler Co.

2. Description: Floor-mounting, enameled, cast-iron fixture with front apron, raised back, and coated, wire rim guard.
   a. Size: 28 by 28 inches.
   c. Faucet: Sink American Standard 8344.111 with threaded spout and 48 inch hose and damp or equal by
1) Eljer.
2) Kohler.
3) Speakman.

d. Drain: Grid with NPS 2 outlet.

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. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 and 23 Section "Valves."

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. 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.

M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

N. Install toilet seats on water closets.

O. 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.

P. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
Q. 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.

R. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

S. 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.

T. 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 Division 22 and 23 Section "Basic Mechanical Materials and Methods."

U. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 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 Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

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.

E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

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

B. Operate and adjust all fixtures. Replace damaged and malfunctioning units and controls.

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

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

E. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   2. Remove sediment and debris from drains.

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 22 40 00
SECTION 22 47 00
DRINKING FOUNTAINS AND 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. Pressure 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. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.
D. Fitting: Device that controls flow of water into or out of fixture.
E. Fixture: Drinking fountain or water cooler unless one is specifically indicated.
F. 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 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. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

1.6 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. Filter Cartridges: Equal to 100 percent of amount installed for each type and size indicated, but no fewer than 1 of each.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS

A. Water Coolers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elkay Manufacturing Co. model EZSTL8C or equal by
      b. Acorn Aqua.
      c. Haws Corporation.
      d. Prior approved equal.
   2. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-mounting water cooler for adult and child-mounting height.
      a. Cabinet: Bilevel with two attached cabinets and with bilevel skirt kit.
      b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
      c. Control: Push bar.
      d. Supply: NPS 3/8 with ball, gate, or globe valve.
      e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
      f. Drain(s): Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.1.
      g. Provide with auxiliary bottle filler, Elkay EZH20 or prior approved equal.
      h. Cooling System: Electric, with 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.
         2) Electrical Characteristics: 1/3 hp; 120-V ac; single phase; 60 Hz.
      i. 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.
   7. Prior approved equal.

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 II: Bilevel, hanger-type carrier with three vertical uprights.
   2. 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 mounting frames for recessed water coolers, unless otherwise indicated.
C. Set freestanding and pedestal drinking fountains on floor.
D. Set remote water coolers on floor, unless otherwise indicated.
E. 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 required by authorities having jurisdiction.
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 Division 22 and 23 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 Division 22 and 23 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 Division 7 Section "Joint Sealants."

3.4 CONNECTIONS
A. Piping installation requirements are specified in other Division 22 and 23 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 Division 26 Section "Grounding and Bonding."
D. Connect wiring according to Division 26 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 22 47 00
SECTION 23 01 00
GENERAL REQUIREMENTS FOR PLUMBING AND HVAC

PART 1 - GENERAL

1.1 GENERAL
   A. General Conditions and Division 01 apply to this Division.
   B. See Section 220100, “General Requirements for Plumbing and HVAC.”

1.2 SCOPE
   A. All requirements and information contained in Division 22 Section 220100, “General Requirements for Plumbing and HVAC” shall apply to both Divisions 22 and 23.

1.3 SITE OBSERVATION
   A. The Contractor shall examine the site and understand the conditions which may affect the performance of work of this Division before submitting proposals for this work.
   B. No subsequent allowance for time or money will be considered for any consequence related to failure to examine existing site conditions.

1.4 DRAWINGS
   A. See Section 220100, “General Requirements for Plumbing and HVAC.”

1.5 COORDINATION OF WORK:
   A. See Section 220100, “General Requirements for Plumbing and HVAC.”

1.6 EQUIPMENT & MATERIALS:
   A. See Section 220100, “General Requirements for Plumbing and HVAC.”

1.7 PROJECT SUBMITTALS:
   A. See Section 220100, “General Requirements for Plumbing and HVAC.”

1.8 WARRANTY GUARANTEE:
   A. See Section 220100, “General Requirements for Plumbing and HVAC.”
   B. The Contractor shall warrant all materials and equipment to be of quality consistent with specifications as represented by manufacturer's published data.
   C. The Contractor shall guarantee that the installation and operation of the equipment shall be free from defects for a period of one year beginning at date of substantial completion and acceptance. The Contractor shall replace or repair any part of the installation that is found to be defective or incomplete within the guarantee period.
   D. The one year guarantee on equipment and systems shall commence when equipment has been demonstrated to work and has been accepted. (Example: If an equipment item fails to perform and it takes 9 months after substantial completion to correct, then the guarantee shall commence after the item has been demonstrated to perform and has been accepted.)
   E. Substantial completion and acceptance in no way relieves the Contractor from providing the systems and equipment as specified.
1.9  OPERATION AND MAINTENANCE MANUAL FOR MECHANICAL SYSTEMS

A.  See Section 220100, "General Requirements for Plumbing and HVAC."

PART 2 - PRODUCTS
(Not Used)
PART 3 - EXECUTION
(Not Used)

END OF SECTION 23 01 00
SECTION 23 05 00
BASIC PLUMBING AND HVAC 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.
B. Division 22, Section 220500, “Basic Plumbing and HVAC Materials and Methods.”

1.2 SUMMARY
A. All requirements in Division 22, Section 220500, “Basic Plumbing and HVAC Materials and Methods” shall apply to both Divisions 22 and 23.
1. Equipment installation requirements common to equipment sections.

PART 2 - PRODUCTS

2.1 See Division 22, Section 220500, “Basic Plumbing and HVAC Materials and Methods.”

PART 3 - EXECUTION

3.1 See Division 22, Section 220500, “Basic Plumbing and HVAC Materials and Methods”

END OF SECTION 23 05 00
SECTION 23 05 23
VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 1 Specification Sections, apply to this Section.
   B. Section 220523 Valves

1.2 SUMMARY
   A. Section 220523 “Valves” shall apply to both Divisions 22 and 23.

PART 2 - PRODUCTS

2.1 SEE SECTION 220523 “Valves”

PART 3 - EXECUTION

3.1 SEE SECTION 220523 “Valves”

END OF SECTION 23 05 23
SECTION 23 05 48
VIBRATION AND SEISMIC CONTROLS FOR HVAC AND 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 1 Specification Sections, apply to this Section.
   B. Section 220548 “Vibration and Seismic Controls for HVAC and Plumbing Piping and
      Equipment” shall apply to both divisions 22 and 23.

1.2 SUBMITTALS
   A. See section 220548:

PART 2 - PRODUCTS

2.1 See section 220548 “Vibration and Seismic Controls for HVAC and Plumbing Piping and
     Equipment”

PART 3 - EXECUTION

3.1 See section 220548 “Vibration and Seismic Controls for HVAC and Plumbing Piping and
     Equipment”

END OF SECTION 23 05 48
SECTION 23 05 53
IDENTIFICATION FOR MECHANICAL AND PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary
   Conditions and Division 1 Specification Sections, apply to this Section.
B. Section 22 “Identification for Mechanical and Plumbing Piping and Equipment”

SUMMARY
C. Section 22 “Identification for Mechanical and Plumbing Piping and Equipment” shall apply to
   both divisions 22 and 23.

PART 2 - PRODUCTS
SEE SECTION 22 “Identification for Mechanical and Plumbing Piping and Equipment”

PART 3 - EXECUTION
SEE SECTION 22 “Identification for Mechanical and Plumbing Piping and Equipment”

END OF SECTION 23 05 53
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 TAB to produce design objectives for the following:
      1. Air Systems:
         a. Constant-volume air systems.
         b. Variable-air-volume systems.
      2. Hydronic Piping Systems:
         a. Constant-flow systems.
         b. Variable-flow systems.
         c. Primary-secondary systems.
      3. HVAC equipment quantitative-performance settings.
      4. Existing systems TAB.
      5. Verifying that automatic control devices are functioning properly.
      6. Reporting results of activities and procedures specified in this Section.

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 indicated quantities.
   C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
   D. 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.
   E. NC: Noise criteria.
   F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
   G. RC: Room criteria.
   H. Report Forms: Test data sheets for recording test data in logical order.
   I. 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.
   J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
   K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   L. 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.
   M. TAB: Testing, adjusting, and balancing.
N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

O. Test: A procedure to determine quantitative performance of systems or equipment.

P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

A. Qualification Data: Within 15 days from Contractor's Notice to Proceed, submit 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.


C. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 4 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

E. Sample Report Forms: Submit two sets of sample TAB report forms.

F. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC or NEBB.

B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:
   a. Submittal distribution requirements.
   c. TAB 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 TAB Reports: Certify TAB field data reports. This certification includes the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.


E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or 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 six months or more frequently if required by instrument manufacturer.
1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

G. Approved TAB agencies:
   1. Bonneville Test and Balance.
   2. BTC Services.
   3. Certified Test and Balance.
   4. Intermountain Test and Balance.
   5. Mechanical Testing Corporation
   6. RS Analysis.
   7. Tempco
   8. Testing and Balancing, Inc.

1.6 PROJECT CONDITIONS
   A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
   B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with 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 TAB activities.
   B. Notice: Provide seven days’ advance notice for each test. Include scheduled test dates and times.
   C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY
   A. National Project Performance Guarantee: Provide a guarantee on AABC’s “National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems” forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
      1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
      2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS
(Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems’ designs that may preclude proper TAB of systems and equipment.
      1. Contract Documents are defined in the General and Supplementary Conditions of 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 Project Record Documents described in Division 1 Section “Project Record Documents.”

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems’ output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. 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 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.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. 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 that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

L. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

M. Examine strainers for clean screens and proper perforations.

N. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

P. Examine system pumps to ensure absence of entrained air in the suction piping.

Q. Examine equipment for installation and for properly operating safety interlocks and controls.

R. Examine automatic temperature system components to verify the following:
   1. Dampers, valves, and other controlled devices are operated by the intended controller.
   2. Dampers and valves are in the position indicated by the controller.
   3. 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 two-way valves and three-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 indicated values.

9. Interlocked systems are operating.

10. Changeover from heating to cooling mode occurs according to indicated values.

S. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare 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 indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC’s "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or 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 insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems’ “as-built” duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check airflow patterns from the 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.
L. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure fan static pressures to determine actual static pressure as follows:
      a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
      b. Measure static pressure directly at the fan outlet or through the flexible connection.
      c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
      d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
   2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
      a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
   3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
   4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
   5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
   6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
   1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
      a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
   2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.
   1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.

2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

3. Measure total system airflow. Adjust to within indicated airflow.

4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.

5. 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 outlets balanced for maximum airflow.

6. Remeasure 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.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.

8. Record the final fan performance data.

3.7 GENERAL 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.
3.8 PROCEDURES FOR HYDRONIC SYSTEMS
A. Measure 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. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
   2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
   3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on 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 indicated flow.
E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
   1. Determine the balancing station with the highest percentage over indicated flow.
   2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated 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.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS
A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS
A. Balance the primary system crossover flow first, then balance the secondary system.

3.11 PROCEDURES FOR 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.
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.

3.12 PROCEDURES FOR CONDENSING UNITS
A. Verify proper rotation of fans.
B. Measure entering- and leaving-air temperatures.
C. Record compressor data.

3.13 PROCEDURES FOR HEAT-TRANSFER COILS
A. Water Coils: Measure the following data for each coil:
   1. Entering- and leaving-water temperature.
   2. Water flow rate.
   3. Water pressure drop.
   4. Dry-bulb temperature of entering and leaving air.
   5. Wet-bulb temperature of entering and leaving air for cooling coils.
   6. Airflow.
   7. Air pressure drop.
B. Refrigerant Coils: Measure the following data for each coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Wet-bulb temperature of entering and leaving air.
   3. Airflow.
   4. Air pressure drop.
   5. Refrigerant suction pressure and temperature.

3.14 PROCEDURES FOR TEMPERATURE MEASUREMENTS
A. During TAB, report the 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 two successive eight-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.

3.15 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS
A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
   1. Measure and record the operating speed, airflow, and static pressure of each fan.
   2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
   3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate drain trap.
7. Check bearings and other lubricated parts for proper lubrication.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished.
   1. New filters are installed.
   2. Coils are clean and fins combed.
   3. Drain pans are clean.
   4. Fans are clean.
   5. Bearings and other parts are properly lubricated.
   6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
   1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan, speed, filter, and coil face velocity.
   2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
   3. If calculations increase or decrease the airflow and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated airflow and water flow rates. If 5 percent or less, equipment adjustments are not required.
   4. Air balance each air outlet.

3.16 PROCEDURES FOR TESTING DUCT SYSTEMS
A. Perform duct leakage tests and duct cleanliness tests.
B. Duct system will be considered defective if it does not pass initial tests and inspections. The sheet metal contractor shall be responsible to make corrections and repairs as necessary to pass the tests. TAB contractor shall include initial test and 1 follow up test. Any additional follow up tests required due to system not passing shall be performed by the TAB contractor at the Division 22 and 23 contractor’s expense.

3.17 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. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
E. Check free travel and proper operation of control devices such as damper and valve operators.
F. Check the 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. Check the interaction of electrically operated switch transducers.
H. Check the interaction of interlock and lockout systems.
I. Check main control supply-air pressure and observe compressor and dryer operations.
J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.18 TOLERANCES
A. Set HVAC system airflow and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
   2. Air Outlets and Inlets: 0 to minus 10 percent.
   3. Heating-Water Flow Rate: 0 to minus 10 percent.
   4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.19 REPORTING
A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
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.

3.20 FINAL REPORT
A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-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 instruments used for procedures, along with proof of calibration.
C. Provide final report on standard AABC or NEBB forms.

3.21 INSPECTIONS
A. Initial Inspection:
   1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
   2. Randomly check the following for each system:
      a. Measure airflow of at least 10 percent of air outlets.
      b. Measure water flow of at least 5 percent of terminals.
      c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
      d. Measure sound levels at two locations.
      e. Measure space pressure of at least 10 percent of locations.
      f. Verify that balancing devices are marked with final balance position.
      g. Note deviations to the Contract Documents in the Final Report.
B. Final Inspection:
   1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.

3. Architect shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.

4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.

7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.22 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   B. See section 220700 for HVAC and plumbing insulation.

1.2 SUMMARY
   A. Section 220700 HVAC and Plumbing insulation shall apply to insulation requirements for both division 22 and 23.
   B. Division 23 Section 233113 "Metal Ducts" for duct liners.

1.3 SUBMITTALS
   A. See section 220700.

PART 2 - PRODUCTS

2.1 See section 220700.

PART 3 - EXECUTION

3.1 See section 220700

END OF SECTION 23 07 00
SECTION 23 11 23
FACILITY NATURAL-GAS 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. Section Includes:
1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.3 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, crawlspaces, and tunnels.
B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS
A. Minimum Operating-Pressure Ratings:
1. Piping and Valves: 100 psig minimum unless otherwise indicated.

1.5 SUBMITTALS
A. Product Data: For each type of the following:
1. Piping specialties.
2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Indicate pressure ratings and capacities.
B. Welding certificates.
C. Field quality-control reports.
D. Operation and Maintenance Data: For pressure regulators to include in operation, and maintenance manuals.

1.6 QUALITY ASSURANCE
A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

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

1.9 COORDINATION

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

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 8 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
      b. End Connections: Threaded or butt welding to match pipe.
      c. Lapped Face: Not permitted underground.
      e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
   5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
      a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.

2.3 JOINING MATERIALS
A. Joint Compound and Tape: Suitable for natural gas.

2.4 MANUAL GAS SHUTOFF VALVES
A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
   1. CWP Rating: 125 psig.
   3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
   5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
   6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
   1. CWP Rating: 125 psig.
   2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
   4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. BrassCraft Manufacturing Company; a Masco company.
      c. Lyall, R. W. & Company, Inc.
      e. Perfection Corporation; a subsidiary of American Meter Company.
      f. Prior approved equal.
   3. Ball: Chrome-plated brass.
   4. Stem: Bronze; blowout proof.
   5. Seats: Reinforced TFE; blowout proof.
   6. Packing: Separate packnut with adjustable-stem packing threaded ends.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 EARTHQUAKE VALVES
A. Earthquake Valves: Comply with ASCE 25.
   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. Vanguard Valves, Inc.
      b. Safe-T-Quake.
      c. Koso
      d. Trembler Tech
      e. Prior approved equal.
   2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   3. Maximum Operating Pressure: 5 psig.
   5. Nitrile-rubber valve washer.
   7. Threaded end connections complying with ASME B1.20.1.
   8. Wall mounting bracket with bubble level indicator.

2.6 PRESSURE REGULATORS
A. General Requirements:
   1. Single stage and suitable for natural gas.
   2. Steel jacket and corrosion-resistant components.
   3. Elevation compensator.
   4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Actaris.
      b. American Meter Company.
      c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
      d. Invensys.
      e. Richards Industries; Jordan Valve Div.
      f. Prior approved equal.
   2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: [100 psig] <Insert pressure>.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION
A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.
   1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
C. Install underground, PE, natural-gas piping according to ASTM D 2774.
D. Install fittings for changes in direction and branch connections.
E. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
F. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
G. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
H. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 22 and 23 Section "Meters and Gages."

3.4 INDOOR PIPING INSTALLATION
A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. 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.

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

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

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

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

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

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

K. Install escutcheons at penetrations of interior walls, ceilings, and floors.

1. New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
   c. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
   d. Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
   e. Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated or rough-brass finish.

L. 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 Division 7 Section "Through-Penetration Firestop Systems."

M. Verify final equipment locations for roughing-in.

N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

Q. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

R. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.

2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.

3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.

4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
   a. Exception: Tubing passing through partitions or walls does not require striker barriers.

5. Prohibited Locations:
   a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
   b. Do not install natural-gas piping in solid walls or partitions.

S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

T. Connect branch piping from top or side of horizontal piping.

U. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

V. Do not use natural-gas piping as grounding electrode.

W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

X. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 22 and 23 Section "Meters and Gages."

3.5 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

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

C. Threaded Joints:
   1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
   2. Cut threads full and clean using sharp dies.
   3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
   4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. 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.

D. Welded Joints:
   2. Bevel plain ends of steel pipe.
   3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.7 HANGER AND SUPPORT INSTALLATION
   A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 and 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
   B. Comply with requirements for pipe hangers and supports specified in Division 22 and 23 Section "Hangers and Supports."
   C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
      1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
      2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
      3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
      4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
      5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.8 CONNECTIONS
   A. Connect to utility's gas main according to utility's procedures and requirements.
   B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
   C. Install piping adjacent to appliances to allow service and maintenance of appliances.
   D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
   E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING
   A. Comply with requirements in Division 22 and 23 Section "Mechanical Identification" for piping and valve identification.
   B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING
   A. Comply with requirements in Division 9 painting Sections for painting interior and exterior natural-gas piping.
   B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
      1. Alkyd System: MPI EXT 5.1D.
         c. Topcoat: Exterior alkyd enamel (flat).
d. Color: By owner.
C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
  1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
     c. Topcoat: Interior latex (semigloss).
     d. Color: By owner.
D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL
A. Perform tests and inspections.
B. Tests and Inspections:
   1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.

3.12 OUTDOOR PIPING SCHEDULE
A. Aboveground natural-gas piping shall be the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.

3.13 INDOOR PIPING SCHEDULE
A. Aboveground, branch piping shall be the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
B. Aboveground, distribution piping 2” and larger shall be the following:
   1. Steel pipe with wrought-steel fittings and welded joints.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE
A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:
   1. One-piece, bronze ball valve with bronze trim.
B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.
   3. Cast-iron, nonlubricated plug valve.
C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
   1. One-piece, bronze ball valve with bronze trim.
D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.
   3. Cast-iron, lubricated plug valve.

END OF SECTION 23 11 23
SECTION 23 31 13
METAL DUCTS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
1. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. Double-wall round and flat-oval ducts and fittings.
4. Sheet metal materials.
5. Duct liner.
7. Hangers and supports.
B. Related Sections:
1. Division 22 and 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
2. Division 22 and 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing requirements for metal ducts.

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:
   a. Supply Ducts (except in Mechanical Rooms): 2-inch wg.
   b. Supply Ducts (Upstream from Air Terminal Units): 3-inch wg.
   c. Supply Ducts (Downstream from Air Terminal Units): 1-inch wg.
   d. Supply Ducts (in Mechanical Equipment Rooms): 2-inch wg.
   e. Return Ducts (Negative Pressure): 1-inch wg.
2. Leakage Class:
   a. Round Supply-Air Duct: 3 cfm/100 sq. ft. at 1-inch wg.
   b. Flat-Oval Supply-Air Duct: 3 cfm/100 sq. ft. at 1-inch wg.
   c. Rectangular Supply-Air Duct: 6 cfm/100 sq. ft. at 1-inch wg.
   d. Flexible Supply-Air Duct: 6 cfm/100 sq. ft. at 1-inch wg.
B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

1.4 SUBMITTALS
A. Product Data: For each type of the following products:
   1. Liners and adhesives.
   2. Sealants and gaskets.
B. Welding certificates.
C. Field quality-control reports.

1.5 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, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS
A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
1. Manufacturers: Subject to compliance with requirements, 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. Sheet Metal Connectors, Inc.
   e. Spiral Manufacturing Co., Inc.
   f. Metco.
   g. Prior approved equal.
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, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "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."

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."

2.3 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. Sheet Metal Connectors, Inc.
5. Metco.
6. Prior approved equal.

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: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "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. Longitudinal Seams: Select seam types and fabricate according to 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."

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. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
   3. Coat insulation with antimicrobial coating.
   4. Cover insulation with polyester film complying with UL 181, Class 1.

2.4 SHEET METAL MATERIALS

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

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. 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.

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

2.5 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. Prior approved equal.
      f. 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. Solvent-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

4. Duct insulation shall have a minimum R value = 5 for installation in an unconditioned space, and a minimum R value = 8 for installation outdoors.

B. Insulation Pins and Washers:
   1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 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. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
   7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
   8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
      a. Fan discharges.
      b. Intervals of lined duct preceding unlined duct.
      c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
   9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
      a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
   10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.
2.6 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   5. Mold and mildew resistant.
   6. VOC: Maximum 75 g/L (less water).
   7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   8. Service: Indoor or outdoor.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.
   2. Type: S.
   3. Grade: NS.
   5. Use: O.

D. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 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, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 22 Section "Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 SEAM AND JOINT SEALING

A. Seal duct seams and joints for duct static-pressure and leakage classes specified in "Performance Requirements" Article, according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements," unless otherwise indicated.

1. For static-pressure classes 1- and 1/2-inch wg, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class C, except as follows:
   a. Ducts that are located directly in zones they serve.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.

2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "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.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 22 and 23 Section "Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:
   2. Test the following systems:
      a. Supply air.
   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.
   5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.
   2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
      a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

   1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct.
Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 22 and 23 Section "Duct Accessories" for access panels and doors.

2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:
1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.7 DUCT SCHEDULE
A. Fabricate ducts with galvanized sheet steel:
B. Intermediate Reinforcement:
2. Stainless-Steel Ducts: Galvanized steel.
3. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.

C. Liner:
1. Supply- and Return-Air Ducts: Fibrous glass, Type I.

D. Double-Wall Duct Interstitial Insulation:
1. Supply- and Return-Air Ducts: 1 inch thick.

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 in Elbows."
   c. Velocity 1500 fpm 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 ratio and five segments for 90-degree elbow.
   b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

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: Spin in.

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.

G. Duct Schedule
1. Rectangular duct with liner:
   a. Low pressure supply and return.
2. Rectangular duct wrapped with insulation:
   a. Low pressure exhaust and fresh air.
3. Single wall round with wrapped insulation:
   a. Low pressure supply and return.
4. Double wall round and flat oval:
   a. Medium pressure supply (upstream of VAV).

END OF SECTION 23 31 13
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.
   2. Volume dampers.
   3. High Efficiency Take-Offs.
   4. Motorized control dampers.
   5. Fire dampers.
   6. Ceiling fire dampers.
   7. Smoke dampers.
   8. Combination fire and smoke dampers.
  10. Duct-mounting access doors.
  11. Flexible connectors.
  12. Flexible ducts.
  13. Duct accessory hardware.
B. Related Sections include the following:
   1. Division 22 and 23 Section "HVAC Instrumentation and Controls" for electric and pneumatic damper actuators.

1.3 SUBMITTALS
A. Product Data: For the following:
   1. Backdraft dampers.
   2. Volume dampers.
   3. High Efficiency Take-Offs.
   4. Motorized control dampers.
   5. Fire dampers.
   6. Ceiling fire dampers.
   7. Smoke dampers.
   8. Combination fire and smoke dampers.
  10. Turning vanes.
  11. Duct-mounting access doors.
  12. Flexible connectors.
  13. Flexible ducts.

1.4 QUALITY ASSURANCE
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.
   1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS
2.1 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS
A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.
   B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
   C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
   D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT DAMPERS
A. Manufacturers:
   1. Air Balance, Inc.
   2. American Warming and Ventilating.
   3. CESCO Products.
   4. Duro Dyne Corp.
   5. Greenheck.
   7. Prefco Products, Inc.
   8. Ruskin Company.
   9. Tamco
   11. Air Rite.
   12. Prior approved equal.
   B. Description: Multiple-blade, parallel action gravity balanced, with blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.
   C. Frame: 0.052-inch thick, galvanized sheet steel, with welded corners and mounting flange.
   D. Blades: 0.025-inch thick, roll-formed aluminum.
   E. Blade Seals: Neoprene.
   F. Blade Axles: Galvanized steel.
   G. Tie Bars and Brackets: Galvanized steel.
2.4 VOLUME DAMPERS

A. Manufacturers:
   1. Air Balance, Inc.
   2. American Warming and Ventilating.
   3. Clifco
   5. Leader
   7. METALAIRE, Inc.
   8. Nailor Industries Inc.
  10. Ruskin Company.
  12. Air Rite.

B. General Description: 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 Classes 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.

C. Standard Volume Dampers: Opposed-blade design, standard 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.
   3. Aluminum Frames: Hat-shaped, 0.10-inch thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
   4. Roll-Formed Aluminum Blades: 0.10-inch thick aluminum sheet.
   5. Extruded-Aluminum Blades: 0.050-inch thick extruded aluminum.
   8. Tie Bars and Brackets: Aluminum.

D. 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.

2.5 HIGH EFFICIENCY TAKE-OFF

A. Factory-manufactured rectangular-to-round or round-to-round 45 degree leading tap fabricated of 24 ga zinc-coated lockforming quality steel sheets meeting requirements of ASTM A 653, with G-90 coating.
B. One inch wide mounting flange with die formed corner clips, pre-punched mounting holes, and adhesive coated gasket.

C. Manual Volume Damper:
   1. Single blade, 22 ga minimum.
   2. 3/8 inch minimum square rod with brass damper bearings at each end.
   3. Heavy duty locking quadrant on 1-1/2 inch high stand-off mounting bracket attached to side of round duct.

D. Approved Manufacturers:
   1. HETD-L by Daniel Manufacturing.
   2. STO by Flexmaster USA Inc.
   3. HET by Sheet Metal Connectors Inc.
   4. Hercules.
   5. Clifco
   6. Air-Rite.
   7. Prior approved equal.

2.6 MOTORIZED CONTROL DAMPERS

A. Manufacturers:
   1. Air Balance, Inc.
   2. American Warming and Ventilating.
   3. CESCO Products.
   4. Duro Dyne Corp.
   5. Greenheck.
   7. METALAIRE, Inc.
   8. Nailor Industries Inc.
   10. Ruskin Company.
   11. Tamco
   13. Air Rite.

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 1/2-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 closed-cell neoprene edging.

2.7 FIRE DAMPERS

A. Manufacturers:
   1. Air Balance, Inc.
2. CESCO Products.
5. METALAIRE, Inc.
6. Nailor Industries Inc.
7. Penn Ventilation Company, Inc.
8. Prefco Products, Inc.
12. Prior approved equal.

B. Fire dampers shall be labeled according to UL 555.
C. Fire Rating: 1-1/2 hours.
D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: 0.052 or 0.138 inch thick as indicated and of length to suit application.
   2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.
F. Mounting Orientation: Vertical or horizontal as indicated.
G. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
I. Fusible Links: Replaceable, 165 deg F rated.

2.8 CEILING FIRE DAMPERS
A. Manufacturers:
   1. Air Balance, Inc.
   2. CESCO Products.
   5. METALAIRE, Inc.
   6. Nailor Industries Inc.
   7. Penn Ventilation Company, Inc.
   8. Prefco Products, Inc.
   12. Prior approved equal.
B. General Description: Labeled according to UL 555C; comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."
C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.
D. Blades: Galvanized sheet steel with refractory insulation.
E. Fusible Links: Replaceable, 165 deg F rated.

2.9 SMOKE AND COMBINATION FIRE AND SMOKE DAMPERS
A. Manufacturers:
   1. Air Balance, Inc.
   2. CESCO Products.
   4. Leader
   5. Nailor Industries Inc.
   7. Ruskin Company.
   8. Prior approved equal.
B. General Description: Labeled according to UL 555S. Combination fire and smoke dampers shall be labeled according to UL 555 for 1-1/2-hour rating.
C. Fusible Links: Replaceable, 165 deg F rated.
D. Frame and Blades: 0.064-inch thick, galvanized sheet steel.
E. Mounting Sleeve: Factory-installed, 0.052-inch thick, galvanized sheet steel; length to suit wall or floor application.
F. Damper Motors: Modulating and two-position action.
   1. Comply with requirements in Division 22 and 23 Section "Motors."
   2. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
   3. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
   4. Outdoor Motors and Motors in Outside-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
   5. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
   6. Electrical Connection: 115 V, single phase, 60 Hz.

2.10 TURNING VANES
A. Fabricate to comply with SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
B. Manufactured Turning Vanes: Fabricate 1-1/2-inch wide, single-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.
   1. Available Manufacturers:
      a. Ductmate Industries, Inc.
      b. Duro Dyne Corp.
      c. METALAIRE, Inc.
      d. Ward Industries, Inc.
      e. Prior approved equal.
C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.11 DUCT-MOUNTING ACCESS DOORS
A. General Description: Fabricate doors airtight and suitable for duct pressure class.
B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.
   1. Manufacturers:
      a. American Warming and Ventilating.
      b. CESCO Products.
      c. Ductmate Industries, Inc.
      d. Flexmaster U.S.A., Inc.
      e. Greenheck.
      g. Nailor Industries Inc.
      h. Ventfabrics, Inc.
      i. Ward Industries, Inc.
      j. Air Rite.
      k. Prior approved equal.
   2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
   3. Provide number of hinges and locks as follows:
      a. Less Than 12 Inches Square: Secure with two sash locks.
      b. Up to 18 Inches Square: Two hinges and two sash locks.
      c. Up to 24 by 48 Inches: Three hinges and two compression latches.
      d. Sizes 24 by 48 Inches and Larger: One additional hinge.
   C. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
   D. Insulation: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.12 FLEXIBLE CONNECTORS
A. Manufacturers:
   1. Ductmate Industries, Inc.
   2. Duro Dyne Corp.
   3. Ventfabrics, Inc.
   5. Prior approved equal.
B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.
   1. Minimum Weight: 26 oz./sq. yd..
   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F.
E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
   1. Minimum Weight: 24 oz./sq. yd.
   2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
   3. Service Temperature: Minus 50 to plus 250 deg F.

2.13 FLEXIBLE DUCTS
A. Manufacturers:
   1. Flexmaster U.S.A., Inc.
   2. Hart & Cooley, Inc.
   4. Themaflex.
   5. Quietflex
   6. Prior approved equal.

B. Insulated-Duct Connectors: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor barrier film.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   3. Temperature Range: Minus 20 to plus 210 deg F.

C. Flexible Duct Clamps: [Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action] [Nylon strap], in sizes 3 through 18 inches to suit duct size.

2.14 DUCT ACCESSORY HARDWARE
A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION
3.1 APPLICATION AND INSTALLATION
A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

F. Provide test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers, with fusible links, according to manufacturer's UL-approved written instructions.

H. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
1. On both sides of duct coils.
2. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
3. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
4. On sides of ducts where adequate clearance is available.

I. Install the following sizes for duct-mounting, rectangular access doors:
   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.

J. Install the following sizes for duct-mounting, round access doors:
   1. One-Hand or Inspection Access: 8 inches in diameter.
   3. Head and Hand Access: 12 inches in diameter.

K. Label access doors according to Division 22 and 23 Section "Mechanical Identification."

L. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

M. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

O. Connect diffusers to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

P. Connect flexible ducts to metal ducts with [adhesive] [liquid adhesive plus tape] [draw bands] [adhesive plus sheet metal screws].

Q. Install duct test holes where indicated and required for testing and balancing purposes.

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 Division 22 and 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 23 33 00
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. Centrifugal roof ventilators.
   2. Ceiling Mounting Ventilator.

1.3 PERFORMANCE REQUIREMENTS
A. Project Altitude: Base fan-performance ratings on actual Project site elevations.
B. Operating Limits: Classify according to AMCA 99.

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. Field quality-control test reports.
D. Operation and Maintenance Data: For power ventilators to include in 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. AMCA 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.
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, as 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 Division 3.
   C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 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.

PART 2 - PRODUCTS
2.1 CENTRIFUGAL ROOF VENTILATORS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Loren Cook Company ACE-B or equal by Acme Engineering & Mfg. Corp.
      2. Aerovent; a Twin City Fan Company
      3. American Coolair Corp.
      4. Carnes Company HVAC.
      5. Greenheck.
      6. JencoFan; Div. of Breidert Air Products.
      7. Penn Ventilation.
      8. Twin City
   B. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
   C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
      1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.
      2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
   D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
   E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
      1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
      4. Fan and motor isolated from exhaust airstream.
F. Accessories:
1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire. 
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
4. Spring loaded, automatic belt tensioning pulley.

G. 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: 12 inches.
5. Metal Liner: Galvanized steel.
6. Mounting Pedestal: Galvanized steel with removable access panel.
7. Vented Curb: Unlined with louvered vents in vertical sides.


2.2 CEILING-MOUNTING VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Loren Cook Company. Gemini or equal by.
2. American Coolair Corp.
3. Carnes Company HVAC.
5. JencoFan; Div. of Breidert Air Products.
6. NuTone Inc.
7. Penn Ventilation.
8. Twin City

B. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.

C. Housing: Steel, lined with acoustical insulation.

D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

E. Grille: Plastic, louvered grille with flange on intake and thumbscrew attachment to fan housing.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

G. Accessories:
2. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
3. Motion Sensor: Motion detector with adjustable shutoff timer.
4. Manufacturer’s standard roof jack or wall cap, and transition fittings.

2.3 **MOTORS**
   A. Enclosure Type: Totally enclosed, fan cooled.

2.4 **SOURCE QUALITY CONTROL**
   A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
   B. 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 units using restrained spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."
      1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.
   C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
   D. Support suspended units from structure using threaded steel rods and spring hangers with vertical-limit stops. Insert device having a static deflection of 1 inch. Vibration-control devices are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."
   E. Install units with clearances for service and maintenance.
   F. Label units according to requirements specified in Division 22 and 23 Section "Mechanical Identification."

3.2 **CONNECTIONS**
   A. Duct installation and connection requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 22 Section "Duct Accessories."
   B. Install ducts adjacent to power ventilators to allow service and maintenance.
   C. Ground equipment according to Division 26 Section "Grounding and Bonding."
   D. Connect wiring according to Division 26 Section "Conductors and Cables."

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 systems are in fully open position.

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. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION 23 34 23
SECTION 23 37 13
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. Division 23 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS
A. Product Data: For each product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 GRILLES AND REGISTERS
A. Adjustable Bar Side Wall Supply Grille:
   1. Products:
      a. Carnes; RVEA.
      b. Krueger; 5815.
      c. METALAIRE, Inc., Metal Industries Inc.; 422.
      d. Price Industries; LBMR.
      e. Titus; 1707.
      f. Tuttle & Bailey; VF5.
      g. Or equal by:
         1) A-J Manufacturing Co., Inc.
         2) Anemostat; a Mestek Company.
         3) Dayus Register & Grille.
         5) Nailor Industries of Texas Inc.
   3. Finish: Baked enamel, white.
   5. Frame: 1 inch wide.
B. Fixed Face Ceiling Return, Exhaust, or Transfer Air Grille:
1. Products:
   a. Carnes; RSLA.
   b. Krueger; S85H.
   c. Price Industries; 535.
   d. Titus; 355RL.
   e. Tuttle & Bailey; T70D.
   f. Or equal by:
      1) A-J Manufacturing Co., Inc.
      2) Anemostat; a Mestek Company.
      3) Dayus Register & Grille.
      5) Nailor Industries of Texas Inc.

3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2 inch horizontal blade spacing.

C. Low Sidewall Return Grilles
1. Finish – Standard white baked enamel.
2. Zero degree deflection.
3. Approved Manufacturers And Models
   a. Carnes - RSHA
   b. J & J - S-590
   c. Krueger - S480H
   d. Metal*Aire - HD-RH
   e. Price - 90-L
   f. Titus - 30RL or 30 SL
   g. Tuttle & Bailey - T110 or equal by
   h. Agitair
   i. Anemostat
   j. Barber Colman
   k. Environmental Air Products
   l. Air Control Products
   m. Nailor

D. Floor Grilles:
1. Finish: Clear anodized.
2. Approved Products:
   a. Carnes: CCJB (with mitered corners welded on face and sanded).
   c. Krueger: 1500F.
   d. Metal*Aire: 2000F.
   e. Nailor: 49-240-FN-MM.
   f. Price: LBP-25B.
E. Door Grilles:
   1. Finish: Baked enamel. Match door as closely as possible as approved by Architect.
   2. Approved Products:
      a. Carnes.
      b. J & J.
      c. Krueger.
      d. Metal*Aire.
      e. Nailor: 61OGD.
      f. Price: STGI-BF.
      g. Titus: T-700.
      h. Tuttle & Bailey.

2.3 LINEAR SLOT OUTLETS
A. Linear Slot Diffuser:
   1. Manufacturers:
      a. Air Research Diffuser Products, Inc.
      b. Anemostat; a Mestek Company.
      c. Carnes.
      e. Krueger.
      f. METALAIRE, Inc.; Metal Industries Inc.
      g. Nailor Industries of Texas Inc.
      h. Price Industries.
      i. Titus.
      j. Tuttle & Bailey.
      k. Prior approved equal.
   5. Finish - Pattern Controller: Baked enamel.
   7. Slot Width: As indicated on drawings.
   8. Number of Slots: As indicated on drawings.

2.4 CEILING DIFFUSER OUTLETS
A. Round Ceiling Diffuser Duct Mounted Exposed:
   1. Manufacturers:
      a. Price RCD or equal by:
         1) Anemostat; a Mestek Company.
         2) Carnes.
         4) METALAIRE, Inc.; Metal Industries Inc.
5) Nailor Industries of Texas Inc.
6) Titus.
7) Tuttle & Bailey.
8) Prior approved equal.

4. Face Style: Three cone.
5. Pattern: Two position horizontal.

B. Rectangular and Square Ceiling Diffusers:
1. Products:
   a. Carnes.
   b. Krueger.
   c. METALAIRE, Inc., Metal Industries Inc.
   d. Price Industries; SPD or equal by.
   e. Titus.
   f. Tuttle & Bailey.
   g. A-J Manufacturing Co., Inc.
   h. Anemostat; a Mestek Company.
   j. Nailor Industries of Texas Inc.
   k. Prior approved equal.

3. Finish: Baked enamel, white.

2.5 SOURCE QUALITY CONTROL
A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION
3.1 EXAMINATION
A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION
A. Install diffusers, registers, and grilles level and plumb.
B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, provide lay-in ceiling module. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
3.3 **ADJUSTING**

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13
SECTION 23 74 13
PACKAGED OUTDOOR, CENTRAL- STATION AIR HANDLING 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 cooling and heating packaged rooftop units.

1.3 DEFINITIONS
A. DDC: Direct-digital controls.

1.4 SUBMITTALS
A. Product Data: Include rated capacities, furnished specialties, and accessories.
B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, and location and size of each field connection. Prepare the following by or under the supervision of a qualified professional engineer:
   1. Design Calculations: For selecting and designing restrained vibration isolation roof-curb rails.
   2. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
C. Startup service reports.
D. Operation and Maintenance Data: For rooftop units to include in operation, and maintenance manuals.
E. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE
A. Product Options: Drawings indicate size, profiles, and dimensional requirements of rooftop units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
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. Units shall be designed to operate with HCFC-free refrigerants.

1.6 COORDINATION
A. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."
B. Coordinate size, location, and installation of rooftop unit manufacturer's roof curbs and equipment supports with roof installer.
   1. Coordinate installation of restrained vibration isolation roof-curb rails, which are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."

1.7 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components listed below that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

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. Fan Belts: One set for each belt-driven fan.
   2. Filters: One set for each unit.

PART 2 - PRODUCTS
2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AAON, Inc.
   2. Carrier.
   3. Trane.
   5. Prior approved equal.

2.2 CABINET
A. Construction: Single wall.
B. Exterior Casing: Galvanized steel with baked-enamel paint finish and with lifting lugs and knockouts for electrical and piping connections.
C. Interior Casing: Galvanized steel.
D. Base Rails: Galvanized-steel rails for mounting on roof curb.
E. Service Doors: Hinged access doors with neoprene gaskets.
F. Internal Insulation: Fibrous-glass duct lining complying with ASTM C 1071, Type II.
   1. Thickness: 1 inch.
   2. Insulation Adhesive: Comply with ASTM C 916, Type I.
   3. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.
G. Condensate Drain Pans: Formed sections of galvanized-steel sheet designed for self-drainage. Fabricate pans with slopes to preclude buildup of microbial slime.

2.3 SUPPLY-AIR FAN
A. Fan: Forward curved centrifugal; statically and dynamically balanced, [galvanized] [coated] steel, mounted on solid-steel shaft with [self-aligning, permanently lubricated ball bearings] [pillow-block bearings rated $L_{50}$ for 200,000 hours and having external grease fittings].
B. Motor: Open dripproof, single-speed motor.
C. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.4 service factor.
D. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with elastomeric isolators.

2.4 REFRIGERATION SYSTEM
A. Fabricate and label refrigeration system to comply with ASHRAE 15, “Safety Code for Mechanical Refrigeration.”
B. Compressors: Scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief.

D. Refrigerant: R-410A.

E. Refrigeration System Specialties:
   1. Expansion valve with replaceable thermostatic element.
   2. Refrigerant dryer.
   3. High-pressure switch.
   4. Low-pressure switch.
   5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
   6. Brass service valves installed in discharge and liquid lines.
   7. Operating charge of refrigerant.

F. Refrigerant Coils: Evaporator and condenser coils shall be designed, tested, fabricated, and rated according to ARI 410 and ASHRAE 33. Coils shall be leak tested under water with air at 315 psig.
   1. Capacity Reduction: Circuit coils for interleaved control.
   2. Tubes: Copper.
   3. Fins: Aluminum.
   5. Suction and Distributor: Seamless copper tube with brazed joints.
   6. Source Quality Control: Test to 450 psig, and to 300 psig underwater.

G. Condenser Fan: Propeller type, directly driven by motor.

H. Safety Controls:
   1. Compressor motor and outside-coil fan motor low ambient lockout.
   2. Overcurrent protection for compressor motor and outside-coil fan motors.

2.5 INDIRECT-FIRED GAS FURNACE

   1. AGA Approval: Designed and certified by and bearing label of AGA.

B. Burners: Aluminized steel with stainless-steel inserts with a minimum thermal efficiency of 80 percent.
   1. Fuel: Natural gas.
   2. Ignition: Electronically controlled electric spark with flame sensor.
   3. High-Altitude Kit: For Project elevations more than 2000 feet above sea level.

C. Heat-Exchanger Drain Pan: Stainless steel.

D. Venting: Gravity vented.

E. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.

F. Safety Controls:
   1. Gas Control Valve: Two stage.

2.6 OUTDOOR-AIR INTAKE AND DAMPERS

A. Dampers: Leakage rate, according to AMCA 500, shall not exceed 2 percent of air quantity at face velocity of 2000 fpm through damper and pressure differential of 4-inch wg.
B. Damper Operators: Electric.
C. Mixing Boxes: Parallel-blade, galvanized-steel dampers mechanically fastened to steel operating rod inside cabinet. Connect operating rods with common interconnecting linkages so dampers operate simultaneously.
D. Outdoor-Air Intake Hoods: Galvanized steel, with bird screen and finish to match cabinet.

2.7 ECONOMIZER:
A. Provide fully modulating damper motors and controls to position outside and return air dampers so that outside air will be used to satisfy the building cooling load in the economizer cycle and minimum outside air during occupied mode.
B. Low leakage dampers shall ride on nylon bearings.
C. Integrated economizer control shall allow compressors to cycle for additional cooling as needed based on outdoor enthalpy.
D. Damper actuators shall be opposing gear driven, 24 volt, fully modulating design. Plug-in control board shall consist of adjustable minimum positioner, enthalpy setpoint, and DIP switches for setting type of control logic use.
E. Outdoor air hood with filters shall be galvanized steel with a powder coat enamel paint finish electrostatically bonded to the metal.
F. For units 5 tons and under, provide extruded aluminum gravity relief dampers to prevent blow-back and outdoor air infiltration during off cycle.
G. For units over 5 tons, provide Centrifugal power exhaust fan which ever is standard for size of unit.
H. Provide rainhoods and birdscreen.

2.8 FILTERS
A. Comply with NFPA 90A.
B. Cleanable Filters: 2-inch- thick, cleanable metal mesh.
C. Disposable Panel Filters: 2-inch- thick, factory-fabricated, flat-panel-type, disposable air filters with holding frames, with a minimum efficiency report value of 6 according to ASHRAE 52.2 and 90 percent average arrestance according to ASHRAE 52.1.
   1. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
   2. Frame: Galvanized steel.

2.9 CONTROLS
A. Control equipment and sequence of operation are specified in Division 22 and 23 Section "HVAC Instrumentation and Controls."
B. Factory-wire connection for controls' power supply.
C. Control devices, including sensors, transmitters, relays, switches, thermostats, humidistats, detectors, operators, actuators, and valves, shall be manufacturer's standard items to accomplish indicated control functions.
D. Unit Controls: Solid-state control board and components with field-adjustable control parameters.
E. Supply-Fan Control: Units shall be electrically interlocked with corresponding exhaust fans, to operate continuously when exhaust fans are running. Time clock shall switch operation from occupied to unoccupied. Night setback thermostat shall cycle fan during unoccupied periods to maintain space temperature.
   1. Timer: Seven-day electronic clock.
   2. Electrically interlock kitchen hood fire-extinguishing system to de-energize unit when fire-extinguishing system discharges.
F. Unit-Mounted Status Panel:
1. Cooling/Off/Heating Controls: Control operational mode.
2. Damper Position: Indicates position of outdoor-air dampers in terms of percentage of outdoor air.
3. Status Lights:
   a. Filter dirty.
   b. Fan operating.
   c. Cooling operating.
   d. Heating operating.
G. Refrigeration System Controls:
   1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb of dry air or outdoor-air temperature is less than 60 deg F.
H. Heating Controls:
   1. Staged Burner Control: Two steps of control.
I. Damper Controls - Integrate with BMS:
   1. Wall-mounting pressure sensor modulates outdoor- and return-air dampers to maintain a positive pressure in space served by rooftop unit at minimum 0.05-inch wg.
J. Integral Smoke Alarm: Smoke detector installed in supply and return air. For units 2000 cfm and larger.
K. DDC Temperature Control: Stand-alone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with temperature-control system specified in Division 15 Section “HVAC Instrumentation and Controls.” Links shall include the following:
   1. Start/stop interface relay, and relay to notify DDC temperature-control system alarm condition.
   2. Hardware interface or additional sensors for the following:
      a. Room temperature.
      b. Discharge air temperature.
      c. Refrigeration system operating.
      d. Furnace operating.
      e. Constant and variable motor loads.
      f. Monitor variable frequency drive operation.
      g. Monitor cooling load.
      h. Monitor economizer cycles.
      i. Monitor air distribution static pressure and ventilation air volumes.

2.10 STANDARD FULL PERIMETER ROOF CURB
A. Provide unit manufacturer’s factory built curb that shall meet the National Roofing Contractors Association August 1985 guidelines for roof mounted installations.
B. The curb shall be 14 inches high, 16 gauge, galvanized steel construction with a 2 x 4 pressure treated wood nailer strip furnished on the outside.
C. Curb shall be installed by the roofing contractor.

2.11 VIBRATION ISOLATION CURB
A. Roof curbs shall be constructed of galvanized steel. Curbs are to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit.
1. Unit shall be provided with a heavy duty, one piece vibration isolation curb. Each curb shall have the following features:
   a. 1 g seismic restraint and 200 mph wind restraint.
   b. Access ports for inspection and adjustment at each spring.
   c. 2" deflection springs.
   d. High frequency noise isolation.
   e. Supply and return duct support hardware.
   f. Galvanized steel curb with wood nailer.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation of rooftop units.
   B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
   C. Examine roof curbs and equipment supports for suitable conditions where rooftop units will be installed.
   D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
   A. Install roof curb on roof structure, according to ARI Guideline B. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing with roof construction.
   B. Install restrained vibration isolation roof-curb rails on roof structure according to ARI Guideline B. Install and secure rooftop units on rails and coordinate roof penetrations and flashing with roof construction. Restrained isolation roof-curb rails are specified in Section "Mechanical Vibration and Seismic Controls."
   C. Install wall- and duct-mounting sensors, thermostats, and humidistats furnished by manufacturers for field installation. Install control wiring and make final connections to control devices and unit control panel.

3.3 CONNECTIONS
   A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
   B. Install piping adjacent to machine to allow service and maintenance.
      1. Gas Burner Connections: Comply with requirements in Section "Fuel Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union[, pressure regulator,] and shutoff valve with sufficient clearance for burner removal and service.
   C. Duct Connections: Duct installation requirements are specified in Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to rooftop units with flexible duct connectors. Flexible duct connectors are specified in Division 22 and 23 Section "Duct Accessories."
   D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.
   E. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.4 STARTUP SERVICE
   A. Engage a factory-authorized service representative to perform startup service.
   B. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
1. Inspect for visible damage to furnace combustion chamber.
2. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
3. Inspect casing insulation for integrity, moisture content, and adhesion.
4. Verify that clearances have been provided for servicing.
5. Verify that controls are connected and operable.
6. Verify that filters are installed.
7. Clean outside coil and inspect for construction debris.
8. Clean furnace flue and inspect for construction debris.
9. Inspect operation of power vents.
11. Inspect and adjust vibration isolators and seismic restraints.
12. Verify bearing lubrication.
13. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
14. Adjust fan belts to proper alignment and tension.
15. Start unit.
16. Start refrigeration system when outdoor-air temperature is within normal operating limits.
17. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
18. Operate unit for run-in period.
19. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:
   a. Measure gas pressure at manifold.
   b. Measure combustion-air temperature at inlet to combustion chamber.
   c. Measure flue-gas temperature at furnace discharge.
   e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
20. Calibrate thermostats.
22. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
23. Start refrigeration system and measure and record the following:
   a. Coil leaving-air, dry- and wet-bulb temperatures.
   b. Coil entering-air, dry- and wet-bulb temperatures.
   c. Outdoor-air, dry-bulb temperature.
   d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
24. Verify operational sequence of controls.
25. Measure and record the following airflows. Plot fan volumes on fan curve.
   a. Supply-air volume.
   b. Return-air volume.
   c. Outdoor-air intake volume.
26. Simulate maximum cooling demand and inspect the following:
   a. Compressor refrigerant suction and hot-gas pressures.
b. Short circuiting of air through outside coil or from outside coil to outdoor-air intake.

27. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
   a. High-limit heat exchanger.
   b. Alarms.

C. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.

D. Remove and replace components that do not pass tests and inspections and retest as specified above.

E. Prepare written report of the results of startup services.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

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

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop units. Refer to Division 1 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION 23 74 13
SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. All sections of Division 01, General Requirements, apply to this section.

B. Equipment requiring rough-ins and/or connections by Division 26 may be shown on the Architectural Drawings and/or specified in Division 01 through Division 23. Division 26 shall be responsible for these rough-ins and/or connections whether shown on the Electrical Drawings or not.

C. The work shall comply with the following Codes, as adopted by State of Utah and Local Jurisdiction:
   1. National Electrical Code – NEC 2017
   5. Lightning Protection Installation Standard UL 96A and NFPA 780
   6. Utah State Fire Marshal’s Rules R710
   8. Agency/Institution Design Standards
   9. American Corrections Association – ACA
   10. Institute of Electrical and Electronic Engineers – IEEE
   11. Underwriters Laboratories – UL
   13. US Department of Justice Federal Registers – Americans with Disabilities Act
   14. Utah Division of Facilities Construction and Management (DFCM) Design Requirements
   15. Utah Department of Corrections (UDC) Requirements
   16. Utah State Construction and Fire Code Act
   17. Laws and Rules of the Utah State Fire Marshal
   18. Utah State Labor Commission Requirements
   19. Utah State Department of Health
   20. Utah State Department of Environmental Quality

1.02 SUMMARY

A. Section includes common electrical installation requirements.

1.03 WORK SPECIFIED UNDER OTHER DIVISIONS

A. Concrete housekeeping pads and curbs for electrical equipment: Section 03 30 00 and 260529.

B. Medical Equipment: Section 11 73 00.

C. Detention Equipment: Section 11 19 00.

D. Coordinate with Commissioning Work. Comply with the requirements of Division 01 Section “General Commissioning Requirements” and Division 26 Section “Electrical Commissioning.”

1.04 SUBSTITUTIONS

A. Submit request for substitution of materials as part of product submittal, in accordance with the requirements of Division 01.

1.05 SUBMITTALS

A. Provide in accordance with Section 01 33 00 “Submittal Procedures”.
B. Compliance with Specifications:
   1. The Contractor and manufacturer shall submit a point-by-point statement of any deviations from the specifications.
   2. The statement shall consist of numbered paragraphs, and a full description of the deviation.
   3. Where the proposed system complies fully, then no such statement is required.
C. Shop drawings detailing fabrication and installation of supports and anchorage for electrical items.
D. Shop drawings approved by the Owner’s Representative is not a release from Contract requirements as defined by the Drawings, Specifications, and governing codes and regulations.
E. Operations and Maintenance (O&M) manuals: Prepare O&M manuals that include the following:
   1. Description of function, normal operation characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
   2. Manufacturer’s printed operating procedures to include start-up, break-in and routine and normal operating instructions; regulation, control stopping, shutdown and emergency instructions.
F. Record Drawings/Documents:
   1. The Contractor shall maintain a current and up to date electronic copy for DFCM that is available for review or distribution at any time. one record copy of the Drawings, Specifications, Addenda, Change Orders and other Modifications, in good order and marked weekly to record changes and selections made during construction, as well as approved Shop Drawings, Product Data, Samples and similar submittals. These aforementioned items shall be available to the A/E and shall be delivered to the A/E for submittal to DFCM upon completion of the Work, signed by the Contractor, certifying that they show complete and exact “As-Built” conditions, stating sizes, kind of materials, vital piping, conduit locations and similar matters.
   2. Record documents shall indicate the following installed conditions:
      a. Equipment locations dimensioned from prominent building lines.
      b. Approved substitutions, Contract modifications, and actual equipment and materials installed.
      c. Contract Modifications, actual equipment and materials installed.
      d. Equipment sizes.
      e. Aboveground and underground conduit routing and stub up locations.
      f. All circuit designations as installed.

1.06 QUALITY ASSURANCE
A. Comply with applicable local, state and federal codes.
B. Labels and Listings: Materials, appliances and equipment provided shall meet the requirements of the Underwriters Laboratories, Inc. (UL), Electrical Testing Laboratories (ETL), or other standard testing organizations.
C. Current Models:
   1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
   2. Replacement parts shall be available.
   3. There shall be a permanent service organization maintained or trained by the manufacturer to provide satisfactory service within 100 mile radius of the project site.
D. Experience: Manufactured items shall have been installed and used, without modification, renovation or repair, on other projects for not less than three years prior to the date of bid opening for this project.
1.07 SITE CONDITIONS
A. Security Requirements:
   1. Special security requirements will be provided by the facility.
   2. Contractor shall abide by all facility rules.
   3. Special requirements may include limited access to the work area by area or time; background checks of on-site personnel, restriction of equipment and tools to include tool counts may be required in any area in active use by the prison (i.e. buildings that may have been constructed in earlier packages and are operational).
   4. The Owner will assign a contact person for the contractor to coordinate day-to-day activities and access into secure areas. Coordinate all system interruptions and scheduled down time with the contact person. The contractor shall include in its bid all time to which it may be subjected to working in an active inmate areas (i.e. buildings that may have been constructed in earlier packages and are operational).

1.08 DELIVERY, STORAGE AND HANDLING
A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels and other information needed for identification.
B. Handle carefully to prevent damage. Following manufacture’s written instructions for rigging. Replace damaged products.
C. Store in clean dry place off the ground. Protect from weather, water and physical damage.

PART 2 - PRODUCTS
2.01 GENERAL REQUIREMENTS
A. Products are as specified by manufacturer name, description, and/or catalog number. Discrepancies between equipment specified and the intended function of equipment shall be brought to the attention of the Architect/Engineer in writing prior to bidding. Failure to report any conflict, including catalog numbers, discontinued products, etc., does not relieve the Contractor from meeting the intent of the Contract Documents nor shall it change the Contract cost. If the Contractor is unable to interpret any part of the Plans and/or Specifications, or should he find discrepancies therein, he shall bring this to the attention of the Architect/Engineer who will issue interpretation and/or additional instructions to Bidders before the project is bid.
B. Manufacturers: Furnish and install electrical products from manufacturers as specified or accepted through methods specified herein. The manufacturers’ descriptions and catalog numbers are to establish basic product quality required.
C. Samples may be required for non-standard or substituted items before installation during construction. Provide all samples as required.
D. No materials or apparatus may be substituted after the bid opening except where the equipment specified has been discontinued.
E. Provide only equipment specified in the Contract Documents or approved by addendum.

2.02 MAINTENANCE MATERIALS AND PRODUCT WARRANTIES
A. General:
   1. Section includes minimum requirements for surplus maintenance materials of installed products (“attic stock”) to be furnished as part of the Project and delivered to Owner’s designated storage facility.
   2. Section includes product warranty requirements.
   3. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
B. Definitions:
1. Maintenance Materials: Additional material designated within this Section intended to match and replace non-standard products installed in this Project. Non-standard products may include materials that require a specific color or pattern.

2. Spare Parts: Parts, tools, service kits, or equipment components that are included in the purchase of the original materials or equipment and are provided by the original equipment manufacturer for use by the Owner.

3. Perishable Items: Items such as paint, coatings, adhesives, batteries, and other items with a finite shelf life.

C. Delivery, Storage and Handling:

1. Prepare items for storage as follows:
   a. Items shall be delivered in undamaged, original packing, or packaged in a protective covering for storage.
   b. Item description, manufacturer’s name and model number where applicable, quantity, project name, and building name shall be clearly marked on a visible surface of the packaging.
   c. Mechanical rooms, electrical rooms, telecommunications, and other service areas shall not be used as storage or staging areas, unless Contractor obtains prior written approval from the Owner.

2. Approved Storage Locations:
   a. Warehouse Building (W)
   b. Central Maintenance Building (M)

3. Delivery:
   a. Deliver materials directly to an Owner-approved, designated storage or warehouse facility, confirmed prior to delivery.
   b. The Owner’s maintenance supervisor is responsible for the acceptance and storage of spare parts.
   c. Installation aids, transportation tools and all items that are not deemed as spare parts shall be disposed of per Owner’s waste disposal policies, or may be retained by the Contractor.

D. Maintenance Material and Product Warranty Schedule:

E.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Item Description</th>
<th>Maintenance Materials (Attic Stock) Quantity</th>
<th>Warranty</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 05 13</td>
<td>Medium-Voltage Electrical Power Conductors and Cables</td>
<td>None required.</td>
<td>Manufacturer agrees to repair or replace all materials and products that fail in materials or workmanship within the specified warranty period. Warranty Period: Shall begin at temporary certificate of occupancy for the building or system, and extend twelve (12) months from the date of substantial completion for the entire prison facility, inclusive of all GMPs, buildings, and systems.</td>
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<tr>
<td>26 05 19</td>
<td>Low-Voltage Electrical Power Conductors and Cables</td>
<td>None required.</td>
<td>Manufacturer agrees to repair or replace all materials and products that fail in materials or workmanship within the specified warranty period. Warranty Period: Shall begin at temporary certificate of occupancy for the building or system, and extend twelve (12) months from the date of substantial completion for the entire prison facility, inclusive of all GMPs, buildings, and systems.</td>
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<td>Date</td>
<td>Description</td>
<td>Requirement</td>
<td>Warranty Details</td>
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<tr>
<td>26 05 23</td>
<td>Control-Voltage Electrical Cables</td>
<td>None required.</td>
<td>Manufacturer agrees to repair or replace all materials and products that fail in materials or workmanship within the specified warranty period. Warranty Period: Shall begin at temporary certificate of occupancy for the building or system, and extend twelve (12) months from the date of substantial completion for the entire prison facility, inclusive of all GMPs, buildings, and systems.</td>
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<tr>
<td>26 09 23</td>
<td>Lighting Control Devices</td>
<td>None required.</td>
<td>Manufacturer agrees to repair or replace all materials and products that fail in materials or workmanship within the specified warranty period. Warranty Period: Shall begin at temporary certificate of occupancy for the building or system, and extend twelve (12) months from the date of substantial completion for the entire prison facility, inclusive of all GMPs, buildings, and systems.</td>
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<tr>
<td>26 09 23</td>
<td>Relay Based Lighting Controls</td>
<td>None required.</td>
<td>Manufacturer agrees to repair or replace all materials and products that fail in materials or workmanship within the specified warranty period. Warranty shall be comprehensive and cover the entire lighting control system. Warranty</td>
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<td>Date</td>
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<td>26 12 19</td>
<td>Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers</td>
<td>1) One (1) 300 kVA, 12,470 V delta primary, 208/120 V wye secondary. Manufacturer agrees to repair or replace all materials and products that fail in materials or workmanship within the specified warranty period. Warranty Period: Shall begin at temporary certificate of occupancy for the building or system, and extend twelve (12) months from the date of substantial completion for the entire prison facility, inclusive of all GMPs, buildings, and systems.</td>
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<tr>
<td>26 13 29</td>
<td>Medium-Voltage, Pad-Mounted Switchgear</td>
<td>1) One set (three individual) of fuses for every size fuse used on site. Manufacturer agrees to repair or replace all materials and products that fail in materials or workmanship within the specified warranty period. Warranty Period: Shall begin at temporary certificate of occupancy for the building or system, and extend twelve (12) months from the date of substantial completion for the entire prison facility, inclusive of all GMPs, buildings, site, and systems.</td>
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<td>26 24 16</td>
<td>Panelboards</td>
<td>None required. Manufacturer agrees to repair or replace all materials and products that fail in materials or workmanship within the specified warranty period. Warranty Period: Shall begin at temporary certificate of occupancy for the building or system, and extend twelve (12) months from the date of substantial completion for the entire prison facility, inclusive of all GMPs, buildings, site, and systems.</td>
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<td>26 27 26</td>
<td>Wiring Devices</td>
<td>None required.</td>
<td>Manufacturer agrees to repair or replace all materials and products that fail in materials or workmanship within the specified warranty period. Warranty Period: Shall begin at temporary certificate of occupancy for the building or system, and extend twelve (12) months from the date of substantial completion for the entire prison facility, inclusive of all GMPs, buildings, and systems.</td>
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<tr>
<td>26 28 13</td>
<td>Fuses, 600V and below.</td>
<td>One (1) of each size and type installed.</td>
<td>Manufacturer agrees to repair or replace all materials and products that fail in materials or workmanship within the specified warranty period. Warranty Period: Shall begin at temporary certificate of occupancy for the building or system, and extend twelve (12) months from the date of substantial completion for the entire prison facility, inclusive of all GMPs, buildings, and systems.</td>
</tr>
<tr>
<td>26 28 16</td>
<td>Enclosed Switches and Circuit Breakers</td>
<td>1) Fuses: One (1) of each size and type.</td>
<td>Manufacturer agrees to repair or replace all materials and products that fail in materials or workmanship within the specified warranty period. Warranty Period: Shall begin at temporary certificate of occupancy for the building or system, and extend twelve (12) months from the date of substantial completion for the entire prison facility, inclusive of all GMPs, buildings, and systems.</td>
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<td>Code</td>
<td>Description</td>
<td>Details</td>
<td>Manufacturer agreement</td>
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| 26 56 00 | Exterior Lighting                                | 1) LED drivers and associated appurtenances: One (1) of each type and rating installed.  
2) Bolts/fasteners: Ten (10) of each type of bolt or fastener attaching handhole covers for fixtures. | Manufacturer agrees to repair or replace all materials and products that fail in materials or workmanship within the specified warranty period. Warranty Periods:  
1) Luminaires, Color Retention, and LED Arrays and Drivers: Shall begin at temporary certificate of occupancy for the building or system, and extend five (5) years from the date of substantial completion for the entire prison facility, inclusive of all GMPs, buildings, and systems.  
2) Metal Corrosion: Shall begin at temporary certificate of occupancy for the building or system, and extend ten (10) years from the date of substantial completion for the entire prison facility, inclusive of all GMPs, buildings, and systems.  
2) Poles: Shall begin at temporary certificate of occupancy for the building or system, and extend three (3) years from the date of substantial completion for the entire prison facility, inclusive of all GMPs, buildings, and systems. |

**PART 3 - EXECUTION**

**3.01 REQUIREMENTS FOR ELECTRICAL INSTALLATION**

A. Comply with NECA 1.

B. Visit the site and confirm the scope of work prior to bid. Before beginning construction, provide to the owner a construction schedule of electrical work. The construction schedule shall identify all significant milestones with completion dates.

C. Obtain and pay for all permits, licenses and inspection fees required by this work.

D. All work shall be inspected and approved by AHJ before cover-up.
E. Upon completion of the Work, provide all tests necessary, to satisfy the Owner and the Architect, that the true intent and meaning of the Drawings and Specifications (i.e. Contract Documents) has been carried out. Provide all instruments and labor necessary for all required testing. Any Work not in accordance with the Contract Documents shall be replaced by the Contractor at his own expense.

F. Coordinate electrical systems, equipment and materials installations with building components, including work of other trades prior to proceeding with rough in or installation.

G. Install systems and materials level and plumb and to follow building lines.

H. Coordinate connection of electrical systems with exterior underground utilities and services. Comply with requirements of governing regulations, franchised service companies and controlling agencies. Provide required connection for each service.

I. Install systems, materials and equipment to conform with approved submitted data, including coordination drawings, to the greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual systems requirement, notify the Engineer in writing. Maintain manufacture’s recommended clearances under all circumstances.

J. Verify all dimensions by field measurement. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

K. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

L. Coordinate the installation of required supporting devices and sleeves to be set in poured-in place concrete and other structural components, as they are constructed.

M. Sequence, coordinate and integrate installations of electrical materials and equipment for efficient flow of work. Give particular attention to large equipment requiring positioning prior to closing in the building.

N. Arrange for chases, slots and openings in other building components during progress of construction, to allow for electrical installations.

O. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

P. Right of Way: Give to sloped piping systems and ductwork.

Q. Provide access panels in ceilings, partitions, enclosures, etc. as required in order to achieve easy access to all equipment and devices provided or installed under Division 26 Work.
   1. For non-security walls, partitions, ceilings, enclosures, etc.: Provide access panels as Work of Division 26. Requirements for access doors/panels are specified in Section 08 31 13, “Access Doors and Frames.”
   2. For security walls, partitions, ceilings (other than metal detention ceilings), enclosures, etc., provide security access panels (SAP’s) as Work of Division 26. Refer to Section 11 19 00 “General Provisions for Detention Work.”
   3. For metal detention ceilings: Ceiling access panels are to be provided as Work of the Detention Equipment Contractor furnishing and installing the security ceilings, refer to Section 11 19 00 “General Provisions for Detention Work.” As part of Division 26 Work, provide complete drawings and tabulation to General Contractor indicating all required locations and sizes of security ceiling access doors for devices and equipment provided or installed under Division 26 Work.

3.02 PROJECT COORDINATION DRAWINGS

A. General: Assist with the coordination and preparation of 3D models and coordination drawings per Section 01 31 00, “Project Management and Coordination”.

19386100 / UDC_FBI FIRING 26 05 00 - 9 COMMON WORK RESULTS FOR RANGE & TRAINING FACILITY ELECTRICAL
3.03  ROUGH-IN
   A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
   B. Refer to Architectural, Civil, Mechanical, Security, Telecommunications, Kitchen, Laundry etc. Drawings for equipment not shown on the Division 26 Drawings that may require electrical connections by Division 26.

3.04  CUTTING AND PATCHING
   A. General: Perform all cutting and patching in accordance with Division 01.

3.05  FIRESTOPPING
   A. Fire-Rated-Assembly Penetrations:
      1. Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations.
      2. Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
      3. Seal raceway and cable penetration sleeves with firestop materials.
      4. Comply with Section 07 81 00 "Applied Fireproofing."
      5. Comply with Section 07 81 23 "Intumescent Fireproofing."

3.06  CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
   A. Manage construction waste produced by Work of this Section in accordance with provisions of Section 01 74 19 “Construction Waste Management and Disposal.”

3.07  DEMONSTRATIONS
   A. Provide start-up services and instruct Owner’s personnel in operation and maintenance of major items of equipment.
   B. Start-up equipment “only” in accordance with manufacture’s written instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
   C. Train Owner’s personnel on start-up and shut-down procedures, troubleshooting procedures, servicing and preventive maintenance scheduled procedures. Review with Owner personnel the data contained in the Operating and Maintenance Manuals specified in this specification. This shall include:

END OF SECTION 26 05 00
PART 1 - GENERAL

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

1.02 SUMMARY
A. Section includes cables and related cable splices, terminations, and accessories for medium-voltage (2001 to 35,000 V) electrical distribution systems.

1.03 DEFINITIONS
A. Jacket: A continuous nonmetallic outer covering for conductors or cables.
C. Sheath: A continuous metallic covering for conductors or cables.

1.04 ACTION SUBMITTALS
A. Provide point-by-point statement of any deviations or exceptions with specifications, in accordance with Section 26 05 00.1.5B.
B. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.
C. Samples: 16-inch (400-mm) lengths for each type of cable submitted.

1.05 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Indicate location of each cable, splice, and termination.
B. Qualification Data: For installer and testing agency.
C. Material Certificates: For each type of cable and accessory.
D. Design Data: Cable pulling calculations, including conduit size and fill percentage, pulling tensions, cable sidewall pressure, jam probability, voltage drop, and ground wire sizing for each cable.
E. Source quality-control reports.
F. Field quality-control reports.

1.06 QUALITY ASSURANCE
A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.
B. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.07 FIELD CONDITIONS
A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than 10 business days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner's written permission.
PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with IEEE C2 and NFPA 70.

2.02 CABLES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Kerite Co. (The).
   2. Okonite Company (The).
   3. Prysmian Power Cables and Systems USA, LLC.
   4. Southwire.
B. Cable Type: Type MV 105.
C. Conductor Insulation: Ethylene-propylene rubber.
   1. Voltage Rating: 15 kV.
   2. Insulation Thickness: 133 percent insulation level.
D. Conductor: Copper.
F. Conductor Strand: Compact round, concentric lay, Class B.
G. Strand Filling: Conductor interstices are filled with impermeable compound.
H. Shielding: Copper tape, helically applied over semiconducting insulation shield.
I. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.
J. Cable Jacket: Sunlight-resistant PVC.

2.03 CONNECTORS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Burndy.
   2. 3M.
   4. Raychem; a brand of nVent.
   5. Thomas & Betts Corporation; A Member of the ABB Group.
B. Comply with ANSI C119.4 for connectors between aluminum conductors or for connections between aluminum to copper conductors.
C. Copper-Conductor Connectors: Copper barrel crimped connectors.

2.04 SOLID TERMINATIONS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. 3M.
   3. Raychem; a brand of nVent.
   4. Thomas & Betts Corporation; A Member of the ABB Group.
B. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.
1. Class 1 Terminations, within cabinet or enclosure: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal. Fully compatible with cable.

2.05 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. 3M.
   3. Raychem; a brand of nVent.
   4. Thomas & Betts Corporation; A Member of the ABB Group.

C. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

D. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

E. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

F. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer’s standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
   1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
   2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
   3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.

2.06 SPLICE KITS

A. Description: For connecting medium voltage cables; type as recommended by cable or splicing kit manufacturer for the application.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. 3M.
   3. Raychem; a brand of nVent.
   4. Thomas & Betts Corporation; A Member of the ABB Group.

C. Standard: Comply with IEEE 404.

D. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
   1. Combination tape and cold-shrink-rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
4. Premolded, EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.
5.Separable multiway splice system with all components for the required splice configuration.

2.07 MEDIUM-VOLTAGE TAPES
A. Description: Electrical grade, insulating tape rated for medium voltage application.
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. 3M.
   3. Raychem; a brand of nVent.
   4. Thomas & Betts Corporation; A Member of the ABB Group.
C. Ethylene/proplylene rubber-based, 30-mil (0.76-mm) splicing tape, rated for 130 deg C operation. Minimum 3/4 inch (20 mm) wide.
D. Silicone rubber-based, 12-mil (0.30-mm) self-fusing tape, rated for 130 deg C operation. Minimum 1-1/2 inches (38 mm) wide.
E. Insulating-putty, 125-mil (3.175-mm) elastic filler tape. Minimum 1-1/2 inches (38 mm) wide.

2.08 ARC-PROOFING MATERIALS
A. Description: Fire retardant, providing arc flash protection.
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. 3M.
   3. Raychem; a brand of nVent.
   4. Thomas & Betts Corporation; A Member of the ABB Group.
C. Tape for First Course on Metal Objects: 10-mil- (250-micrometer-) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.
D. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, and compatible with cable jacket.
E. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1 inch (25 mm) wide.

2.09 FAULT INDICATORS
A. Indicators: Automatically reset fault indicator, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.
B. Fault indicators shall be SEL 1ARU12Y2 or prior approved equal.
C. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage and carrying case.

2.10 SOURCE QUALITY CONTROL
A. Test and inspect cables according to ICEA S-94-649 before shipping.

PART 3 - EXECUTION
3.01 INSTALLATION
A. Install cables according to IEEE 576.
B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches (1200 to 1800 mm) on the pull rope.
   1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
   2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
   1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
   2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
   3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
   4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

E. Securely support cables as indicated within drawings and details.

F. Install direct-buried cables on leveled and tamped bed of 3-inch- (75-mm-) thick, clean sand. Separate cables crossing other cables or piping by a minimum of 2 inches (50 mm) of tamped earth, plus an additional 2 inches (50 mm) of sand. Install permanent markers at ends of cable runs, changes in direction, and buried splices.

G. Install "buried-cable" warning tape 12 inches (305 mm) above cables.

H. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.

I. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.

J. Install cable splices at pull points and elsewhere as indicated or as required for cable installation; use standard kits.

K. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.

L. Install separable insulated-connector components as follows:
   1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
   2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.
   3. Standoff Insulator: At each terminal junction, with one on each terminal.

M. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at the following locations:
   1. Transformer locations not protected by conduit or termination materials.
   2. Transformer vault locations not protected by conduit or termination materials.
   3. Medium-Voltage Pad-Mount Switch locations not protected by conduit or termination materials.
   4. Manholes where not protected by conduit or termination materials.
   5. Metal Clad Switchgear not protected by conduit or termination materials.
N. Arc Proofing: In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
   1. Clean cable sheath.
   2. Wrap metallic cable components with 10-mil (250-micrometer) pipe-wrapping tape.
   3. Smooth surface contours with electrical insulation putty.
   4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
   5. Band arc-proofing tape with two layers of 1-inch- (25-mm-) wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.

O. Seal around cables passing through fire-rated elements according to Section 07 84 13 "Penetration Firestopping."

P. Install fault indicators on each phase where indicated.

Q. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

R. Ground shields of shielded cable at one point only. Maintain shield continuity and connections to metal connection hardware at all connection points.

S. Cable Identification: Identify phase and circuit number of each conductor at each splice, termination, manhole, and vault. Include cable labeling as indicated on drawings. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.02 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Perform the following tests and inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
   2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
   3. Perform direct-current High Potential test of each new conductor according to NETA ATS, Ch. 7.3.3. Do not exceed cable manufacturer's recommended maximum test voltage.
   4. Perform Partial Discharge test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.
   5. Perform Dissipation Factor test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.
C. Medium-voltage cables will be considered defective if they do not pass tests and inspections.
D. Prepare test and inspection reports.

END OF SECTION 26 05 13
SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS
A. All sections of Division 01, General Requirements, apply to this section.
B. Related Requirements:
   1. Division 26 Section 26 05 23 “Control-Voltage Electrical Cables”.
C. Where the requirements of this Section are in conflict with the requirements of Division 27 Specification Section(s), the requirements of Division 27 shall take precedence for equipment and systems furnished and installed by Division 27.
D. Coordinate with Commissioning Work. Comply with the requirements of Division 01 Section “General Commissioning Requirements” and Division 26 Section “Electrical Commissioning.”

1.02 SUMMARY
A. Section Includes:
   1. Building wires and cables rated 600V and less.
   2. Connectors, splices, and terminations rated 600V and less.
   3. Identification products.

1.03 SUBMITTALS
A. Provide point-by-point statement of any deviations or exceptions with specifications, in accordance with Section 26 05 00.1.5B.
B. Product Data: For each type of product.
C. Field quality-control reports.
D. Test Reports: Indicate procedures and values obtained.

1.04 SUBSTITUTIONS
A. Submit request for substitution of materials as part of product submittal, in accordance with the requirements of Division 01.

1.05 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum 10 years documented experience.

PART 2 - PRODUCTS

2.01 CONDUCTORS AND CABLES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Cerrowire.
   4. General Cable Technologies Corporation.
   5. Okonite Cable Co.
   6. Republic Cable Co.
   7. Southwire Incorporated.
B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN/THWN-2 and Type XHHW-2.
D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable Type MC and Type SO with ground wire.

2.02 CONNECTORS AND SPLICES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Burndy.
2. AFC Cable Systems, Inc.
5. Ideal Industries, Inc.
6. Ilsco; a branch of Bardes Corporation.
7. NSI Industries LLC.
8. O-Z/Gedney; a brand of the EGS Electrical Group.
9. 3M; Electrical Markets Division.
10. Tyco Electronics.
B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.03 IDENTIFICATION PRODUCTS
A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
1. Impact.
2. Brady Corporation.
3. HellermannTyton.
4. Kroy LLC.
5. Panduit Corp.
B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
C. Comply with drawings and details, where no requirements exist within the drawings, follow requirements in Division 26 Section 26 05 53 “Identification for Electrical Systems.”

2.04 SYSTEM DESCRIPTION
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with NFPA 70.

PART 3 - EXECUTION
3.01 CONDUCTOR MATERIAL APPLICATIONS
A. Feeders: Copper or Aluminum as indicated on Feeder Schedule on the Drawings. Stranded for No. 12 AWG and larger.
B. Branch Circuits: Copper. Stranded for No. 12 AWG and larger.

3.02 APPLICATIONS AND WIRING METHODS
A. Provide factory-fabricated color-coded wire of sizes, ratings, materials and types indicated for each service. Where not indicated, provide proper selection as determined by Installer to comply with project's installation requirements and NEC standards.
B. Refer to Section 26 05 53, “Identification for Electrical Systems,” for color coding standard.
C. 60-degree C ampacity of conductors will be used for #1 AWG and smaller, 75-degree C ampacity will be used for #1/0 AWG and larger.
D. Concealed Dry Interior Locations: Type THHN-75 degree C or THWN-75 degree C rated insulation.

E. Exposed Dry Interior Locations: Type THHN-2 75 degree C, THWN-2, 75 degree C rated insulation wiring.

F. Above Accessible Ceilings: Type THHN-2, 75 degree C, THWN-2, 75 degree C rated insulation wiring.

G. Wet or Damp Interior Locations: THWN-2, 75 degree C or XHHW-2, 90 degree C rated insulation wiring.

H. Exterior Locations: THWN-2, 75 degree C or XHHW-2, 90 degree C rated insulation wiring.

I. Underground Locations: THWN-2, 75 degree C or XHHW-2, 90 degree C rated insulation wiring.

J. Above roof, on top of roof, or inside built-up roofing materials: XHHW-2, 90 degree C rated insulation wiring.

K. Lighting and power circuits: #12 AWG minimum, unless otherwise noted.

L. Metal-clad cable, Type MC: May only be used in areas not accessible to inmates, per following requirements:
   1. MC Cable shall NOT be used for homeruns. Home runs shall be in conduit from electrical panel or cabinet to the first junction or pull box that is closest to the load being served.
   2. MC Cable shall NOT be used for fire alarm wiring.
   3. MC Cable shall be installed concealed, but accessible, in ceilings or walls. MC cable shall be protected from physical damage, and shall be supported directly from building or structure by use of a listed support.
   4. Acceptable to use for branch circuit final connections to lighting fixtures, light switches, or power receptacles. Maximum length shall not exceed 20 feet, unless otherwise noted.
   5. MC Cable shall not be used to penetrate floors or be encased in concrete.
   6. MC is not allowed outside of the building footprint.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Neatly train and lace wiring inside boxes, equipment, and panelboards.

D. Pull conductors into raceway at same time.

E. Install building wire 4 AWG and larger with pulling equipment.

F. 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.

G. Use pulling means including fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables or raceway.

H. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible. Protect exposed cables from damage.

I. Use suitable cable fittings and connectors.

J. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."
K. No more than three (3) circuits, including separate neutral conductors, may be installed in a single raceway. Conductor ampacity shall be derated in accordance with Table NEC 310.15(B)(3)(a), as required.

L. Neutrals: Each 120V or 277V circuit shall be provided with a dedicated neutral conductor. Unless otherwise noted, sharing of neutrals shall not be allowed.

M. For multi-wire branch circuits serving electrified furniture:
   1. A common neutral may be allowed to serve not more than three circuits each connected to a separate phase and installed in a single raceway.
   2. Provide 2-pole or 3-pole circuit breakers to simultaneously disconnect all ungrounded conductors of the multi-wire branch circuit. Circuit breaker handle-ties shall not be acceptable to accomplish this.

N. Contractor shall install UPS branch circuits separate from normal power branch circuits where possible. If they are routed in the same wireways contractor shall be required to bundle UPS power together and not bundle with normal power.

3.04 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Provide compression connections at pad mounted transformer secondary terminals.

C. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.

D. Clean conductor surfaces before installing lugs and connectors.

E. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

F. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.

G. Install split bolt connectors for copper conductor splices and taps, 6 AWG and larger.

H. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.

I. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

J. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

K. Splices within panelboard and switchboard enclosures and within conduit bodies are not allowed.

3.05 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems" unless indicated otherwise in the drawings.

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.06 SLEEVE/SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
3.07 FIRESTOPPING
A. Comply with Section 26 05 00.3.5.A.

3.08 FIELD QUALITY CONTROL
A. Perform the following tests and inspections:
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors.
   3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
      a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
      b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

B. Test and Inspection Reports: Prepare a written report to record the following:
   1. Procedures used.
   2. Results that comply with requirements.
   3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 26 05 19
SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. All sections of Division 01, General Requirements, apply to this section.
B. Coordinate with Commissioning Work. Comply with the requirements of Division 01 Section “General Commissioning Requirements” and Division 26 Section “Electrical Commissioning.”

1.02 SUMMARY

A. Section includes grounding and bonding systems and equipment, plus the following special applications:
   1. Underground distribution grounding.
   2. Roof top distribution grounding
   3. Ground bonding common with lightning protection system.
   4. Foundation steel electrodes.
B. Related Sections include the following:
   1. Section 26 41 13 “Lightning Protection for Structures” for products and installation requirements for the lightning protection system.

1.03 SUBMITTALS

A. Provide point-by-point statement of any deviations or exceptions with specifications, in accordance with Section 26 05 00.1.5B.
B. Product Data: For each type of product indicated.
C. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in “Field Quality Control” Article, including the following:
   1. Underground Perimeter Ground rings.
   2. Test wells.
   3. Ground rods.
   4. Grounding arrangements and connections for separately derived systems.
   5. Grounding for sensitive electronic equipment.
D. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data,” include the following:
      a. Instructions for periodic testing and inspection of grounding features at test wells based on NFPA 70B.
         1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
         2) Include recommended testing intervals.

1.05 SUBSTITUTIONS

A. Submit request for substitution of materials as part of product submittal, in accordance with the requirements of Division 01
1.06 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with UL 467 for grounding and bonding materials and equipment.
C. Comply with the requirements in Section 26 41 13 “Lightning Protection for Structures.”

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Lyncole Grounding Solutions, LLC.; VFC Inc.
   2. Burndy; Part of Hubbell Electrical Systems.
   3. ERICO International Corporation.
   4. Thomas & Betts Corporation.
   5. Harger Lightning and Grounding.
   6. ILSCO.
   7. O-Z/Gedney; A Brand of the EGS Electrical Group.
   8. Robbins Lightning, Inc.

2.02 SYSTEM DESCRIPTION
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with UL 467 for grounding and bonding materials and equipment.
C. Comply with the requirements in Section 26 41 13 “Lightning Protection for Structures.”

2.03 CONDUCTORS
A. Related Sections include the following:
   1. Section 26 41 13 “Lightning Protection for Structures” for products and installation requirements for the lightning protection system.
B. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
C. Bare Copper Conductors:
   4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
      a. Lightning protection system bonding shall be installed and sized per section 26 41 13.
   5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor unless otherwise required.
      a. Lightning protection system bonding conductors shall be installed and sized per section 26 41 13.
   6. Bonding Jumper: Copper tape conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick. Braided conductors shall not be used.
      a. Lightning protection system bonding jumpers shall be installed and sized per section 26 41 13.
   7. Tinned Bonding Jumper: Lightning protection system bonding jumpers shall be installed and sized per section 26 41 13.
D. Grounding Bus Bar: Predrilled rectangular bars of hard drawn copper, minimum 1/4 inch by 2 inch in cross section, with 7/16-inch holes spaced 2 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC,
impulse tested at 5000 V. For ground bus bars in electrical rooms, standoff insulators shall be spaced at least 18 inches apart over the entire length of the bar.

2.04 CONNECTORS
A. Related Sections include the following:
   1. Section 26 41 13 “Lightning Protection for Structures” for products and installation requirements for the lightning protection system.
B. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
C. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.
D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
E. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.05 GROUNDING ELECTRODES
A. Chemical-Enhanced Grounding Electrodes: Comply with the requirements in Section 26 41 13 “Lightning Protection for Structures.”
B. Ground Rod:
   1. Material: Copper-clad stainless steel.
   3. Length: 10 feet.
C. Grounding Well:
   1. Well Pipe: 12 inches diameter by 36 inches long concrete pipe with belled end.
   2. Well Cover: Cast iron, lockable, with legend cast as “GROUND TEST WELL” on the cover.
D. Ground Plates:
   1. Copper, 18” x 18” square with a minimum thickness of 0.032” installed in a minimum 21-inch square hole. Hole shall be backfilled with grounding gravel and installed with at least 1.5” of grounding gravel surround the ground plate and in compliance with manufacturer’s instructions.
   2. Burial ground plate at 36” below finished grade.
E. Grounding Gravel:
   1. Shall be based on a natural earth clay formed by volcanic action.
   2. Shall be environmentally safe and shall meet the NSF standard 60 requirements for long-term contact with drinking water.
   3. Shall be highly conductive to improve the ground system performance, with neutral pH to promote the life of grounding electrodes and/or grids by protecting them from surrounding corrosive soil conditions.
   4. Shall have warranty for 30 years with a life expectancy of 50 years.

PART 3 - EXECUTION
3.01 APPLICATIONS
A. Related Sections include the following:
   1. Section 26 41 13 “Lightning Protection for Structures” for products and installation requirements for the lightning protection system.
B. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger unless otherwise indicated.
   1. Lightning protection system conductors shall be installed and sized per section 26 41 13.
C. Underground Grounding Conductors: Install 2/0-19T Tinned Copper and comply with the requirements in Section 26 41 13 “Lightning Protection for Structures.”
   1. Bury at least 30 inches below grade.
   2. Duct-Bank Grounding Conductor: Provide bare #4/0 copper in the duct bank as indicated on drawings.

D. Roof Top Grounding Conductors:
   1. Comply with the requirements in Section 26 41 13 “Lightning Protection for Structures.”

E. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated and use bonding methods listed for direct burial.
   1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 30 inches above finished floor unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of doorframe, across top of doorway, and down; connect to horizontal bus.

F. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections:
      a. All connections shall be exothermically welded connections.
      b. Lightning protection system underground conductors shall be installed per Section 26 41 13.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.

3.02 GROUNDING AT THE SERVICE
A. Refer to Drawings for Service Entrance Grounding.
B. Lightning protection system bonding shall be installed and sized per section 26 41 13.

3.03 GROUNDING SEPARATELY DERIVED SYSTEMS
A. Generators: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment-grounding conductor and to the frame of the generator. The generator shall have its neutral grounded to the generator frame.
B. Transformers: Ground the secondary neutral.

3.04 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS
A. Comply with IEEE C2 grounding requirements.
B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.05 EQUIPMENT GROUNDING
A. Install insulated equipment grounding conductors with all feeders and branch circuits, including busway. A common equipment ground conductor may be used for multiple circuits that are ran in the same raceway.
B. Boxes, Cabinets, Enclosures, and Panelboards:
1. Bond the equipment-grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes.

2. Provide lugs in each box and enclosure for equipment grounding conductor termination.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment-grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.06 INSTALLATION

A. The following grounding electrodes must be connected to and utilized when available at the building under construction:

1. Metal underground water pipe in contact with the earth for 10 feet or more shall be within 5 feet from the point of entry into the building.

2. Metal frame of a building that is effectively grounded shall follow requirements of NEC Article 250.

3. Concrete encased electrodes.

B. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Install bonding conductor in 3/4"C. and size it the same as system grounding electrode conductor.

1. Lightning protection system bonding shall be installed and sized per section 26 41 13.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a high compression clamp.

4. Lightning protection system bonding shall be installed and sized per section 26 41 13.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

G. Grounding for Steel Building Structure: Bond building structure to building ground ring at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart. Where exterior building dimension is less than 60 feet, bond the building structure to building ground ring at base of each corner column only. The connections from the ground ring to the building steel shall be exothermically welded at the point of attachment to the ring and the building. All cadwelds shall be done by electrician who is certified to do cadwelds.

H. Ground Ring: Install a grounding conductor extending around the perimeter of building as follows:
1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches from building's foundation, and at a depth of not less than 30 inches below the surface of the earth.
3. Comply with UL 96A, NFPA 780, and LPI 175 per Lightning Protection System drawings.

I. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
1. Coordinate location of Ufer Ground with concrete installer to ensure there is no vapor barrier or other non-conductive materials between the concrete and the earth in the location of the Ufer Ground.
2. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
3. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

J. Regarding Buried Grounding Conductors:
1. All buried bare grounding conductors shall be encased in a 6-inch wide by 3-inch deep column of grounding gravel. Lay-in 1-1/2” of grounding gravel, soak with water, lay the conductor centered on top of the first layer, cover with 1-1/12” of grounding gravel, and then backfill remaining trench with natural soil and compact as required.
2. Grounding electrode and bonding conductors exiting the soil shall be protected by flexible conduit extending from within the grounding gravel to point 6-inches above grade. Top of conduit shall be filled with RTV type sealant to prevent water/dirt intrusion.

K. Receptacles shall not be grounded through their mounting screws. Ground receptacles with a jumper from the receptacle green ground terminal to the device box ground screw and a jumper to the branch circuit equipment grounding conductor.

L. Ground lighting fixtures to the equipment grounding conductor of the wiring system. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

M. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

N. Raised Floors: Provide bonding for all raised floor components.

3.07 FIELD QUALITY CONTROL
A. Perform tests and inspections:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
   a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   b. Perform tests by fall-of-potential method according to IEEE 81.
4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Grounding system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. Provide report of all measured ground resistances. Measurements that exceed the following values shall be highlighted for review and correction:
   1. Power and Lighting Equipment or System with Capacity of 1500 kVA and less: 5 ohms or less.
   4. Lightning Protection System: 5 ohms or less.

E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26
SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. All sections of Division 01, General Requirements, apply to this section.
B. Coordinate with Commissioning Work. Comply with the requirements of Division 01 Section “General Commissioning Requirements” and Division 26 Section “Electrical Commissioning.”

1.02 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.
B. Related Sections include the following:
   1. Section 26 05 48 “Vibration and Seismic Controls for Electrical Systems” for products and installation requirements necessary for compliance with seismic criteria.

1.03 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. IMC: Intermediate steel metal conduit.
C. RMC: Rigid steel metal conduit.

1.04 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways and cable tray, including comprehensive engineering analysis signed and sealed by a qualified professional structural engineer licensed in State of Utah, using performance requirements and design criteria indicated.
B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.05 SUBMITTALS

A. Provide point-by-point statement of any deviations or exceptions with specifications, in accordance with Section 26 05 00.1.5B.
B. Product Data: For the following:
   1. Steel slotted support systems.
   2. Nonmetallic slotted support systems.
C. Shop Drawings: Signed and sealed by a qualified professional structural engineer. Show fabrication and installation details and include structural calculations for the following:
   1. Trapeze hangers. Include Product Data for components.
   2. Steel slotted channel systems. Include Product Data for components.
   3. Nonmetallic slotted channel systems. Include Product Data for components.
   4. Equipment supports.
D. Welding certificates.
1.06 SUBSTITUTIONS
   A. Submit request for substitution of materials as part of product submittal, in accordance with the requirements of Division 01.

1.07 QUALITY ASSURANCE
   B. Comply with NFPA 70.

1.08 COORDINATION
   A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
   B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS
   A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. Superstrut.
         b. Cooper B-Line, Inc.
         c. ERICO CADDY International Corporation.
         d. Thomas & Betts Corporation.
         e. Unistrut; Atkore International.
         f. Wesanco, Inc.
      2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
      3. Channel Dimensions: Selected for applicable load criteria.
   B. Nonmetallic Slotted Support 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 1 surface.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. Power-Strut; Atkore International.
         b. Cooper B-Line, Inc.
         c. Seasafe, Inc.
      2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
      3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
      4. Rated Strength: Selected to suit applicable load criteria.
   C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
   D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
   E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
   F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Hilti, Inc.
      2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co., Inc.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cooper B-Line, Inc.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti, Inc.
      4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.


2.02 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 05 50 00 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.01 APPLICATION

A. Outdoors, within manholes, or where exposed to moisture: Provide hot-dipped galvanized materials and hardware.

B. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps.

E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
3.02 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
   6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or spring-tension clamps.
   7. To Light Steel: Sheet metal screws.
   8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 05 50 00 "Metal Fabrications" for site-fabricated metal supports.

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

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

3.04 CONCRETE BASES

A. Install switchboard, switchgear, and unit substation equipment, floor mounted transformers, floor mounted UPS Systems, floor mounted central lighting inverters, and similar electrical equipment on 4-inch high concrete pad with chamfered edges, 6-inches larger on each side than base of unit, unless otherwise specified, indicated, or equipment manufacturer’s recommendation calls for.

B. For other floor-mounted equipment, construct concrete bases of dimensions indicated but not less than 6 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base. All edges of each housekeeping pad shall be chamfered. Coordinate size and location of equipment pads and curbs with Work of other Sections.
C. **Use 3000-psi, 28-day compressive-strength concrete.** Concrete materials, reinforcement, and placement requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."

D. Anchor equipment to concrete base.
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

### 3.05 PAINTING

A. **Touchup:** Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. **Touchup:** Comply with requirements in Section 09 91 13 "Exterior Painting" Section 09 91 23 "Interior Painting" and Section 09 96 00 "High Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. **Galvanized Surfaces:** Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

**END OF SECTION 26 05 29**
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS
A. All sections of Division 01, General Requirements, apply to this section.
B. Coordinate with Commissioning Work. Comply with the requirements of Division 01 Section “General Commissioning Requirements” and Division 26 Section “Electrical Commissioning.”

1.02 SUMMARY
A. Section Includes:
   1. Metal conduits, tubing, and fittings.
   2. Nonmetal conduits, tubing, and fittings.
   3. Metal wireways and auxiliary gutters.
   4. Surface raceways.
   5. Boxes, enclosures, and cabinets.
B. Related Requirements:
   1. Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
   2. Section 11 19 00 “General Provisions for Detention Work.”
   3. Section 26 05 34 “Telecommunications Pathways and Spaces.”

1.03 DEFINITIONS
A. EMT: Electrical metallic tubing.
B. FMC: Flexible metal conduit.
C. GRC: Galvanized rigid steel conduit.
D. IMC: Intermediate metal conduit.
E. LFMC: Liquid-tight flexible metallic conduit.
F. LFNC: Liquid-tight flexible non-metallic conduit.
G. RMC: Rigid steel metal conduit.
H. RNC or RNMC: Rigid non-metallic conduit.
I. Inmate-Accessible Areas: Refer to security zoning diagrams included in the Contract Documents.
J. BICSI: Governing (Not-for-Profit) organization for the Telecommunications credentials of RCDD, Technician/Installer, OSP & Datacenters - Building Industry Consulting Service International
K. RCDD: Registered Communication Distribution Designer
L. eABF: Enterprise Air Blown Fiber-optics system composed of bundled MicroDuct pathways and MicroCable fiber that is push-jetted with air-assistance for maximum distance
M. Jetted Fiber: MicroCable that is typically no more than 4.5mm OD, with striations (ribs) on the outside jacket … available in 1 to 96 strand density
N. OSP: Outside Plant

1.04 SUBMITTALS
A. Provide point-by-point statement of any deviations or exceptions with specifications, in accordance with Section 26 05 00.1.5B.
B. Product Data: For conduits, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

D. Samples: For surface raceways and for each color and texture specified, 12 inches long.

E. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
   1. Structural members in paths of conduit groups with common supports.
   2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

F. Source quality-control reports.

1.05 QUALITY ASSURANCE
A. Testing Agency Qualifications: Member Company of NETA or an NRTL.

1.06 SUBSTITUTIONS
A. Submit request for substitution of materials as part of product submittal, in accordance with the requirements of Division 01.

PART 2 - PRODUCTS
2.01 METAL CONDUITS, TUBING, AND FITTINGS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Thomas & Betts Corporation.
   3. Allied Tube & Conduit.
   5. Western Tube and Conduit Corporation.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch, minimum.
   3. Manufacturer may be selected by the contractor.

F. EMT: Comply with ANSI C80.3 and UL 797.

G. FMC: Comply with UL 1; zinc-coated steel.

H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Fittings for Metal Conduit:
      a. Material: Steel.
      b. Type: Set-screw. In wet locations, provide compression rain-tight fittings.
   2. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
J. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
2. RACO; Hubbell.
3. Thomas & Betts Corporation.
4. ARNCO Corporation.
5. CANTEX Inc.
6. CertainTeed Corporation.
8. Electri-Flex Company.
10. Lamson & Sessions; Carlon Electrical Products.
11. Niedax-Kleinhuis USA, Inc.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated. RNC shall be assembled by using an approved cleaner and cement.

D. RTRC: Comply with UL 1684A and NEMA TC 14.

E. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

2.03 METAL WIREWAYS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, seismic joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Continuous-hinge cover with flush latch, unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish with rust inhibiting primer coating.

2.04 BOXES, ENCLOSURES, AND CABINETS

A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with integral threaded conduit hubs and gasketed cover.

C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

E. Cast-Metal Access, Pull, and Junction Boxes:
1. Material: NEMA FB 1, galvanized, cast iron.
2. Cover: Provide with ground flange and neoprene gasketed cover with stainless steel cover screws.

F. In-Grade Cast Metal Box:
1. Material: Galvanized cast iron, NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting.
2. Cover: Provide cover rated for the application, with nonskid and neoprene gasketed cover with stainless steel cover screws. Traffic rated covers, rating as required, where subject to heavy trucks.
3. Cover shall have molded lettering to indicate type of Utility or Service as follows:
   a. “ELECTRIC”
   b. “TELECOMMUNICATIONS”

G. Fiberglass Concrete composite Boxes: Die-molded, glass-fiber or concrete composite boxes:
1. Cover: Glass-fiber concrete composite, weatherproof cover with nonskid finish.
2. Cover shall have molded lettering to indicate type of Utility or Service as follows:
   a. “ELECTRIC”
   b. “TELECOMMUNICATIONS”

H. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer’s standard enamel.

I. Cabinets:
1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer’s standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.05 Not used

PART 3 - EXECUTION

3.01 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS
A. Comply with requirements in Section 26 05 44 “Sleeves and Sleeve Seals for Electrical Raceways and Cabling.”

3.02 FIRESTOPPING
A. Comply with Section 26 05 00.3.5.A.

3.03 RACEWAY APPLICATION
A. Outdoors:
1. Refer to Section 26 05 43 – Underground ducts and raceways for electrical systems.

B. Indoors: Apply raceway products as specified below, unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT. Includes inmate-accessible areas such as open interior warehouse walls, interior vocational area walls, and maintenance areas.
2. Exposed and Subject to Physical Damage: GRC. Includes raceways in the following locations:
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical and plumbing rooms: EMT
   d. Plumbing chases: EMT.
   e. Inmate-accessible kitchen, storage room, and corridor areas.
3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in locations such as Kitchens, Laundry Rooms, Mechanical Rooms, Plumbing Rooms, Plumbing Chases, and Fire Riser Rooms. Length not to exceed 36”.

5. Damp or Wet Locations: GRC.

6. Raceways for Optical Fiber or Telecommunications: EMT.

7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations, including Kitchen areas.

8. Metal-clad (MC) Cable: Refer to 260519.3.2.M.

C. RMC shall be used to enclose all medium voltage conductors within buildings.

D. Conduits that pass though drilled holes in walls or foundations of a building below grade shall be rigid and include segmented link seals at exterior building penetrations.

3.04 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. The Contractor shall coordinate this work with work of other trades. Any discrepancies, ambiguities, or conflicts shall be brought to the attention of the Architect prior to submitting bid. Any potential conflicts not clarified prior to bid shall be subject to the interpretation of the Owner at no additional cost to the Owner.

C. In general, install conduit and raceways to be concealed within finished walls, above ceilings, or underground, unless otherwise indicated. Secure locations such as plumbing chases, electrical rooms, mechanical rooms, IT rooms, security electronic rooms, are exempt from this requirement.

D. Conduits, raceways, junction boxes, or similar items shall not be installed exposed in inmate-accessible areas and inmate-housing areas (including circulation corridors), unless specifically noted otherwise.

E. Where there are more than three (3) current-carrying conductors in a raceway, the ampacity of the conductors shall be derated in accordance with Table NEC 310.15(B)(3)(a).

F. All raceways, boxes, and conductors shall be supported directly from building structure via listed supporting devices, independently from all other electrical, mechanical, or plumbing systems.

G. Provide outlet boxes with rigid support using metal bar hangars between studs in accordance with DFCM requirements.

H. Gang receptacle and voice/data outlets as close together as possible. In all cases, the installation shall comply with ADA mounting height requirements.

I. Electrical or voice/data outlets on opposite sides of a common wall shall be located on separate stud cavities. Back-to-back outlets are not allowed. Where specific dimensions contradict this requirement, the contractor shall relocate one outlet to the opposite side of the stud nearest that dimension.

J. Minimum Raceway Size: 3/4-inch trade size. 1-inch for underground raceways and raceways under slabs on grade.

K. 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.

L. Complete raceway installation before starting conductor installation.

M. Support raceways as specified in Section 260529 "Hangers and Supports for Electrical Systems."

N. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
O. Install no more than the equivalent of four 90-degree bends in any conduit run except for communications conduits, for which fewer bends are permitted, per Section 26.05.34 “Telecommunications Pathways and Spaces.”

P. Raceways under slab on grade:

1. Bury raceways at a minimum to the depth of the code-required bend radius below the concrete slab. Depth shall be measured to the top of the raceway.
2. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
3. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
4. Provide PVC coated GRC conduit riser elbows to turn up through the slab. Elbows shall have radius of 10 times conduit diameter and include PVC coated GRC from top of conduit exposure to elbow. When a coupling is connected to different materials, the coupling shall be of the greater strength material.

Q. Raceways shall not be embedded in suspended slabs.

1. Exception: Raceways serving recessed boxes for surface-mounted fixtures and devices may be installed in suspended slabs so that the raceway is not exposed or accessible. In these cases, conduits shall not be grouped (single-runs only with no overlapping each other), shall be installed in the middle 1/3 of the slab, be no larger than 1.25” dia., and comply with all other requirements set forth by the structural engineer.

R. Radius sweep of rigid steel risers for conduit stub up shall be as required by code for the minimum bend radius, and as recommended by the manufacturer for the specific system cable (power, telecom, security, etc.), wrapped in 20-mil PVC tape or PVC coated from top of conduit exposure to bottom of slab. When a coupling is connected to different materials, the coupling shall be of the greater strength material.

S. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

T. Install pull wires in empty raceways. 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.

U. All empty raceways shall be capped to prevent raceways from being used to hide contraband.

V. Expansion-Joint/Seismic-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet.

1. Install expansion-joint/seismic-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
   c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F temperature change.
   d. Attics: 135 deg F temperature change.
2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.
3. Install each expansion-joint/seismic-joint fitting with position, mounting, and piston setting selected according to manufacturer’s written instructions for conditions at specific location at the time of installation.

W. Flexible Conduit Connections:

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

X. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
Y. For recessed lighting fixtures, junction boxes shall be located within 36" of the light fixture with flexible steel conduit to connect fixture (to facilitate future removal/relocation).

Z. Set metal floor boxes level and flush with finished floor surface.

AA. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

BB. All circuits shall be in raceways, unless otherwise indicated.
   1. The raceway system shall be conduit or tubing of the appropriate material except in special applications.
      a. Underfloor duct systems, floor boxes, or poke-thru devices may be used for open office areas.
      b. Multi-outlet assemblies, trolley cable systems, surface metal raceway and similar industrial type wiring systems may be used in industrial instruction and production areas as appropriate for the process.
      c. Busway, Cablebus, cabletray and similar systems may be used in buildings devoted to utilities as appropriate to the buildings' use and circuits involved.

CC. All conduit entering switchboards or switchgear shall be equipped with grounding bushings regardless of size.

3.05 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33
SECTION 26 05 43
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. All sections of Division 01, General Requirements, apply to this section.

B. Coordinate with Commissioning Work. Comply with the requirements of Division 01 Section “General Commissioning Requirements” and Division 26 Section “Electrical Commissioning.”

C. Drawings take precedence if shown in details or plans.

1.02 SUMMARY

A. Section Includes:
   1. Direct-buried conduit, ducts, and duct accessories.
   2. Concrete-encased conduit, ducts, and duct accessories.
   3. Handholes and boxes for exterior underground cabling.

1.03 DEFINITIONS

A. Traffic ways: Locations where vehicular or pedestrian traffic is a normal course of events.

B. RNC: Rigid Nonmetallic Conduit.

C. Inmate-Accessible Areas: Refer to security zoning diagrams included in the Contract Documents.

1.04 SUBMITTALS

A. Provide point-by-point statement of any deviations or exceptions with specifications, in accordance with Section 26 05 00.1.5B.

B. Product Data: For each type of product.
   1. Include duct-bank materials, including separators and miscellaneous components.
   2. Include ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
   3. Include accessories for handholes and boxes.
   4. Include warning tape.

C. Shop Drawings:
   1. Precast or Factory-Fabricated Underground Utility Structures:
      a. Include plans, elevations, sections, details, attachments to other work, and accessories.
      b. Include duct entry provisions, including locations and duct sizes.
      c. Include reinforcement details.
      d. Include frame and cover design and manhole frame support rings.
      e. Include Ladder details.
      f. Include grounding details.
      g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
      h. Include joint details.
      i. Structural Calculations for Manholes: Submit structural calculations based on the current approved IBC, stamped and signed by a Structural Engineer in the State of Utah.
   2. Include the following information and certification that all dimensions and values are within the design calculations of the registered engineer.
      a. Maximum allowable depth of cover of the manhole roof.
      b. Maximum inside depth of the manhole.
c. Maximum dimension for the manhole in fluid soil with a 3-foot water table.
d. Maximum dimension for the manhole in hard compacted ground.

D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
   1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

E. Source quality-control reports.
F. Field quality-control reports.

1.05 SUBSTITUTIONS
A. Submit request for substitution of materials as part of product submittal, in accordance with the requirements of Division 01.

1.06 QUALITY ASSURANCE
A. Testing Agency Qualifications:
   1. Member Company of NETA or an NRTL.
   2. Qualified according to ASTM E 329 for testing indicated.

1.07 COORDINATION
A. Coordinate layout and installation of ducts, manholes, handholes, and pull boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and pull boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes wherever practicable, and as approved by Architect.

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

B. Ground Water: Assume ground-water level is 24 inches (900 mm) below final site finished grade surface unless a higher water table is noted within geotechnical report. Include provisions required to address ground water during excavation and installation of manholes, handholes, ductbanks, and ducts.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR DUCTS AND RACEWAYS
A. Comply with ANSI C2.

2.02 CONDUIT
A. Manufacturers: See Section 26 05 33.
B. GRC: Comply with ANSI C80.1 and UL 6.
C. RNC: NEMA TC 2, Type EPC-40-PVC, Type EPC-80-PVC, UL 651, compatible fittings complying with NEMA TC 3 and UL 514B.
D. Minimum underground conduit size: 1 inch.
2.03 NON-METALLIC DUCTS AND DUCT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one or more of the following:
1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Spiraduct/AFC Cable Systems, Inc.

B. Underground Plastic Utilities Duct: NEMA TC 2, UL 651, ASTM F 512, Type EPC-40, Type EPC-80, with compatible fittings complying with NEMA TC 3.

C. Duct Accessories:
1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of ducts with which used, and selected to provide minimum duct spacing indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Section 26 05 53 "Identification for Electrical Systems."

2.04 OUTDOOR MICRODUCT

A. Manufacturers:
1. Duraline
2. Equal

B. Description: 7 Way Microduct UDC
1. All MicroDuct shall be composed of all dielectric materials (except for armored version). All MicroDuct shall be manufactured to include enhanced jetting design, such as internal ribbing to minimize surface contact and permanent slick interior to eliminate the need for jetting lubricant. Two-channels with internal divider to isolate power from data.
2. 12.7mm OD/10mm ID
3. Microduct Rating FP (OSP)
4. 7-way
5. Color Blue

C. Description: 7 Way Microduct DTS
1. All MicroDuct shall be composed of all dielectric materials (except for armored version). All MicroDuct shall be manufactured to include enhanced jetting design, such as internal ribbing to minimize surface contact and permanent slick interior to eliminate the need for jetting lubricant. Two-channels with internal divider to isolate power from data.
2. 12.7mm OD/10mm ID
3. Microduct Rating FP (OSP)
4. 7-way
5. Color Orange

D. Description: 4 Way Microduct Fire Alarm
1. All MicroDuct shall be composed of all dielectric materials (except for armored version). All MicroDuct shall be manufactured to include enhanced jetting design, such as internal ribbing to minimize surface contact and permanent slick interior to eliminate the need for jetting lubricant. Two-channels with internal divider to isolate power from data.
2. 12.7mm OD/10mm ID
3. Microduct Rating FP (OSP)
4. 4-way
5. Color Red
2.05 OUTDOOR INNERDUCT

A. Manufacturers:
   1. Duraline
   2. Equal

B. Description:
   1. All InnerDuct shall be composed of all dielectric materials (except for armored version). All InnerDuct shall be manufactured to include internal ribbing to minimize surface contact and permanent slick interior to eliminate the need for lubricant.
   2. 1.25"
   3. Innerduct Rating FP (OSP)
   4. Color Green

2.06 PRECAST MANHOLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brooks Products
   2. Christ Concrete Products
   3. Dura-crete, Inc.
   4. Elmhurst-Chicago Stone Co.
   5. Jensen Precast
   6. Oldcastle Precast, Inc.
   7. Rinker Group, Ltd.
   8. Riverton Concrete Products
   9. Utility Concrete Products, LLC.
   10. Utility Vault Co.
   11. Wausau Tile Inc.

B. Comply with ASTM C 858 and with interlocking mating sections, complete with accessories, hardware, and features.
   1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
      a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
      b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
      c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
   2. Duct Entrances in Manhole Walls: Core or Cast end-bell or duct-terminating fitting in wall for each entering duct, seal with grout for watertight installation.
      a. Type and size shall match fittings to duct or conduit to be terminated.
      b. Fittings shall align with elevations of approaching ducts and be located.
   3. Manhole shell shall be a minimum of 8" reinforced walls, roof, and floor.
   4. Full width lift off roof panel.
   5. Floor sloped to grate drain knockout.
   7. Manhole opening located in center of manhole.

C. Concrete Knockout Panels: 1-1/2 to 2 inches (38 to 50 mm) thick, for future conduit entrance and sleeve for ground rod. Provided as needed for project.

D. Manhole Sump: Provide solid concrete knockout panel within floor of manhole for future field installed sump. Knockout panel shall be water-tight.
   1. Slope floor to sump knockout panel.
E. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

F. Structural Design Loading
1. Comply with requirements of AASHTO HS20 44, latest revision, relating to dead loads, live loads, and impact loads.
2. Calculations to include loads associated with ground water table at 3'-0" below finished grade and an applied surcharge of 2'-0". Top of manhole shall be assumed to be installed at 2'-0" below finished grade.

2.07 CAST-IN-PLACE MANHOLES
A. Not permitted.

2.08 PRECAST TRANSFORMER PAD/VAULT
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brooks Products
   2. Christ Concrete Products
   3. Dura-crete, Inc.
   4. Elmhurst-Chicago Stone Co.
   5. Jensen Precast
   6. Oldcastle Precast, Inc.
   7. Rinker Group, Ltd.
   8. Riverton Concrete Products
   9. Utility Concrete Products, LLC.
   10. Utility Vault Co.
   11. Wausau Tile Inc.
B. Comply with ASTM C 857A-16, complete with accessories, hardware, and features.
   1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
      a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
      b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
      c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
   2. Duct Entrances in Walls: Core or Cast end-bell or duct-terminating fitting in wall for each entering duct, seal with grout for watertight installation.
      a. Type and size shall match fittings to duct or conduit to be terminated.
      b. Fittings shall align with elevations of approaching ducts and be located.
   3. Pad/Vault shell shall be a minimum of 8" reinforced walls, roof, and floor.
   4. Transformer conduit blockout area cast into precast pad.
   5. Padlockable, Dual door, hinged, galvanized, nonslip, diamond plate vault access doors.
C. Sump: Provide solid concrete knockout panel within floor of manhole for future field installed sump. Knockout panel shall be water-tight.
   1. Slope floor to sump knockout panel.
D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
E. Structural Design Loading
1. Comply with requirements of AASHTO HS20 44, latest revision, relating to dead loads, live loads, and impact loads.
2. Calculations to include loads associated with ground water table at 3'-0" below finished grade and an applied surcharge of 2'-0". Top of manhole shall be assumed to be installed at 2'-0" below finished grade.

2.09 UTILITY STRUCTURE ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Bilco Company (The).
   2. Campbell Foundry Company.
   3. Christy Concrete Products.
   4. Cretex Concrete Products West, Inc.; Riverton Division.
   7. Hubbell Power Systems; Lenoir City Division.
   15. Underground Devices, Inc.
   16. Utility Concrete Products, LLC.
   17. Wausau Tile Inc.

B. Ferrous metal hardware, where indicated, shall be hot-dip galvanized complying with ASTM A 153 (A 153M) and A 123 (A 123M).

C. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
   1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 30 inch opening, 32 inch cover.
      a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
      b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
   2. Cover Legend: Cast in. Retained to suit system.
      a. Legend: "ELECTRIC" for duct systems with medium-voltage cables.
      b. Legend: "COMMUNICATIONS" for communications, data, and telephone duct systems.
   3. Manhole Chimney Components: Solid pour concrete grade ring with dimensions matched to those of roof opening.
      a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387/C 387M, Type M, may be used.
   4. Provide locking manhole lid accessories as indicated on drawings for manholes indicated in the drawings.

D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt. Install one near the floor of each wall, centered on the wall.
   1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.
E. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
   1. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.
   2. Provide (4) each, one centered on each wall near floor.

F. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1-1/4 inches (32 mm) minimum at base.
   1. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.

G. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch (13-mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.

H. Cable Rack Assembly: Steel, hot-rolled galvanized except insulators.
   1. Flush-mounted cast-in horizontal cable supports, (3) evenly spaced rows with lowest support at 12” AFF, with the others at 3'-8” and 6'-4” AFF.
   2. Stanchions: T-section or channel; 2-1/4-inch (57-mm) nominal size; punched with 14 holes on 1-1/2-inch (38-mm) centers for cable-arm attachment.

I. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

J. Fixed Manhole Ladders: Arranged for attachment to roof or wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin. Ladders shall be 14” wide with 1-1/2” x 1/2” runners and 3/4” knurled risers at 12” on center. It shall be securely bolted to the structure at the top and bottom of the manhole with stainless steel bolts.

K. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N) and greater. Two required.

L. Air Vents
   1. Provide where shown on plans.
   2. Two 12” schedule 80 PVC air vents shall be located on opposite walls, one near the bottom of one short wall and one near the top of the opposite short wall.
   3. Each air vent riser shall extend below manhole wall entry into a gravel drywell.
   4. Air vent openings shall be routed below grade to the designated landscape area shown on plans.

2.10 PRECAST CONCRETE HANDHOLES AND BOXES

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. Brooks Products
   2. Christ Concrete Products
   3. Dura-crete, Inc.
   4. Elmhurst-Chicago Stone Co.
   5. Jensen Precast
   6. Oldcastle Precast, Inc.
   7. Rinker Group, Ltd.
   8. Riverton Concrete Products
   9. Utility Concrete Products, LLC.
   10. Utility Vault Co.
   11. Wausau Tile Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.
C. AASHTO approved H-20 for use in roadways or in deliberate vehicular traffic paths within parking lots.
1. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and open-bottom enclosures as indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
   a. Frame and Cover: Weatherproof cast iron frame, with cast iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts. Provide locking nut/bolt as specified on drawings
   b. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   c. Cover shall have molded lettering to indicate type of Utility or Service as follows:
      1) “ELECTRIC”
      2) “TELECOMMUNICATIONS”
   d. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
   e. Extensions: Designed to mate with bottom of enclosure. Same material as enclosure.
      1) Extension shall provide increased depth of 12 inches.
   f. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
   g. Duct Entrances in bottom of Handhole or Box.
   h. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

D. AASHTO approved H-10 for use in incidental traffic, parking lots, immediately adjacent to roadways.
1. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and open-bottom enclosures as indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
   a. Frame and Cover: Weatherproof cast iron frame, with cast iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts. Provide locking nut/bolt as specified on drawings
   b. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   c. Cover shall have molded lettering to indicate type of Utility or Service as follows:
      1) “ELECTRIC”
      2) “TELECOMMUNICATIONS”
   d. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
   e. Extensions: Designed to mate with bottom of enclosure. Same material as enclosure.
      1) Extension shall provide increased depth of 12 inches.
   f. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
   g. Duct Entrances in bottom of Handhole or Box.
   h. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.11 FIBERGLASS HANDHOLES AND BOXES
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. Armorcast Products Company.
2. Carson Industries LLC
3. Christy Concrete Products
4. NewBasis
5. Nordic Fiberglass, Inc.
Comply with SCTE 77. Comply with tier 5 requirements (minimum) in "Underground Enclosure Application" Article.

1. Description: Factory-fabricated, molded of fiberglass-reinforced polyester resin, with frame and covers of skid-resistant cast iron. For use in landscape areas only. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
   b. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
   c. Cover: Cast-iron, weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   d. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   e. Cover shall have molded lettering to indicate type of Utility or Service as follows:
      1) "ELECTRIC".
      2) "TELECOMMUNICATIONS"
   f. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   g. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.
   h. Provide locking nut/bolt as specified on drawings

2.12 SOURCE QUALITY CONTROL
A. Test and inspect precast concrete utility structures according to ASTM C 1037.

PART 3 - EXECUTION

3.01 PREPARATION
A. Coordinate layout and installation of ducts, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes if practicable, and as approved by Architect.

3.02 SLEEVE/SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS
A. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.03 FIRESTOPPING
A. Comply with Section 26 05 00.3.5.A.

3.04 UNDERGROUND DUCT APPLICATION
A. Ducts for Electrical Feeders 120-600V:
   1. RNC, NEMA Type EPC-40-PVC, direct buried.
   2. Provide PVC-coated or PVC-tape-wrapped GRC elbows at the transition point from underground RNC to aboveground GRC.

B. Ducts for Electrical Feeders 600V and Higher:
   1. RNC, NEMA Type EPC-40-PVC, in concrete encased duct bank unless otherwise indicated.
2. Provide RNC, NEMA Type EPC-80-PVC for pole riser sweeps.

C. Ducts for Communications and Low Voltage Ductbanks:
1. RNC, NEMA Type EPC-40-PVC, in concrete encased duct bank unless otherwise indicated.

3.05 UNDERGROUND ENCLOSURE APPLICATION

A. Manholes: Precast factory fabricated concrete.
1. Units shall be rated for Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. All new manholes shall be pre-cast concrete units. Where pre-cast cannot be used due to restricted site access or other obstructions, then cast-in-place manholes will be considered and must obtain permission in writing from the Owner for approval.
3. All new manhole lids shall be pre-cast concrete, dimensions to be coordinated with existing manhole.
4. Lids shall be securely anchored to manhole as recommended by precast manhole manufacturer.

3.06 EARTHWORK

A. Excavation and Backfill: Comply with Section 31 20 00 "Earth Moving."
B. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 32 90 00 "Planting."
D. Cut and patch existing pavement in the path of underground ducts and utility structures according to the "Cutting and Patching" Article in Section 01 73 00 "Execution."

3.07 DUCT BANK INSTALLATION

A. Install ducts according to NEMA TCB 2.
B. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes, to drain in both directions as practicable.
C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends.
1. For Communications utilize long sweep bends with a minimum radius of 60 inches for 6 inch conduit, both horizontally and vertically, at other locations unless otherwise indicated
2. For Medium-Voltage Power utilize long sweep bends with a minimum radius of 48 horizontally and a minimum radius of 36 inches vertically when stubbing up to equipment unless indicated otherwise on the drawings.
D. For conduit for electrical feeders 600V conduit bends in duct runs shall not have a radius of less than 48 inches unless otherwise noted.
E. For communications conduit bends in duct runs shall not have a radius of less than 60 inches unless otherwise noted.
F. Joints: Use solvent-cemented joints in ducts and fittings to seal according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
G. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.
1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
2. Grout end bells into structure walls from both sides to provide water resistant entrances.
H. Vault and Manhole Penetrations: Terminate with flush bell ends. Install conduit penetrations of building walls as specified in Division 26 Section “Common Work Results for Electrical.”

I. Sealing: Provide temporary closure at terminations of ducts that have cables pulled with Sika “Sikadur Combiflex” sealing system or prior approved equal. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure and seal with silicon sealant.

J. After installation of duct bank perform the following for each duct:
   1. Run a mandrel that is 80% of conduit diameter through each duct to proof the duct.
   2. Swab the duct to clean any small remaining debris, repeat as necessary until duct is clear.
   3. Install cabling.
   4. Plug with ductsealant after installation of cables and/or pullrope is complete.

K. Pulling Cord: Install Muletape WP1250P or equal including footage markings in each empty ducts, 6 feet of additional tape shall be included on both ends.

L. Concrete-Encased Ducts:
   1. Support ducts on duct separators.
   2. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Section 31 20 00 "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.
   3. Width: Excavate trench wider than duct bank on each side and provide trench forms or earth form if ductbank walls are able to maintain vertical edges during the entire process.
   4. Depth: Install top of duct bank at least 36 inches (600 mm) below finished grade unless indicated otherwise. Obtain written approval from architect/engineer prior to any work that may deviate from this requirement.
   5. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
   6. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than four spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
   7. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 3 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.
   8. Elbows: Use manufactured duct elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run unless otherwise indicated. Extend concrete encasement throughout length of elbow.
   9. Elbows: Use manufactured rigid steel or fiberglass conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run. Where elbows are installed completely concealed in concrete or where total conduit run is less than 75 feet, manufactured fiberglass elbows are permitted.
      a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
      b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 6 inches above finished grade. Install end bushings on all metallic conduit ends.
   10. Reinforcement: Reinforce concrete-encased duct banks as indicated in drawings. Duct bank reinforcement is not required from utility yard medium-voltage manhole to medium-voltage switches and from medium-voltage switches to medium-voltage transformers when they are located within the same utility yard or within 50 feet of each other measured horizontally.
   11. Dowel concrete ductbank into manholes and vault wall as indicated in drawings, where no requirement exists in drawings install a minimum of 4 points with steel reinforcement rods no less than ¾ inch diameter.
12. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

13. Concrete Cover: Install a minimum of 3 inches (75 mm) of concrete cover at top and bottom, and a minimum of 3 inches (50 mm) on each side of duct bank.

14. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation wherever possible.
   a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.

15. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 03 30 00 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

16. Trenching and backfill:
   a. Place minimum 3 inches (75 mm) of gravel as a bed for duct bank.
   b. Place engineered fill above concrete encased ductbank.
   c. Place minimum 6 inches (150 mm) of topsoil fill for the final top backfill layer within landscape and sod areas. Repair trench landscaping to match existing conditions such as sod, plantings, etc.
   d. Provide a minimum of 5 inches (150 mm) of finished surface material to match existing conditions such as asphalt, concrete, gravel, etc.

M. Warning Tape: Bury detectable warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and direct bury duct banks. Align tape parallel to and within 3 inches (75 mm) of centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

N. Adjacent Utilities:
   1. Where other utility piping systems are encountered or being installed along a raceway route, maintain a 12-inch minimum vertical separation between raceways and other systems at crossings. Maintain a 12-inch minimum separation between raceways and other systems in parallel runs. Do not place raceways over valves or couplings in other piping systems.
   2. Maintain a 10-foot minimum separation between electrical conduits and steam lines, unless conduits are engineered for steam or high temperature applications.
   3. Adjust duct bank depth horizontally up to 10 feet and/or vertically up 6 feet down as required for utility conflicts. Exceptions to this must be submitted to architect/engineer for review and approval prior to adjustment.

O. RNC shall be assembled by using an approved cleaner and cement.

3.08 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 20 00 "Earth Moving" for pipe less than 6 inches in nominal diameter.
   2. Install backfill as specified in Section 31 20 00 "Earth Moving."
   3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 20 00 "Earth Moving."
4. Install manufactured rigid steel conduit elbows wrapped in 20 mil PVC tape or PVC coated with radius of 10 times conduit diameter and riser for conduit stub-ups.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of slurry or a minimum of 10 inches on each side of the coupling.
   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 6 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
5. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."
6. All underground conduits shall slope to pull boxes.

B. Joint Trenches:
1. There shall be a separation of 12 inches minimum from secondary conduits, primary conduits and phone/cable conduits.
2. Compaction shall be a minimum 90% at trench bottom to reduce settling and breakage.
3. All slurry encased duct banks will be include red dye with the minimum strength of 3000 psi. Red dye may either be mixed into the concrete or installed on the top of the concrete after pour, but prior to setting.
4. Indicate marking tape on all buried conduit outside the building footprint 12 inches above power ducts.

3.09 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:
1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
4. Install manholes and vaults water resistant free of any Honeycombing, interior surfaces shall be smooth. There shall be no through cracks or openings from any outside surface to any inside surface. Exterior surfaces and joints should be water resistant with hot applied asphalt bitumen dampproofing. Seal all ground rod openings with Owner approved sealant after the ground rods are in place. Seal all unused conduit openings with a removable plug.

B. Elevations:
1. Manhole Roof: Install with rooftop at least 15 inches (375 mm) below finished grade.
2. Manhole Frame: In paved areas and traffic ways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.
3. Handhole Covers: In paved areas and traffic ways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
4. Cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

D. Manhole Access:
1. Circular opening in manhole roof; sized to match cover size.
   a. Manholes with Fixed Ladders: ladders to be located as indicated on drawings.
   b. Install extension ring, constructed of precast concrete, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to extension ring.

E. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. After duct has been connected and grouted, and before
backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole extension rings and chimneys after mortar has cured at least three days.

F. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing shall be hot applied asphalt bitumen dampproofing per manufacturer instructions. After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole extension rings and chimneys after mortar has cured at least three days.

G. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

H. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (97 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field.

3.10 GROUNDING

A. Ground underground ducts and utility structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.11 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
   1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
   2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 6-inch- long mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.12 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 26 05 43
SECTION 26 05 44
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS
A. All sections of Division 01, General Requirements, apply to this section.
B. Coordinate with Commissioning Work. Comply with the requirements of Division 01 Section “General Commissioning Requirements” and Division 26 Section “Electrical Commissioning.”

1.02 SUMMARY
A. Section Includes:
   1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   5. Silicone sealants.
B. Related Requirements:
   1. Section 07 81 00 “Applied Fireproofing.”
   2. Section 07 81 23 “Intumescent Fireproofing.”

1.03 SUBMITTALS
A. Provide point-by-point statement of any deviations or exceptions with specifications, in accordance with Section 26 05 00.1.5B.
B. Product Data: For each type of product.

1.04 SUBSTITUTIONS
A. Submit request for substitution of materials as part of product submittal, in accordance with the requirements of Division 01.

PART 2 - PRODUCTS

2.01 SLEEVES
A. Wall Sleeves:
B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
F. Sleeves for Rectangular Openings:
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.
2.02 SLEEVE-SEAL SYSTEMS
A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Legrand.
      b. Advance Products & Systems, Inc.
      c. CALPICO, Inc.
      d. Metraflex Company (The).
      e. Pipeline Seal and Insulator, Inc.
      f. Proco Products, Inc.
   2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Stainless steel.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.03 SLEEVE-SEAL FITTINGS
A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Presealed Systems.

2.04 GROUT
A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

2.05 SILICONE SEALANTS
A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
   2. Emissions from Various Sources Using Small-Scale Environmental Chambers.”
B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION
3.01 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS
A. Comply with NECA 1.
B. “Electrical penetration” is defined as when raceways, cables, wireways, or busways penetrate concrete slabs, concrete or masonry walls, fire-rated and non-fire rated floor and wall assemblies.
C. Use circular (pipe) sleeves unless penetration arrangement requires rectangular sleeved opening.
D. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.

E. Seal space outside of sleeves with mortar or grout for penetrations of concrete and masonry:
   1. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

F. Concrete Slabs and Concrete Walls:
   1. Install sleeves for penetrations unless core-drilled holes or formed openings are used.
   2. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   3. Install sleeves for floor penetrations. Extend sleeves 2 inches above finished floor level.

G. Interior Penetrations of Non-Fire-Rated Walls and Floors:
   1. Install sleeves for penetrations unless core-drilled holes or formed openings are used.
   2. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   3. Install sleeves for floor penetrations. Extend sleeves 2 inches above finished floor level.
   4. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
   5. Comply with requirements in Section 07 92 00 “Joint Sealants.”

H. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

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

J. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION
   A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
   B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.03 SLEEVE-SEAL-FITTING INSTALLATION
   A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
   B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
   C. Secure nailing flanges to concrete forms.
   D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 44
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. All sections of Division 01, General Requirements, apply to this section.

B. Coordinate with Commissioning Work. Comply with the requirements of Division 01 Section “General Commissioning Requirements” and Division 26 Section “Electrical Commissioning.”

1.02 DESCRIPTION OF WORK

A. Extent of electrical equipment noise control, vibration isolation and seismic restraints is indicated by the Drawings, specified in other Division-26 Sections, and by this Section.

B. Section Includes:
   1. Restraint channel bracings.
   2. Restraint cables.
   4. Mechanical anchor bolts.
   5. Adhesive anchors (Epoxy anchors).

C. Vibration isolation and seismic restraints include the following:
   1. Flexible conduits at connections to motors and other vibrating equipment.
   2. Seismic restraint for vibration isolated equipment.

1.03 SEISMIC RESTRAINT REQUIREMENTS

A. Provide supports, attachments, and seismic restraints designed and installed in compliance with the requirements defined in applicable Codes and Standards, including the International Building Code.

B. Seismic Design Criteria:
   1. Occupancy Category: As defined in the Architectural and/or Structural Documents.
   2. Seismic Design Category: As defined in the Structural Documents.
   3. Site Classification: As defined in the Structural Documents.

C. Component Importance Factor (Ip): Seismic restraints shall be designed as follows:
   1. Anchorage of all electrical components in the following buildings shall be designed with an Importance Factor (Ip) of 1.5:
      a. Medical/Mental Health/Geriatric Building (MMH).
      b. Men’s Max Building (MAX).
      c. Women’s Max Building (WMX).
      e. Women’s General Population Building (WGP).
      f. SATP/SOTP Building (STP).
      g. RAO Building.
   2. Anchorage of electrical systems (wiring and equipment) that are designated as life-safety OR standby shall be designed with an Importance Factor (Ip) of 1.5.
   3. All other electrical components shall be designed with an Importance Factor (Ip) of 1.0.

D. Provide seismic certification for the following electrical equipment and systems:
   1. Emergency AND standby power systems equipment:
      a. Generators
      b. Fuel tanks
      c. Automatic transfer switches
   2. Central lighting inverter systems and associated batteries.
   3. UPS systems and associated batteries.
   4. Transformers.
5. Electrical substations.
6. Switchgear, including Medium-voltage Switches.

1.04 SUBMITTALS
A. Provide point-by-point statement of any deviations or exceptions with specifications, in accordance with Section 26 05 00.1.5B.
B. The submittal shall contain the following information:
   1. Catalog cuts and data sheets on specific vibration isolators, mufflers, electrical box pads and other equipment to be utilized, showing compliance with this Specification.
   2. An itemized list showing the items of equipment to be isolated, the isolator type and model number selected, isolator loading and deflection.
   3. Calculations by a Structural Engineer licensed in the State of Utah certifying that the seismic restraints will act in accordance with the relevant codes.
   4. Certification by the manufacturer or its representative that their vibration isolation equipment have been installed correctly.

1.05 SUBSTITUTEIONS
A. Submit request for substitution of materials as part of product submittal, in accordance with the requirements of Division 01.

1.06 COORDINATION
A. The Contractor shall coordinate the Work with other trades to avoid rigid contact between isolated transformers, raceways and the building. He shall inform other trades following his Work to avoid any contact that would reduce the vibration isolation.

1.07 CONFLICTS AND DISCREPANCIES
A. The Contractor shall bring to the Architect's attention prior to installation any conflicts with other trades that will result in unavoidable contact to the equipment, raceways, etc., described herein, due to inadequate space, etc. Corrective work necessitated by conflicts after installation shall be at the Contractor's expense.
B. The Contractor shall bring to the Architect's attention any discrepancies between the Specifications and field conditions, changes required due to specific equipment selection, etc., prior to installation. Corrective Work necessitated by discrepancies after installation shall be at the Contractor's expense.

1.08 INSPECTION AND INSTRUCTION
A. The Contractor shall obtain approval from the Inspector of any installation to be covered or enclosed prior to such closure.
B. The Contractor shall comply with instructions from the vibration isolation manufacturer as to the proper installation and adjustment of vibration isolation devices and seismic restraints.

1.09 RESPONSIBILITY OF MANUFACTURER
A. Vibration isolation manufacturer shall:
   1. Determine vibration isolation sizes and locations.
   2. Provide equipment isolation system as scheduled or specified.
   4. Provide installation instructions and drawings.
   5. Provide calculations signed by a Structural Engineer licensed in the State of Utah certifying that the seismic restraints will act in accordance with the relevant State and local codes and will maintain equipment in captive position.

1.10 VIBRATION ISOLATION AND NOISE CONTROL REQUIREMENTS
A. Floor Mounted Transformers:
   1. On grade neoprene pads – 0.06" static deflection
2. Above grade – less than 100KVA – neoprene mounts – 0.20 in. static deflection (supported) or neoprene hangers.
3. Above grade – 100KVA or greater – steel springs – 1.0” static deflection (supported) or spring hangers
4. Locate at 4 corners of transformer.
5. Bolt to floor.
6. Seismic restraints as required.

B. Flexible Electrical Connections:
   1. At all transformers within building.
   2. At connections to motor or other vibrating equipment.

1.11 ELECTRICAL BOX PADS
A. Provide electrical box pads on all junction boxes located within sound insulated drywall partitions.

PART 2 - PRODUCTS

2.01 FLEXIBLE CONNECTIONS
A. Conduit 1-inch ID or over: Make electrical connections to vibrating equipment via flexible expansion/deflection conduit coupling sized as required. Coupling shall have a flexible and watertight outer jacket, an internal grounding strap, plastic inner sleeve to maintain smooth wireway, and end hubs with threads to fit standard threaded metal conduit. Acceptable units include:
   1. XD Expansion Deflection Coupling by Crouse-Hinds of Syracuse, NY.
   2. Type DF Expansion and Deflection fitting by Spring City Electrical Mfg. Co. of Spring City, PA.

B. Conduit under 1-inch ID: Use flexible conduit with slack at least 3-feet or 15 diameters long, whichever is the longer or provide a flexible coupling as defined above.

2.02 RESTRAINT CHANNEL BRACINGS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.; a division of Cooper Industries.
   2. Hilti, Inc.
   3. Mason Industries, Inc.
   4. Unistrut; an Atkore International company.

B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.03 RESTRAINT CABLES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Kinetics Noise Control, Inc.
   2. Loos & Co., Inc.
   3. Vibration Mountings & Controls, Inc.

B. Restraint Cables: ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.04 SEISMIC-RESTRAINT ACCESSORIES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.
4. TOLCO; a brand of NIBCO INC.

B. Hanger-Rod Stiffener: Reinforcing steel angle clamped to hanger rod.
C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.
F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.05 MECHANICAL ANCHOR BOLTS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.; a division of Cooper Industries.
   2. Hilti, Inc.
   4. Mason Industries, Inc.
B. Mechanical Anchor Bolts: Refer to Section 03 56 00 “Post-Installed Anchors”.

2.06 ADHESIVE ANCHORS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hilti, Inc.
   2. Kinetics Noise Control, Inc.
   3. Mason Industries, Inc.
B. Adhesive Anchors: Refer to Section 03 56 00 “Post-Installed Anchors”.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine areas and equipment to receive seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.

3.02 APPLICATIONS
A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or other evaluation service agency acceptable to authorities having jurisdiction.
B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where required to prevent buckling of hanger rods caused by seismic forces.
C. Strength of Support and Seismic-Restraint Assemblies: Select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.
3.03 INSTALLATION OF BUILDING ATTACHMENTS

A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainrel, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms.

1. Poured-in Place Concrete Inserts:
   a. Install before concrete is poured. Fasten inserts securely to forms per manufacturer’s installation requirements.
   b. Install centered in low flutes or conform to manufacturer installation requirements.
   c. For equipment greater than 20 pounds or distributed systems weighing 5 pounds/foot or more, provide poured in place concrete insert with current ICC ESR or IAMPO report.

2. Post-Installed Anchors:
   a. Acceptable anchors are specified in Section 03 65 00.
   b. Power-Driven Fasteners: Not allowed.

3. Loading of Hangers on Steel Beams:
   a. Do not place eccentric loads on steel beams for loads greater than 50 pounds (23 kg).
   b. For loads greater than 50 pounds (23 kg), use attachments that create concentric loading.

4. Loading of Hangers on Open Web Steel Joists:
   a. Do not place eccentric loads on open web steel joists.
   b. For loads greater than 100 pounds, contractor shall coordinate with steel joist manufacturer to ensure joists are designed for imposed loads.

5. Loading of Hangers on Concrete Slabs:
   a. See Structural Drawings for allowable maximum load limits.
   b. For loads greater than specified maximum point load, or where minimum spacing cannot be maintained, contractor shall submit proposed concrete slab loading and attachment for approval by project structural engineer.

6. Loading of Hangers on Concrete Fill over Metal Deck:
   a. See Drawings for allowable maximum load limits.
   b. For loads greater than specified maximum point load, or where minimum spacing cannot be maintained, contractor shall:
      1) Make attachment to building structure or auxiliary steel, rather than to deck.
      2) Or submit proposed deck loading and attachment for approval by project structural engineer.

7. Loading of Hangers on Bare Metal Deck:
   a. See Drawings for allowable attachment methods and maximum load limits.
   b. For loads greater than specified maximum point load, or where minimum spacing cannot be maintained, contractor shall:
      1) Make attachment to building structure or auxiliary steel, rather than to deck.
      2) Or submit proposed deck loading and attachment for approval by project structural engineer.

8. Powder-Driven Concrete Inserts: Not allowed.

3.04 INSTALLATION OF SEISMIC-RESTRAINT DEVICES

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete."

B. Equipment and Hanger Restraints:
   1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
2. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or other evaluation service agency acceptable to authorities having jurisdiction providing required submittals for component.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

G. Drilled-in Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Expansion Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened. Install in accordance with evaluation reports and the manufacturer’s written instructions.
   4. Adhesive Anchors: Prepare substrate and install in accordance with evaluation reports and the manufacturer’s written instructions.
   5. Refer to Section 03 65 00 “Post-Installed Anchors” for additional requirements.
   6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications and wet locations.

3.05 DEMONSTRATION OF SEISMIC COMPLIANCE

A. Equipment identified as part of a Designated Seismic System shall be certified by the manufacturer as operable following the occurrence of a design level seismic event. Evidence demonstrating compliance with this requirement shall be submitted for review by the Owner’s Representative.

B. Certification shall be seismically qualified by at least one of the following methods:
   1. Analysis using dynamic characteristics and forces.
   2. Testing based upon a nationally recognized testing standard procedure, such as ICC-ES AC156.
   3. Experience data, based upon nationally recognized procedures.
   4. Evidence that the component is sufficiently rugged based on comparison with similarly seismically qualified components.

3.06 COORDINATION

A. Contractor shall coordinate his Work with other trades to avoid rigid contact between isolated equipment and raceways with the building.

B. Contractor shall inform other trades following his Work to avoid any contact that would reduce the vibration isolation.

C. Coordinate and adjust seismic restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 26 05 48
PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS
A. All sections of Division 01, General Requirements, apply to this section.
B. Coordinate with Commissioning Work. Comply with the requirements of Division 01 Section “General Commissioning Requirements” and Division 26 Section “Electrical Commissioning.”

1.02 SUMMARY
A. Section Includes:
   1. Identification for raceways.
   2. Identification of power and control cables.
   3. Identification for conductors.
   5. Warning labels and signs.
   6. Instruction signs.
   7. Equipment identification labels.
   8. Tags at concealed equipment and devices requiring periodic maintenance.
B. Coordinate with the Owner and Commissioning Agent to determine specific standards for identification materials, methods, nomenclature, and schemes. Follow the Owner’s standards for identification for each Building and site-wide. In the case of inconsistencies between the Owner’s standards and the requirements in this Section, the Owner’s standards shall apply.

1.03 SUBMITTALS
A. Provide point-by-point statement of compliance with specifications, in accordance with Section 26 05 00.1.5B.
B. Product Data: For each electrical identification product indicated.
C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.04 SUBSTITUTIONS
A. Submit request for substitution of materials as part of product submittal, in accordance with the requirements of Division 01.

1.05 QUALITY ASSURANCE
A. Comply with ANSI A13.1.
B. Comply with NFPA 70.
D. Comply with ANSI Z535.4 for safety signs and labels.

1.06 COORDINATION
A. Coordinate identification names, abbreviations, colors, and other features with Owner requirements and requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
C. Coordinate installation of identifying devices with location of access panels and doors.
D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS
   A. In accordance with drawing details.

2.02 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS
   A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.
   B. Snap-Around Cable Marker: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

2.03 CONDUCTOR IDENTIFICATION MATERIALS
   A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 or 2 inches wide.
   B. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the conductor diameter such that the clear shield overlaps the entire printed legend.
   C. Marker Tapes: Vinyl-cloth, self-adhesive wrap-around type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.04 FLOOR MARKING TAPE
   A. 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

2.05 WARNING LABELS AND SIGNS
   B. Baked-Enamel Warning Signs:
      1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
      2. 1/4-inch grommets in corners for mounting.
      3. Nominal size, 7 by 10 inches.
      4. Warning label and sign shall include, but are not limited to, the following legends:
         a. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
         b. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
   C. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
      1. Engraved legend with black letters on white face, unless otherwise noted.
      2. Punched or drilled for mechanical fasteners.
      3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
   D. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.
   E. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.
2.06 UNDERGROUND-LINE WARNING TAPE

A. Tape:
1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:
1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag:
1. Pigmented polyolefin, bright-colored, compounded for direct-burial service.
2. Thickness: 4 mils.
3. Weight: 18.5 lb./1000 sq. ft..
4. 3-Inch Tensile According to ASTM D 882: 30 lbf, and 2500 psi.

2.07 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
1. Engraved legend, white background with black letters.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.08 EQUIPMENT IDENTIFICATION LABELS

A. Engraved laminated three-layer plastic nameplates:
2. Emergency Power: Red background, white letters.
3. Legally Required or Standby Power: White background, red letters.
4. UPS Power: Blue background, white letters.
5. Lettering: Engraved, minimum 1/4 inch high letters to correspond with the designations on the drawings, unless otherwise noted.
6. Attachment: Attach with rivets, self-tapping screws or machine screws. Self-adhering or adhesive backed nameplates shall not be used.

2.09 LIGHT FIXTURE IDENTIFICATION LABELS

A. Engraved laminated three-layer plastic nameplates complying to drawings details.

2.10 CONCEALED EQUIPMENT/DEVICES REQUIRING PERIODIC MAINTENANCE

A. Equipment and devices requiring periodic maintenance concealed behind access doors, panels, hatches, and above ceilings shall be provided with labels on the panel or ceiling grid directly below. Label shall be machined with black text on white background by thermal transfer or equivalent process, on a permanent adhesive backed polyester label. Nomenclature, text height and label position to be coordinated with Owner.

B. Similar to Brady B-423 labeling system including labeling machine.

2.11 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
   B. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self-locking.
      2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
      3. UL 94 Flame Rating: 94V-0.
      4. Temperature Range: Minus 50 to plus 284 deg F.
      5. Color: Black.

2.12 MISCELLANEOUS IDENTIFICATION PRODUCTS
A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION
3.01 GENERAL INSTALLATION REQUIREMENTS
A. Verify identity of each item before installing identification products.
B. Coordinate with the Owner and Commissioning Agent to determine specific standards for identification materials, methods, nomenclature, and schemes. Follow the Owner’s standards for identification for each Building and site-wide. In the case of inconsistencies between the Owner’s standards and the requirements in this Section, the Owner’s standards shall apply.
C. Location:
   1. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
   2. Install parallel to equipment lines.
D. Apply identification devices to surfaces that require finish after completing finish work.
E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
F. System Identification for Raceways and Cables:
   1. Identification markers shall completely encircle cable or conduit.
   2. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
   3. Install wire marker for each conductor at panelboard, at each pull box, at each outlet and junction box, and at each load connection.
   4. Install wire marker for data/communications cabling at each end.
G. Aluminum Wraparound Marker Labels: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
   1. In Spaces Handling Environmental Air: Plenum rated.
I. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.02 IDENTIFICATION REQUIREMENTS
A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
   2. Lighting.
3. Fire Alarm.
4. BMS.
5. Security
6. Voice/Data

B. Power-Circuit Conductor Identification: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
   1. Color-Coding for Phase and Voltage Level Identification: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
      a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
      b. Colors for 208/120V Circuits:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
         4) Neutral: White.
         5) Ground: Green.
      c. Colors for 480/277V Circuits:
         1) Phase A: Brown.
         2) Phase B: Orange.
         3) Phase C: Yellow.
         4) Neutral: Gray.
         5) Ground: Green.
      d. Colors for 12,470V Circuits:
         1) Phase A: Yellow, 1 stripe.
         2) Phase B: Yellow, 2 stripes.
         3) Phase C: Yellow, 3 stripes.
         4) Ground: Green.
      e. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

C. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

F. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.
   2. Identify system voltage with black letters on an orange background.
   3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of
equipment including, but not limited to, the following:
   a. Controls with external control power connections.

H. Operating Instruction Signs: Install instruction signs to facilitate proper operation and
maintenance of electrical systems and items to which they connect. Install instruction signs with
approved legend where instructions are needed for system or equipment operation.

I. Equipment Identification Labels: On each unit of equipment, install unique designation label
that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual.
Systems include power, lighting, control, communication, signal, monitoring, and alarm systems
unless equipment is provided with its own identification.

1. Labeling Instructions:
   a. Indoor Equipment: Unless otherwise indicated, engraved with single line of text, on
      1-1/2-inch- high label; where two lines of text are required, use labels 2 inches
      high.
   b. Outdoor Equipment: Engraved, label minimum 3 inches high.
   c. Elevated Components: Engraved, label minimum 4 inches high with 1/2 inch high
      letters appropriate for viewing from the floor level.
   d. Labels shall be located on the outside cabinet doors.

2. Apply self-adhesive labels to the following devices and equipment, including but not
   limited to:
   a. Power outlet receptacles. (e.g. panel 'LA', circuit number 1: “LA-1”)
   b. Light switches. (e.g. sim. to power receptacles)
   c. Wall mounted occupancy sensors (e.g. sim. to power receptacles)
   d. Wall mounted time switches (e.g. sim. to power receptacles)
   e. Dimming switches and wall mount dimming controllers (e.g. sim. to power
      receptacles)
   f. Fire Alarm Initiation Devices (Smoke Detectors, Heat Detectors, Pull Stations, etc.)
      and Fire Alarm Notification Devices (Horns, Strobes, etc.).
      1) Each initiation device label shall indicate the addressable node, the
         addressable loop number, device type (S=sensor, M=monitor), and device
         number (i.e., N1-L1S001, N1-L2M001).
      2) Each notification device label shall indicate the device type (H=horn,
         L=strobe), the circuit number, and the device number (i.e., S1-1 or L1-2).
   g. Control stations and devices.
   h. Electrical contactors and relays.
   i. All junction boxes containing security and telecommunications wiring.
   j. Time clocks.
   k. Security monitoring and control equipment.

3. Apply permanently engraved labels to the following devices and equipment, including but
   not limited to:
   a. Switchgear, including breakers and spare/spaces.
   b. Switchboards, including breakers and spare/spaces.
   c. Transformers.
   d. Panelboards.
   e. Enclosed circuit breakers and protection equipment.
   f. Enclosed controllers and motor starters.
   g. Enclosures and electrical cabinets.
   h. Access doors and panels for concealed electrical items.
   i. Disconnect switches.
   j. Variable-Frequency Drives.
   k. Central Battery-Inverters.
   l. UPS Systems.
   m. Generators.
   n. Automatic Transfer Switches.
   o. Paralleling Switchgear.
p. Control Panels.
q. Terminal cabinets.
r. Equipment racks of each system.
s. Fire Alarm: Each fire alarm control panel and each remote power supply panel.
t. Lighting control panels, lighting contactor panels, dimming panels.
u. Security Equipment: Central or Master Control Units.

4. Handwritten labeling is permitted for the following:
   a. All junction boxes containing power, lighting, and fire alarm wiring.
   b. Use a permanent chisel tip black marker, and write the required information in a neat and clearly legible manner clearly visible from the floor.
   c. Label each junction box with the applicable circuit number(s) for the cables contained within.

J. Master Nameplate: Provide a permanently engraved master nameplate at the main distribution location affixed with double-sided adhesive tape covering the back of the nameplate, to identify the project, the engineer and the installation date.

K. Duct Bank Identification Nameplates:  
   1. Permanently engraved nameplate labels must be placed adjacent to each entering/leaving duct at the duct banks in the manhole.
   2. Labels are to be 3-in x 5-in yellow with black engraved letters.
   3. Labels are to include a 1/4-in hole in each corner. Each label shall be affixed to the wall using plastic anchors and screws.
   4. Lettering shall indicate the conduit’s next destination point or last departure point (e.g., To MH #123, From Pad #123, To Vault #123).

L. Medium-voltage Cable Nameplates:  
   1. Feeder identification tags shall be attached to each feeder near entrance or exit points inside manholes, vaults or pad locations; at any switch section, the feeder connects to; and, inside the primary compartment of each transformer.
   2. Lamicoid tags shall be 2.5-in x 2.5-in x 1/16-in, diamond orientation (not a square), and shall be yellow with black engraved letters.
   3. Lettering shall be 3/8-in high, centered, and shall indicate the substation and feeder number.
      a. Example: F-71 (indicating substation 7, feeder #1)
      b. Example: RB F-10-2 (indicating the Red Butte Substation, Substation 10, feeder #2).
   4. Lamicoid tags shall be attached to phase B using a black weather resistant zip tie. Tags are to include a 1/4-in hole in the top corner to allow attachment by means of the zip tie.
   5. Tags shall be located where lettering will be readily visible. The zip tie attachment must not be pulled too tight, allowing for minor adjustment by maintenance personnel.

M. Medium-voltage Switchgear Nameplates:  
   1. Permanently engraved nameplate labels shall identify each switch cabinet.
   2. Labels are to be 3-in x 5-in yellow background with black engraved letters.
   3. Each label shall be affixed to the cabinet with double-sided adhesive tape covering the back of the nameplate.

N. Medium-voltage “Switch Cabinet” Nameplates:  
   1. Permanently engraved nameplate labels shall identify each switch cabinet.
   2. Labels are to be 3-in x 5-in yellow background with black engraved letters.
   3. Each label shall be affixed to the cabinet with double-sided adhesive tape covering the back of the nameplate.
   4. Each nameplate shall include the pad number, switch number, the building name and number served by the switch, and voltage.

O. Medium-voltage “Switch” Nameplates:  
   1. A permanently engraved nameplate label shall:
      a. Identify the device the switch will operate; or,
b. Identify the destination manhole, vault, or pad number; the switch number; and, section it serves; or,
c. Identify the destination switch and the section the feeder serves.

2. Labels are to be 3-in x 5-in yellow background with black engraved letters.
3. Each label shall be affixed to the switch with double-sided adhesive tape covering the back of the tag.

P. Pad-Mounted Distribution Transformer Identification Nameplates:
1. Permanently engraved nameplate labels shall identify each transformer and its location.
2. Labels are to be 3-in x 5-in yellow background with black engraved letters.
3. Each label shall be affixed to the cabinet exterior with double-sided adhesive tape covering the back of the nameplate.
4. Each nameplate shall designate the pad number (same as the building number), transformer number, primary and secondary voltages, KVA rating, and the building name/number served by the transformer.

Q. Low-voltage Transformer Identification Nameplates:
1. A permanently engraved nameplate label shall identify each transformer.
2. The nameplate shall be 3-in x 5-in with yellow background and black engraved letters.
3. Each label shall be affixed to the cabinet with double-sided adhesive tape covering the back of the nameplate.
4. The nameplate shall designate the transformer, electrical source feeding the transformer, load supplied, size (kVA), and the primary and secondary voltages.

R. Manhole Identification Nameplates:
1. A manhole identification nameplate, permanently engraved, is required for each manhole.
2. Labels are to be 3-in x 5-in yellow with black engraved letters.
3. The nameplate shall be mounted on the north side of the concrete ring, as one enters the manhole, and shall be easily visible both from ground level outside and from the floor level inside the manhole. This standard shall be followed for all manholes on campus to facilitate a means for convenient orientation by observing the nameplate in a known location, either while entering or when established inside the manhole.
4. The nameplate shall be affixed to the concrete ring using plastic anchors and screws.

S. Panelboards and Distribution Panelboards Nameplates:
1. Permanently engraved nameplate is required for each panelboard and distribution panelboard.
2. Each label shall be affixed to the cabinet in a readily visible location with double-sided adhesive tape covering the back of the nameplate.

T. Switchboard Nameplate:
1. The switchboard label shall include the switchboard name, electrical source feeding the switchboard, voltage, size (amps), number of phases, number of wires, and AIC rating.
2. If the switchboard contains a main building disconnect, this shall be included on the label. Example: Main Building Disconnect 1 of 2
3. Switchboard Breaker and Spare Space Labels:
   a. Switchboard breaker and spare space labels shall be installed to clearly identify each switchboard breaker and spare/space.
   b. Each label shall include the breaker number and the load served. Example: MDP1-1, Panel PH1
   c. For spare/space, the label shall indicate “spare” as well as the size in amps and phase.
      1) Example: Spare, 200A, 3P
      2) Example: Space, 400A max, 3P

U. Panelboard, Switchboard, and Switchgear Schedules: Provide framed, typewritten circuit schedules with explicit description and identification of items controlled by each individual breaker. Schedules shall include as a minimum the equipment name designation as indicated on the design drawings and the voltage, ampere, and phase ratings.
V. Variable Frequency Drive (VFD) Nameplates:
1. Permanently engraved 3-in x 5-in nameplates are required to identify the equipment controlled, electrical source feeding the controller, voltage, number of phases, disconnect and fuse sizes in amps where applicable, and equipment horse power. Example: AHU-1, PH1-1,3,5, 480V, 3P, 200A/150A fuse, 75HP
2. Additionally, provide a second label on the VFD cabinet specifying which control signal is used.
3. Each label shall be affixed to the cabinet in a readily visible location with double-sided adhesive tape covering the back of the nameplate.

W. Fire Alarm Equipment Nameplates:
1. Permanently engraved 3-in x 5-in labels are required for each fire alarm control panel and each remote power supply panel.
2. Each label shall include the panel name and the source feeding the panel. Example: FACP, PL1-1 or NAC-1, PL1-3.

X. Word Processor Generated Panel Schedules:
1. Provide typewritten panel schedules incased in clear, transparent covers for each branch panel.
2. Require the Contractor to label every breaker or available space.
3. Use actual/final room designations (room name and room number) assigned by the Owner. Room identifiers on project drawings may be different than final room assignments.
4. New schedules and labeling shall be provided to accurately reflect the changes or additions to existing panels, distribution boards, etc.

Y. Single Line Diagrams:
1. Provide a copy of the single line diagram in each electrical room. Minimum size shall be 15-inch by 21-inch. Mount the diagram on the wall in a metal or wood frame under plexiglass.
2. Install diagrams at locations for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate the substrate.

END OF SECTION 26 05 53
SECTION 26 09 23
DISTRIBUTED DIGITAL LIGHTING CONTROL SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Digital Lighting and Plug Load Controls
   2. Relay Panels
   3. Emergency Lighting Control (if applicable)

B. Related Sections:
   1. Section 26 27 26 - Wiring Devices Receptacles
   2. Section 26 51 13 – Interior Lighting Fixtures, Lamps, and Ballasts Fluorescent electronic dimming ballasts.

C. Control Intent – Control Intent includes, but is not limited to:
   1. Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.
   2. Initial sensor and switching zones
   3. Initial time switch settings
   4. Emergency Lighting control (if applicable)

1.2 REFERENCES

A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) (www.ansi.org and www.ieee.org)
B. International Electrotechnical Commission (IEC) (www.iec.ch)
C. International Organization for Standardization (ISO) (www.iso.ch):
D. National Electrical Manufacturers Association (NEMA) (www.nema.org)
E. WD1 (R2005) - General Color Requirements for Wiring Devices.
F. Underwriters Laboratories, Inc. (UL) (www.ul.com):
   1. 20 – Plug Load Controls
   2. 508 – Industrial Controls
   3. 916 – Energy Management Equipment
   4. 924 – Emergency Lighting
G. Underwriter Laboratories of Canada (ULC) (www.ulc.ca)

1.3 SYSTEM DESCRIPTION & OPERATION

A. The Lighting Control and Automation system as defined under this section covers the following equipment:
   1. Digital Lighting Management (DLM) local network – Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
   2. Digital Room Controllers – Self-configuring, digitally addressable one, two or three relay plenum-rated controllers for on/off control. Selected models include 0-10 volt or
line voltage forward phase control dimming outputs and integral current monitoring capabilities.


4. Digital Fixture Controllers – Self-configuring, digitally addressable one relay fixture-integrated controllers for on/off/0-10V dimming control.

5. Digital Occupancy Sensors – Self-configuring, digitally addressable, calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.

6. Digital Switches – Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications.

7. Handheld remotes for personal control – On/Off, dimming and scene remotes for control using infrared (IR) communications. Remote may be configured in the field to control selected loads or scenes without special tools.

8. Digital Daylighting Sensors – Single-zone closed loop, multi-zone open loop and single-zone dual-loop daylighting sensors with two-way active infrared (IR) communications for daylight harvesting using switching, bi-level, tri-level or dimming control.

9. Configuration Tools – Handheld remote for room configuration and relay panel programming provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away.

10. Digital Lighting Management (DLM) segment network – Linear topology, BACnet MS/TP network (1.5 twisted pair, shielded) to connect multiple DLM local networks for centralized control.

11. Network Bridge – Provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS) and automatically creates BACnet objects representative of connected devices.

12. Segment Manager – BACnet MS/TP-based controller with web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.

13. Programming and Configuration Software – Optional PC-native application capable of accessing DLM control parameters within a room, for the local network, via a USB adapter, or globally, for many segment networks simultaneously, via BACnet/IP communication.

14. Digital Lighting Management Relay Panel and Zone Controller – Provides up to 8, 24, or 48 mechanically latching relays. Relays include a manual override and a single push-on connector for easy installation or removal from the panel. Panel accepts program changes from handheld configuration tool for date and time, location, holidays, event scheduling, button binding and group programming. Provides BACnet MS/TP-compliant digital networked communication between other lighting controls and/or building automation system (BAS). Zero relay Zone Controller primarily supports Digital Fixture Controller applications.

15. Emergency Lighting Control Unit (ELCU) – Allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building

### 1.4 LIGHTING CONTROL APPLICATIONS
A. Unless relevant provisions of the applicable local energy codes are more stringent, provide a minimum application of lighting controls as follows:

1. Space Control Requirements – Provide occupancy/vacancy sensors with Manual- or Partial-ON functionality in all spaces except toilet rooms, storerooms, library stacks, or other applications where hands-free operation is desirable and Automatic-ON occupancy sensors are more appropriate. Provide Manual-ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room. For spaces with multiple occupants, or where line-of-sight may be obscured, provide ceiling- or corner-mounted sensors and Manual-ON switches.

2. Task Lighting / Plug Loads – Provide automatic shut off of non essential plug loads and task lighting in all spaces except toilet rooms and storerooms. Provide Automatic-ON of plug loads whenever spaces are occupied. For spaces with multiple occupants a single shut off consistent with the overhead lighting may be used for the area.

3. Daylit Areas – Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) where daylight contribution is available as defined by relevant local building energy code:
   a. All luminaires within code-defined daylight zones shall be controlled separately from luminaires outside of daylit zones.
   b. Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes.
   c. Multiple-level switched daylight harvesting controls may be utilized for areas marked on drawings.
   d. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.

4. Conference, meeting, training, auditoriums, and multipurpose rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four preset lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to turn off all lighting in the space. Spaces with up to four moveable walls shall include controls that can be reconfigured when the room is partitioned.

1.5 SUBMITTALS
A. Submittals Package: Submit the shop drawings, and the product data specified below at the same time as a package.
B. Shop Drawings:
   1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed.
   2. Show exact location of all digital devices, including at minimum sensors, load controllers, and switches for each area on reflected ceiling plans. (Contractor must provide AutoCAD format reflected ceiling plans.)
   3. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
   4. Network riser diagram including floor and building level details. Include network cable specification and end-of-line termination details, if required. Illustrate points of
connection to integrated systems. Coordinate integration with mechanical and/or other trades.

C. Product Data: Catalog sheets, specifications and installation instructions.

D. Include data for each device which:
   1. Indicates where sensor is proposed to be installed.
   2. Prove that the sensor is suitable for the proposed application.

1.6 QUALITY ASSURANCE

1.7 Manufacturer: Minimum 10 years experience in manufacture of lighting controls.

1.8 PROJECT CONDITIONS

A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
   1. Ambient temperature: 0° to 40° C (32° to 104° F).
   2. Relative humidity: Maximum 90 percent, non-condensing.

1.9 WARRANTY

A. Provide a five year limited manufacturer’s warranty on all room control devices and panels.

1.10 MAINTENANCE

A. Spare Parts:
   1. Provide the minimum of 5% or [5] of each of the following spares of each product that are used on this project to be used for maintenance as listed below:
      a. Single-zone room controller
      b. Two-zone room controller
      c. Three-zone room controller
      d. Single-zone dimming controller
      e. Two-zone dimming controller
      f. Three-zone dimming controller
      g. Plug load controller
      h. Fixture controller
      i. Network bridge
      j. Isolated auxiliary relay
      k. Ceiling occupancy sensor (each type used)
      l. Wall mount occupancy sensor (each type used)
      m. Wall switch (each type used)
      n. Interior photocell

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer:
1. Basis of design product: WattStopper Digital Lighting Management (DLM) or subject to compliance and prior approval with specified requirements of this section, one of the following:
   a. nLight
   b. Hubbell Building Automation

2. Substitutions: All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the design professional a minimum of 10 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.

2.2 DIGITAL LIGHTING CONTROLS
A. Furnish the Company’s system which accommodates the square-footage coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors, switches, daylighting sensors and accessories which suit the lighting and electrical system parameters.

2.3 DLM LOCAL NETWORK (Room Network)
A. The DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building.
   B. Features of the DLM local network include:
      1. Plug n’ Go™ automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
      2. Simple replacement of any device in the local DLM network with a standard off the shelf unit without requiring significant commissioning, configuration or setup.
      3. Push n’ Learn™ configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
      4. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.
   C. Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors, which provide both data and power to room devices. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable.
   D. If manufacturer’s pre-terminated Cat5e cables are not used for the installation, the contractor is responsible for testing each cable following installation and supplying manufacturer with test results.
   E. WattStopper Product Number: LMRJ-Series

2.4 DIGITAL LOAD CONTROLLERS (ROOM, PLUG LOAD AND FIXTURE CONTROLLERS)
A. Digital controllers for lighting and plug loads automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room and plug load controllers shall be provided to match the room lighting and plug load control requirements. The controllers will be simple to install, and will not have dip switches or potentiometers, or require special configuration for standard Plug n’ Go applications. The control units will include the following features:
1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.

2. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf.

3. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are sequentially assigned using each controller’s device ID’s from highest to lowest.

4. Device Status LEDs to indicate:
   a. Data transmission
   b. Device has power
   c. Status for each load
   d. Configuration status

5. Quick installation features including:
   a. Standard junction box mounting
   b. Quick low voltage connections using standard RJ-45 patch cable

6. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
   a. Turn on to 100%
   b. Turn off
   c. Turn on to last level

7. Each load shall at a minimum be configurable to operate in the following sequences based on occupancy:
   a. Auto-on/Auto-off (Follow on and off)
   b. Manual-on/Auto-off (Follow off only)

8. The polarity of each load output shall be reversible, via digital configuration, so that on is off and off is on.

9. BACnet object information shall be available for the following objects:
   a. Load status
   b. Electrical current (when available)
   c. Total watts per controller
   d. Schedule state – normal or after-hours
   e. Demand response enable and disable
   f. Room occupancy status
   g. Total room lighting and plug loads watts
   h. Total room watts/sq ft
   i. Force on/off all loads

10. UL 2043 plenum rated

11. Manual override and LED indication for each load
12. Dual voltage (120/277 VAC, 60 Hz), or 347 VAC, 60 Hz (selected models only). 120/277 volt models rated for 20A total load, derating to 16A required for some dimmed loads (forward phase dimming); 347 volt models rated for 15A total load; plug load controllers carry application-specific UL 20 rating for receptacle control.

13. Zero cross circuitry for each load

14. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.

B. On/Off Room Controllers shall include:
   1. One or two relay configuration
   2. Efficient 150 mA switching power supply
   3. Three RJ-45 DLM local network ports with integral strain relief and dust cover
   4. WattStopper product numbers: LMRC-101, LMRC-102

C. On/Off/Dimming enhanced Room Controllers shall include:
   1. Real time current monitoring
   2. Multiple relay configurations
      a. One, two or three relays (LMRC-21x series)
      b. One or two relays (LMRC-22x series)
   3. Efficient 250 mA switching power supply
   4. Four RJ-45 DLM local network ports with integral strain relief and dust cover
   5. One dimming output per relay
      a. 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting. (LMRC-21x series)
      b. Line Voltage, Forward Phase Dimming - Where indicated, one forward phase control line voltage dimming output per relay for control of compatible two-wire or three-wire ballasts, LED drivers, MLV, forward phase compatible ELV, neon/cold cathode and incandescent loads. (LMRC-22x series)
      c. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver.
      d. The LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
      e. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100% dimming range defined by the minimum and maximum calibration trim.
      f. Calibration and trim levels must be set per output channel.
      g. Devices that set calibration or trim levels per controller are not acceptable.
      h. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.
6. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.

7. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.

8. The following dimming attributes may be changed or selected using a wireless configuration tool:
   a. Establish preset level for each load from 0-100%
   b. Set high and low trim for each load
   c. Set lamp burn in time for each load up to 100 hours

9. Override button for each load provides the following functions:
   a. Press and release for on/off control
   b. Press and hold for dimming control

10. WattStopper product numbers: LMRC-211, LRMC-212, LRMC-213, LMRC-221, LMRC-222

D. Plug Load Controllers shall include:
   1. One relay configuration with additional connection for unswitched load
   2. Configurable additive time delay to extend plug load time delay beyond occupancy sensor time delay (e.g. a 10 minute additive delay in a space with a 20 minute occupancy sensor delay ensures that plug loads turn off 30 minutes after the space is vacated).
   3. Factory default operation is Auto-on/Auto-off, based on occupancy
   4. Real time current monitoring of both switched and un-switched load (LMPL-201 only)
   5. Efficient switching power supply
      a. 150mA (LMPL-101)
      b. 250mA (LMPL-201)
   6. RJ-45 DLM local network ports
      a. Three RJ-45 ports (LMPL-101)
      b. Four RJ-45 ports (LMPL-201)
   7. WattStopper product numbers: LMPL-101, LMPL-201

E. Fixture Controllers shall include:
   1. A form factor and product ratings to allow various OEM fixture manufacturers to mount the device inside the ballast/driver cavity of standard-sized fluorescent or LED general lighting fixtures.
   2. One 3A 120/277V rated mechanically held relay.
   3. Programmable behavior on power up following the loss of normal power:
      a. Turn on to 100%
      b. Turn off
      c. Turn on to last level
4. Requirement for 7 mA of 24VDC operating power from the DLM local network.
   a. The Fixture Controller does not require a connection to a neutral conductor to operate, and unlike other types of Load Controllers it does not contribute power to the DLM local network to drive accessory devices.
   b. Power to drive the LMFC Fixture Controller electronics can come from any Room or Plug Load Controller, LMPB-100 Power Booster and/or LMZC-301 Zone Controller (described later in the LMCP LIGHTING CONTROL PANELS specification section).

5. 0-10V dimming capability via a single 0-10 volt analog output from the device for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Fixture Controller.

6. Terminals to connect an RJ-45 adaptor with 24” leads, mountable in a ½” KO, for connection to the DLM local network.
   a. The adaptor leads are insulated for use in a fixture cavity, and the lead length allows the OEM fixture manufacturer flexibility to position the Fixture Controller and the RJ45 jack in the best locations on each fixture.

7. A complete set of dimming features described above in the section detailing On/Off/Dimming Enhanced Room Controllers (subsection C.5 onward).


2.5 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR

   A. Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor.

   B. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:

   1. Digital calibration and pushbutton configuration for the following variables:
      a. Sensitivity – 0-100% in 10% increments
      b. Time delay – 1-30 minutes in 1 minute increments
      c. Test mode – Five second time delay
      d. Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
      e. Walk-through mode

   2. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.

   3. Programmable control functionality including:
      a. Each sensor may be programmed to control specific loads within a local network.
      b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
      c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
e. Ultrasonic and Passive Infrared
f. Ultrasonic or Passive Infrared
g. Ultrasonic only
h. Passive Infrared only
i. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.

4. One or two RJ-45 port(s) for connection to DLM local network.
5. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
6. Device Status LEDs, which may be disabled for selected applications, including:
   a. PIR detection
   b. Ultrasonic detection
   c. Configuration mode
d. Load binding
7. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
9. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.

C. BACnet object information shall be available for the following objects:
   1. Detection state
   2. Occupancy sensor time delay
   3. Occupancy sensor sensitivity, PIR and Ultrasonic

D. Units shall not have any dip switches or potentiometers for field settings.

E. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

F. WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

2.6 DIGITAL WALL SWITCH OCCUPANCY SENSORS

A. Wallbox mounted passive infrared PIR or dual technology (passive infrared and ultrasonic) digital occupancy sensor with 1 or 2 switch buttons.

B. Digital Occupancy Sensors shall provide scrolling LCD display for digital calibration and electronic documentation. Features include the following:
   1. Digital calibration and pushbutton configuration for the following variables:
      a. Sensitivity – 0-100% in 10% increments
      b. Time delay – 1-30 minutes in 1 minute increments
c. Test mode – Five second time delay

d. Detection technology – PIR, Dual Technology activation and/or re-activation.

e. Walk-through mode

f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.

2. Programmable control functionality including:

a. Each sensor may be programmed to control specific loads within a local network.

b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.

c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically during the configurable period of time (default 10 seconds) after turning off.

d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:

   i. Ultrasonic and Passive Infrared
   ii. Ultrasonic or Passive Infrared
   iii. Ultrasonic only
   iv. Passive Infrared only

3. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.

4. Two RJ-45 ports for connection to DLM local network.

5. Two-way infrared (IR) transceiver to allow remote programming through handheld configuration tool and control by remote personal controls.

6. Device Status LEDs including

   a. PIR detection
   b. Ultrasonic detection
   c. Configuration mode
   d. Load binding

7. Assignment of any occupancy sensor to a specific load within the room without wiring or special tools.

8. Assignment of local buttons to specific loads within the room without wiring or special tools.


10. All digital parameter data programmed into an individual wall switch sensor shall be retained in non-volatile FLASH memory within the wall switch sensor itself. Memory shall have an expected life of no less than 10 years.

C. BACnet object information shall be available for the following objects:
1. Detection state
2. Occupancy sensor time delay
3. Occupancy sensor sensitivity, PIR and Ultrasonic
4. Button state
5. Switch lock control
6. Switch lock status

D. Units shall not have any dip switches or potentiometers for field settings.

E. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

F. Two-button wall switch occupancy sensors, when connected to a single relay dimming room or fixture controller, shall operate in the following sequence as a factory default:
   1. Left button
      a. Press and release - Turn load on
      b. Press and hold - Raise dimming load
   2. Right button
      a. Press and release - Turn load off
      b. Press and hold - Lower dimming load

G. Low voltage momentary pushbuttons shall include the following features:
   1. Load/Scene Status LED on each switch button with the following characteristics:
      a. Bi-level LED
      b. Dim locator level indicates power to switch
      c. Bright status level indicates that load or scene is active
   2. The following button attributes may be changed or selected using a wireless configuration tool:
      a. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
      b. Individual button function may be configured to Toggle, On only or Off only.
      c. Individual scenes may be locked to prevent unauthorized change.
      d. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
      e. Ramp rate may be adjusted for each dimmer switch.
      f. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
      g. WattStopper part numbers: LMPW, LMDW. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.7 DIGITAL WALL SWITCHES

A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features:
1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.

2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.

3. Configuration LED on each switch that blinks to indicate data transmission.

4. Load/Scene Status LED on each switch button with the following characteristics:
   a. Bi-level LED
   b. Dim locator level indicates power to switch
   c. Bright status level indicates that load or scene is active
   d. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.

5. Programmable control functionality including:
   a. Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority
   b. Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.

6. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.

B. BACnet object information shall be available for the following objects:
   1. Button state
   2. Switch lock control
   3. Switch lock status

C. Two RJ-45 ports for connection to DLM local network.

D. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching.

E. The following switch attributes may be changed or selected using a wireless configuration tool:

F. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
   1. Individual button function may be configured to Toggle, On only or Off only.
   2. Individual scenes may be locked to prevent unauthorized change.
   3. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
   4. Ramp rate may be adjusted for each dimmer switch.
   5. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependant; each button may be bound to multiple loads.

2.8 DIGITAL DAYLIGHTING SENSORS

A. Digital daylighting sensors shall work with load controllers and relay panels to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for rewiring.

1. Closed loop sensors measure the ambient light in the space and control a single lighting zone.

2. Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.

3. Dual loop sensors measure both ambient and incoming daylight in the space to insure that proper light levels are maintained as changes to reflective materials are made in a single zone.

B. Digital daylighting sensors shall include the following features:

1. The sensor's internal photodiode shall only measure lightwaves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. The photodiode shall not measure energy in either the ultraviolet or infrared spectrums. The photocell shall have a sensitivity of less than 5% for any wavelengths less than 400 nanometers or greater than 700 nanometers.

2. Sensor light level range shall be from 1-6,553 footcandles (fc).

3. The capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).

4. For switching daylight harvesting, the photosensor shall provide a field-selectable deadband, or a separation, between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling excessively after they turn off.

5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.

6. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.

7. Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.

8. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.

9. Integral infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.

10. Configuration LED status light on device that blinks to indicate data transmission.

11. Status LED indicates test mode, override mode and load binding.

12. Recessed switch on device to turn controlled load(s) ON and OFF.
13. BACnet object information shall be available for the following daylighting sensor objects, based on the specific photocell’s settings:
   a. Light level
   b. Day and night setpoints
   c. Off time delay
   d. On and off setpoints
   e. Up to three zone setpoints
   f. Operating mode – on/off, bi-level, tri-level or dimming

14. One RJ-45 port for connection to DLM local network.

15. A choice of accessories to accommodate multiple mounting methods and building materials. The photosensors may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox. Standard tube photosensors accommodate mounting materials from 0-0.62” thickness (LMLS-400, LMLS-500). Extended tube photosensors accommodate mounting materials from 0.62”-1.25” thickness (LMLS-400-L, LMLS-500-L). Mounting brackets are compatible with J boxes (LMLS-MB1) and wall mounting (LMLS-MB2). LMLS-600 photosensor to be mounted on included bracket below skylight well.

16. Any load or group of loads in the room can be assigned to a daylighting zone

17. Each load within a daylighting zone can be individually enabled or disabled for discrete control (load independence).

18. All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.

C. Closed loop digital photosensors shall include the following additional features:
   1. An internal photodiode that measures light in a 100-degree angle, cutting off the unwanted light from bright sources outside of this cone.
   2. Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software.
   3. Automatically establishes application-specific setpoints following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of loads.

   4. WattStopper Product Number: LMLS-400, LMLS-400-L.

D. Open loop digital photosensors shall include the following additional features:
   1. An internal photodiode that measures light in a 60-degree angle (cutting off the unwanted light from the interior of the room).
   2. Automatically establishes application-specific setpoints following manual calibration using a wireless configuration tool or a PC with appropriate software. For switching operation, an adequate deadband between the ON and OFF setpoints for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.
   3. Each of the three discrete daylight zones can include any non overlapping group of loads in the room.

   4. WattStopper Product Number: LMLS-500, LMLS-500-L.
E. Dual loop digital photosensors shall include the following additional features:

1. Close loop portion of dual loop device must have an internal photodiode that measures light in a 100 degree angle, cutting off the unwanted light from sources outside of this cone.

2. Open loop portion of dual loop device must have an internal photodiode that can measure light in a 60 degree angle, cutting off the unwanted light from the interior of the room.

3. Automatically establishes application-specific set-points following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of load.

4. Device must reference closed loop photosensor information as a base line reference. The device must be able to analyze the open loop photosensor information to determine if an adjustment in light levels is required.

5. Device must be able to automatically commission setpoints each night to provide adjustments to electrical lighting based on changes in overall lighting in the space due to changes in reflectance within the space or changes to daylight contribution based on seasonal changes.

6. Device must include extendable mounting arm to properly position sensor within a skylight well.

7. WattStopper product number LMLS-600

2.9 DIGITAL PARTITION CONTROLS

A. Partition controls shall enable manual or automatic coordination of lighting controls in flexible spaces with up to four moveable walls by reconfiguring the connected digital switches and occupancy sensors.

B. Four-button low voltage pushbutton switch for manual control.

1. Two-way infrared (IR) transceiver for use with configuration remote control.

2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.

3. Configuration LED on each switch that blinks to indicate data transmission.

4. Each button represents one wall; Green button LED indicates status.

5. Two RJ-45 ports for connection to DLM local network.


C. Contact closure interface for automatic control via input from limit switches on movable walls (by others).

1. Operates on Class 2 power supplied by DLM local network.

2. Includes 24VDC output and four input terminals for maintained third party contract closure inputs.

3. Input max. sink/source current: 1-5mA

   a. Logic input signal voltage High: >18VDC

   b. Logic input signal voltage Low: <2VDC
4. Four status LEDs under hinged cover indicate if walls are open or closed; supports LMPS-104 as remote status indicator.

5. Two RJ-45 ports for connection to DLM local network.

6. WattStopper part number: LMIO-102

2.10 HANDHELD AND COMPUTER CONFIGURATION TOOLS

A. A wireless configuration tool facilitates optional customization of DLM local networks using two-way infrared communications, while PC software connects to each local network via a USB interface.

B. Features and functionality of the wireless configuration tool shall include but not be limited to:

1. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.

2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.

3. Must be able to read and modify parameters for load controllers and relay panels, occupancy sensors, wall switches, daylighting sensors, network bridges, and identify DLM devices by type and serial number.

4. Save up to eight occupancy sensor setting profiles, and apply profiles to selected sensors.

5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.

6. Adjust or fine-tune daylighting settings established during auto-configuration, and input light level data to complete configuration of open loop daylighting controls.

7. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.

8. Verify status of building level network devices.

C. WattStopper Product Numbers: LMCT-100, LMCI-100/LMCS-100

2.11 DLM SEGMENT NETWORK (Room to Room Network)

A. The segment network shall be a linear topology, BACnet-based MS/TP subnet to connect DLM local networks (rooms) and LMCP relay panels for centralized control.

1. Each connected DLM local network shall include a single network bridge (LMBC-300), and the network bridge is the only room-based device that is connected to the segment network.

2. Network bridges, relay panels and segment managers shall include terminal blocks, with provisions for separate “in” and “out” terminations, for segment network connections.

3. The segment network shall utilize 1.5 twisted pair, shielded, cable supplied by the lighting control manufacturer. The maximum cable run for each segment is 4,000 feet. Conductor-to-conductor capacitance of the twisted pair shall be less than 30 pf/ft and have a characteristic impedance of 120 Ohms.

4. Network signal integrity requires that each conductor and ground wire be correctly terminated at every connected device.

5. Substitution of manufacturer-supplied cable must be pre-approved: Manufacturer will not certify network reliability, and reserves the right to void warranty, if non-approved.
cable is installed, and if terminations are not completed according to manufacturer’s specific requirements.

6. Segment networks shall be capable of connecting to BACnet-compliant BAS (provided by others) either directly, via MS/TP, or through NB-ROUTERs, via BACnet/IP or BACnet/Ethernet. Systems whose room-connected network infrastructure require gateway devices to provide BACnet data to a BAS are unacceptable.

B. WattStopper Product Number: LM-MSTP, LM-MSTP-DB

2.12 NETWORK BRIDGE

A. The network bridge module connects a DLM local network to a BACnet-compliant segment network for communication between rooms, relay panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. The network bridge shall use industry standard BACnet MS/TP network communication and an optically isolated EIA/TIA RS-485 transceiver.

1. The network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.

2. Provide Plug n’ Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.

3. The network bridge shall automatically create standard BACnet objects for selected DLM devices to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM devices on each local network. BACnet objects will be created for the addition or replacement of any given DLM device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID and physical MS/TP termination per room are not acceptable. Standard BACnet objects shall be provided as follows:

   a. Read/write the normal or after hours schedule state for the room
   b. Read the detection state of each occupancy sensor
   c. Read the aggregate occupancy state of the room
   d. Read/write the On/Off state of loads
   e. Read/write the dimmed light level of loads
   f. Read the button states of switches
   g. Read total current in amps, and total power in watts through the load controller
   h. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
   i. Activate a preset scene for the room
   j. Read/write daylight sensor fade time and day and night setpoints
   k. Read the current light level, in footcandles, from interior and exterior photosensors and photocells
   l. Set daylight sensor operating mode
   m. Read/write wall switch lock status
n. Read watts per square foot for the entire controlled room
o. Write maximum light level per load for demand response mode
p. Read/write activation of demand response mode for the room
q. Activate/restore demand response mode for the room

B. WattStopper product numbers: LMBC-300

2.13 LMCP LIGHTING CONTROL PANELS AND LMZC ZONE CONTROLLER

A. HARDWARE:
Provide LMCP lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:

1. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 - 8 relays, 1 - 24 relays and 6 four-pole contactors, or 1 - 48 relays and 6 four-pole contactors.
2. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. LMCP panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
3. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. The panel interiors shall include the following features:
   a. Removable, plug-in terminal blocks with connections for all low voltage terminations.
   b. Individual terminal block, override pushbutton, and LED status light for each relay.
   c. Direct wired switch inputs associated with each relay shall support 2-wire momentary switches only.
   d. Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches; digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs; digital IO modules capable of receiving momentary or maintained contact closure inputs or analog sensor inputs; digital daylighting sensors; and digital occupancy sensors. Inputs are divided into two separate digital networks, each capable of supplying 250mA to connected devices.
   e. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.
   f. Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.
   g. Group and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any set of relays can be associated with a group for direct on/off control or pattern (scene) control via a simple programming sequence using the relay override pushbuttons and LED displays for groups 1-8 or a handheld IR programmer for groups 1-99.
h. Relay group status for shall be provided through LED indicators for groups 1-8 and via BACnet for groups 1-99. A solid LED indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.

4. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
   a. Electrical:
      i. 30 amp ballast at 277V
      ii. 20 amp ballast at 347V
      iii. 20amp tungsten at 120V
      iv. 30 amp resistive at 347V
      v. 1.5 HP motor at 120V
      vi. 14,000 amp short circuit current rating (SCCR) at 347V
      vii. Relays shall be specifically UL 20 listed for control of plug-loads
   b. Mechanical:
      i. Replaceable, ½” KO mounting with removable Class 2 wire harness.
      ii. Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
      iii. Dual line and load terminals each support two #14 - #12 solid or stranded conductors.
      iv. Tested to 300,000 mechanical on/off cycles.

5. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.

6. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.

7. Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic by pass of relays controlling emergency circuits upon loss of normal power. Panels shall be properly listed and labeled for use on emergency lighting circuits and shall meet the requirements of UL924 and NFPA 70 - Article 700.

8. Integral system clock shall provide scheduling capabilities for panel-only projects without DLM segment networks or BAS control.
   a. Each panel shall include digital clock capability able to issue system wide automation commands to up to (11) eleven other panels for a total of (12) twelve networked lighting control panels. The clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.
   b. The clock capability of each panel shall support the time-based energy saving requirements of applicable local energy codes.
   c. The clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back up for the clock function and program retention in non-volatile
FLASH memory. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.

d. The clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:
   i. Scheduled ON / OFF
   ii. Manual ON / Scheduled OFF
   iii. Astro ON / OFF (or Photo ON / OFF)
   iv. Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)

e. The user interface shall be a portable IR handheld remote control capable of programming any panel in the system (LMCT-100)

f. The clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.

g. Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.

9. The lighting control panel can operate as a stand-alone system, or can support schedule, group, and photocell control functions, as configured in a Segment Manager controller, via a segment network connection.

10. The lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 MS/TP-based using the BACnet® protocol.

   a. The panel shall have provision for an individual BACnet device ID and shall support the full 222 range (0 – 4,193,304). The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.

   b. The panel shall support MS/TP MAC addresses in the range of 0 – 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.

   c. Lighting control relays shall be controllable as binary output objects in the instance range of 1 – 64. The state of each relay shall be readable and writable by the BAS via the object present value property.

   d. Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 – 64.

   e. The 99 group Normal Hours/After Hours control objects associated with the panel shall be represented by binary value objects in the instance range of 201 – 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the normal hours mode. Commanding 0 or NULL shall put the relays into the after hours mode.

   f. Setup and commissioning of the panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the
handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:

i. Binary output objects in the instance range of 1 – 64 (one per relay) for on/off control of relays.

ii. Binary value objects in the instance range of 1 – 99 (one per channel) for normal hours/after hours schedule control.

iii. Binary input objects in the instance range of 1 – 64 (one per relay) for reading true on/off state of the relays.

iv. Analog value objects in the instance range of 101 – 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace-time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.

g. The description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.

h. The BO and BV 1 – 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. ([http://www.bacnet.org/Addenda/Add-135-2010aa.pdf](http://www.bacnet.org/Addenda/Add-135-2010aa.pdf))

i. Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.

j. Lockout of all digital switch buttons connected to a given panel shall be command-able via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.

11. In addition to the LMCP Relay Panels, an LMZC Zone Controller panel shall be available for zero-relay applications. The panel is designed for applications where LMFC-011 Fixture Controllers or other distributed load controllers are used to switch and/or dim the controlled loads. Key similarities to and differences from the LMCP panel design shall include:

a. The LMZC shall use the same intelligence board as the LMCP relay panel.

b. The LMZC shall not include relay driver boards or relays.

c. The LMZC shall have a removable interior section to facilitate installation, and a Tub/Cover. Cover is for surface mounting applications only.

d. The LMZC tub shall have two interior KOs to allow installation of LMPB-100 Power Boosters. Each installed Power Booster can provide an additional 150 mA for either of the two available DLM local networks provided by the LMZC.

e. All programming and networking (whether DLM Local Network and/or Segment Network) capabilities in the LMZC Zone Controller shall be similar to capabilities for LMCP relay panels, except for functions designed for panel-mounted HDR relays.
12. To aid in project start up, if LMFC Fixture Controllers are connected to an LMZC Zone Controller, Plug n’ Go automatic configuration will establish a unique sequence of operation so that all LMFC-controlled fixtures will turn on to 50% output when any digital occupancy sensor detects motion.


B. USER INTERFACE

Each lighting control panel system shall be supplied with at least (1) handheld configuration tool (LMCT-100). As a remote programming interface the configuration tool shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. The user interface shall have the following panel-specific functions as a minimum:

1. Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.

2. Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.

3. Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.

4. Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays.

5. Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.

6. Programming of panel location information shall be accomplished by the handheld IR remote and include at a minimum LAT, LON, DST zone, and an approximate city/state location.

7. WattStopper Product Number: LMCT-100

2.14 SEGMENT MANAGER

A. For networked applications, the Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser utilizing either unencrypted TCP/IP traffic via a configurable port (default is 80) or 256 bit AES encrypted SSL TCP/IP traffic via a configurable port (default is 443).

B. Each segment manager shall have integral support for at least three segment networks. Segment networks may alternately be connected to the segment manager via external BACnet-to-IP interface routers and switches, using standard Ethernet structured wiring. Each router shall accommodate one segment network. Provide the quantity of routers and switches as shown on the plans.

C. Operational features of the Segment Manager shall include the following:

1. Connection to PC or LAN via standard Ethernet TCP/IP with the option to use SSL encrypted connections for all traffic.
2. Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser. The Segment Manager shall not require installation of any lighting control software on an end-user PC.

3. Log in security capable of restricting some users to view-only or other limited operations.

4. Segment Manager shall provide two main sets of interface screens – those used to initially configure the unit (referred to as the config screens), and a those used to allow users to dynamic monitor the performance of their system, and provide a centralized scheduling interface.

Capabilities using the Config Screens shall include:

a. Automatic discovery of DLM devices and relay panels on the segment network(s). Commissioning beyond activation of the discovery function shall not be required to provide communication, monitoring or control of all local networks and lighting control panels.

b. Allow information for all discovered DLM devices to be imported into the Segment Manager via a single XML based site file from the WattStopper LMCS Software, significantly reducing the time needed to make a system usable by the end user. Importable information can include text descriptions of every DLM component and individual loads, and automatic creation of room location information and overall structure of DLM network. Info entered into LMCS should not have to be re-entered manually via keystrokes into the Segment Manager.

c. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.

d. Ability to view and modify DLM device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation including sensor time delays and sensitivities, and load response to sensor including Manual-On or Auto-On.

e. Provide capabilities for integration with a BAS via BACnet protocol. At a minimum, the following points shall be available to the BAS via BACnet IP connection to the segment manager: room occupancy state; room schedule mode; room switch lock control; individual occupancy sensor state; room lighting power; room plug-load power; load ON/OFF state; load dimming level; panel channel schedule state; panel relay state; and Segment Manager Group schedule state control. Any of above items shall be capable of being moved into an “Export Table” that will provide any integrator with only the data they need, and by using the Export Table effectively create a firewall between the integrator’s request for info and the overall system performance.

5. Capabilities using the Segment Manager’s Dashboard Screens shall include:

a. A dynamic “tile” based interface that allows easy viewing of each individual room’s lighting and plug load power consumption, and lighting and plug load power density (power consumption information requires Enhanced DLM Room and Plug Load Controllers with integral current transducers such as LMRC-21x). Tiles will be automatically organized according to location so a single tile for the building summarizes all information for tiles beneath it on every floor, in every area, in every room. Tiles shall be color coded based on three energy target
parameters, allowing an owner to quickly identify rooms that are not performing efficiently. Tiles for rooms with occupancy sensors shall include an icon to indicate whether that room is occupied. Tiles shall be clickable, and when clicked the underlying hierarchical level of tiles shall become visible. The tile interface shall be accessible via mouse, or touch screen devices. Tiles shall be created automatically by the segment manager, based on the information found during the device discovery and/or information included in a file imported in from LMCS (such as tagged descriptions for each room) without any custom programming.

b. Ability to set up schedules for DLM local networks (rooms) and panels. Schedules shall be capable of controlling individual rooms with either on/off or normal hours/after hours set controlled zones or areas to either a normal hours or after hours mode of operation. Support for annual schedules, holiday schedules and unique date-bound schedules, as well as astro On or astro Off events with offsets. Schedules shall be visible graphically as time bars in a screen set up to automatically show scheduled events by day, week or month.

c. Ability to provide a simple time vs. power graph based on information stored in each Segment Manager’s memory (typically two to three days’ data).

6. If shown in the contract drawings, Segment Managers shall be integrated into a larger control network by the addition of a Network Supervisor package. The Supervisor is a server level computer running a version of the Segment Manager interface software with dedicated communication and networking capability, able to pull information automatically from each individual Segment Manager in the network. By using a Supervisor, information for individual Segment Managers can be accessed and stored on the Supervisor’s hard drive, eliminating the risk of data being overwritten after a few days because of Segment Manager memory limits.

7. The Segment Manager shall allow access and control of the overall system database via Native Niagara AX FOX connectivity. Systems that must utilize a Tridium Niagara controller in addition to the programming, scheduling and configuration server are not acceptable.

D. Segment Manager shall support multiple DLM rooms as follows:

1. Support up to 120 network bridges and 900 digital in-room devices (LMSM-3E).

2. Support up to 300 network bridges and 2,200 digital in-room devices, connected via network routers and switches (LMSM-6E).


2.15 PROGRAMMING, CONFIGURATION AND DOCUMENTATION SOFTWARE

A. PC-native application for optional programming of detailed technician-level parameter information for all DLM products, including all parameters not accessible via BACnet and the handled IR configuration tool. Software must be capable of accessing room-level parameter information locally within the room when connected via the optional LMCI-100 USB programming adapter, or globally for many segment networks simultaneously utilizing standard BACnet/IP communication.

B. Additional parameters exposed through this method include but are not limited to:

1. Occupancy sensor detection LED disable for performance and other aesthetic spaces where blinking LEDs present a distraction.
2. Six occupancy sensor action behaviors for each controlled load, separately configurable for normal hours and after hours modes. Modes include: No Action, Follow Off Only, Follow On Only, Follow On and Off, Follow On Only with Override Time Delay, Follow Off Only with Blink Warn Grace Time, Follow On and Off with Blink Warn Grace Time.

3. Separate fade time adjustments per load for both normal and after hours from 0 - 4 hours.

4. Configurable occupancy sensor re-trigger grace period from 0 - 4 minutes separate for both normal hours and after hours.

5. Separate normal hours and after hours per-load button mode with modes including: Do nothing, on only, off only, on and off.

6. Load control polarity reversal so that on events turn loads off and vice versa.

7. Per-load DR (demand response) shed level in units of percent.

8. Load output pulse mode in increments of 1 second.

9. Fade trip point for each load for normal hours and after hours that establishes the dimmer command level at which a switched load closes its relay to allow for staggered On of switched loads in response to a dimmer.

C. Generation of reports at the whole file, partial file, or room level. Reports include but are not limited to:

1. Device list report: All devices in a project listed by type.

2. Load binding report: All load controller bindings showing interaction with sensors, switches, and daylighting.

3. BACnet points report: Per room Device ID report of the valid BACnet points for a given site's BOM.

4. Room summary report: Device manifest for each room, aggregated by common BOM, showing basic sequence of operations.

5. Device parameter report: Per-room lists of all configured parameters accessible via hand held IR programmer for use with O&M documentation.

6. Scene report: All project scene pattern values not left at defaults (i.e. 1 = all loads 100%, 2 = all loads 75%, 3 = all loads 50%, 4 = all loads 25%, 5-16 = same as scene 1).

7. Occupancy sensor report: Basic settings including time delay and sensitivity(ies) for all occupancy sensors.

D. Network-wide programming of parameter data in a spreadsheet-like programming environment including but not limited to the following operations:

1. Set, copy/paste an entire project site of sensor time delays.

2. Set, copy/paste an entire project site of sensor sensitivity settings.

3. Search based on room name and text labels.

4. Filter by product type (i.e. LMRC-212) to allow parameter set by product.

5. Filter by parameter value to search for product with specific configurations.

E. Network-wide firmware upgrading remotely via the BACnet/IP network.


2. Mass firmware update of specifically selected rooms or areas.

F. WattStopper Product Number: LMCS-100, LMCI-100

2.16 EMERGENCY LIGHTING CONTROL DEVICES

A. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
   1. 120/277 volts, 50/60 Hz, 20 amp ballast rating
   2. Push to test button
   3. Auxiliary contact for remote test or fire alarm system interface

B. WattStopper Product Numbers: ELCU-100, ELCU-200.

PART 3 – EXECUTION

3.1 PRE-INSTALLATION MEETING

A. A factory authorized manufacturer’s representative shall provide the electrical contractor a functional overview of the lighting control system prior to installation. The contractor shall schedule the pre-installation site visit after receipt of approved submittals to review the following:
   1. Confirm the location and mounting of all digital devices, with special attention to placement of occupancy and daylighting sensors.
   2. Review the specifications for low voltage control wiring and termination.
   3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
   4. Discuss requirements for integration with other trades.

3.2 CONTRACTOR INSTALLATION AND SERVICES

A. Contractor to install all devices and wiring in a professional manner. All line voltage connections to be tagged to indicate circuit and switched legs.

B. Contractor to install all room/area devices using manufacturer’s factory-tested Cat 5e cable with pre-terminated RJ-45 connectors. If pre-terminated cable is not used for room/area wiring, the contractor is responsible for testing each field-terminated cable following installation, and shall supply the lighting controls manufacturer with test results. Contractor to install any room to room network devices using manufacturer-supplied LM-MSTP network wire. Network wire substitution is not permitted and may result in loss of product warranty per DLM SEGMENT NETWORK section of specification. Low voltage wiring topology must comply with manufacturer’s specifications. Contractor shall route network wiring as shown in submittal drawings as closely as possible, and shall document final wiring location, routing and topology on as built drawings.

C. Install the work of this Section in accordance with manufacturer’s printed instructions unless otherwise indicated. Before start up, contractor shall test all devices to ensure proper communication.

D. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.
   1. Adjust time delay so that controlled area remains lighted while occupied.

E. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
2. Sequence of operation, (e.g. manual ON, Auto OFF etc.)
3. Load Parameters (e.g. blink warning, etc.)

F. Post start-up tuning – After 30 days from occupancy contractor shall adjust sensor time delays and sensitivities to meet the Owner’s requirements. Provide a detailed report to the Architect / Owner of post start-up activity.

3.3 FACTORY SERVICES
A. Upon completion of the installation, the manufacturer’s factory authorized representative shall start up and verify a complete fully functional system.
B. The electrical contractor shall provide both the manufacturer and the electrical engineer with three weeks written notice of the system start up and adjustment date.
C. Upon completion of the system start up, the factory-authorized technician shall provide the proper training to the owner’s personnel on the adjustment and maintenance of the system.
D. Include a certified lighting control acceptance verified in writing by the factory authorized representative.

3.4 COMMISSIONING SUPPORT SERVICES
A. On this project, a commissioning agent will be hired to verify the installation and programming of all building systems, which includes the lighting control system. Manufacturer should include an extra day of technician’s time to review the functionality and settings of the lighting control hardware with the commissioning agent, including reviewing submittal drawings and ensuring that instructions on how to configure each device are readily available. Manufacturer is NOT responsible for helping the commissioning agent inspect the individual devices. It will be the commissioning agent’s responsibility to create and complete any forms required for the commissioning process, although the manufacturer or contractor may offer spreadsheets and/or printouts to assist the agent with this task.
B. The commissioning agent shall work with the electrical contractor during installation of the lighting control hardware to become familiar with the specific products. The agent may also accompany the manufacturer’s technicians during their start-up work to better understand the process of testing, calibration and configuration of the products. However, the contractor and manufacturer shall ensure that interfacing with the agent does not prevent them from completing the requirements outlined in the contract documents.

3.5 FINE TUNING AFTER SUBSTANTIAL COMPLETION
A. Provide a factory authorized representative for fine tuning and adjustments to the system within 6 months after substantial completion as coordinated and requested by the Owner. Modify and adjust controls, settings, and programming as directed by Owner.

END OF SECTION 26 09 23
SECTION 26 12 19
PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

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

1.02 SUMMARY
A. Section includes pad-mounted, liquid-filled, medium-voltage distribution transformers, with primary and secondary bushings within or without air-terminal enclosures.

1.03 DEFINITIONS
A. BIL: Basic Impulse Insulation Level.
B. Bushing: An insulating structure including a central conductor, or providing a central passage for a conductor, with provision for mounting on a barrier, conducting or otherwise, for the purpose of insulating the conductor from the barrier and conducting current from one side of the barrier to the other.
C. Bushing Elbow: An insulated device used to connect insulated conductors to separable insulated connectors on dead-front, pad-mounted transformers and to provide a fully insulated connection. This is also called an "elbow connector."
D. Bushing Insert: That component of a separable insulated connector that is inserted into a bushing well to complete a dead-front, load break or non-load break, separable insulated connector (bushing).
E. Bushing Well: A component of a separable insulated connector, either permanently welded or clamped to an enclosure wall or barrier, having a cavity that receives a replaceable component (bushing insert) to complete the separable insulated connector (bushing).
F. Elbow Connector: See "bushing elbow" above.

1.04 ACTION SUBMITTALS
A. Provide point-by-point statement of any deviations or exceptions with specifications, in accordance with Section 26 05 00.1.5B.
B. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
C. Shop Drawings: For pad-mounted, liquid-filled, medium-voltage transformers.
   1. Include plans and elevations showing major components and features.
      a. Include a plan view and cross section of equipment base, showing clearances, required workspace, and locations of penetrations for grounding and conduits.
   2. Include details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include single-line diagram.
   4. Include list of materials.
   5. Include nameplate data.
   6. Manufacturer's published time-current curves of the transformer high-voltage fuses, with transformer damage curve, inrush curve, and thru fault current indicated.

1.05 INFORMATIONAL SUBMITTALS
A. Qualification Data: For testing agency.
B. Seismic Qualification Certificates: For transformer assembly, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Product Certificates: For transformers, signed by product manufacturer.

D. Source quality-control reports.

E. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE
A. Testing Agency Qualifications: Member Company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS
2.01 SYSTEM DESCRIPTION
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2.

C. Comply with IEEE C57.12.00.

2.02 PERFORMANCE REQUIREMENTS
A. Seismic Performance: The transformers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the transformer will remain in place without separation of any parts when subjected to the seismic forces specified and the transformer will be fully operational after the seismic event."
   2. Component Importance Factor: 1.0.
   3. Component Amplification Factor: 2.5.

B. Windings Material: Copper.

C. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, fully shielded, separable-elbow type, suitable for plugging into the inserts provided in the high-voltage section of the transformer. Connected in each phase of incoming circuit and ahead of any disconnecting device.

D. Winding Connections: The connection of windings and terminal markings shall comply with IEEE C57.12.70.

E. Efficiency: Comply with 10 CFR 431, Subpart K. Minimally, transformers shall conform to efficiency levels for liquid immersed distribution transformers, as specified in Table I.5 of the Department of Energy ruling 10 CFR Part 431 - Energy Conservation Program: Energy Conservation Standards for Distribution Transformers, effective January 1, 2016. Manufacturer shall comply with the intent of all regulations set forth in noted ruling. This efficiency standard does not apply to step-up transformers.
F. Insulation: Transformer kVA rating shall be as follows: The average winding temperature rise above a 30 deg C ambient temperature shall not exceed 65 deg C and 80 deg C hottest-spot temperature rise at rated kVA when tested according to IEEE C57.12.90, using combination of connections and taps that give the highest average winding temperature rise.

G. Tap Changer: External handle, for de-energized operation.

H. Tank: Sealed, with welded-on cover or manufacturer’s standard design per kVA rating. Designed to withstand internal pressure of not less than 7 psi (50 kPa) without permanent distortion and 15 psig (104 kPa) without rupture. Comply with IEEE C57.12.36.

I. Enclosure Integrity: Comply with IEEE C57.12.28 for pad-mounted enclosures that contain energized electrical equipment in excess of 600 V that may be exposed to the public.

J. Mounting: An integral skid mounting frame, suitable to allow skidding or rolling of transformer in any direction, and with provision for anchoring frame to pad.

K. Insulating Liquids:
   1. Less-Flammable Liquids:
      a. Edible-Seed-Oil-Based Dielectric: Listed and labeled by an NRTL as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic, having passed the Organization for Economic Co-operation and Development G.L.203 with zero mortality, and shall be certified by the U.S. Environmental Protection Agency as biodegradable, meeting Environmental Technology Verification requirements.

L. Sound level shall comply with NEMA TR 1 requirements.

M. Corrosion Protection:
   1. Transformer coating system shall be factory applied, complying with requirements of IEEE C57.12.28, in manufacturer’s standard color green.

2.03 THREE-PHASE TRANSFORMERS

A. MANUFACTURERS
   1. Cooper Industries
   2. ABB
   3. General Electric Company
   4. Federal Pacific Transformer Company
   5. Central Maloney

B. Description:
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Compartment Construction:
   1. Double-Compartment Construction: Individual compartments for high- and low-voltage sections, formed by steel isolating barriers that extend full height and depth of compartments, with hinged, lift-off doors and three-point latching, with a stop in the open position and provision for padlocking.

D. Primary Fusing: Designed and rated to provide thermal protection of transformer by sensing overcurrent and high liquid temperature.
   1. 150-kV BIL current-limiting fuses, conforming to requirements of IEEE C37.47.
   2. Interrupting Rating: 50,000 rms A symmetrical at system voltage.
4. Provide bayonet fuse assembly with an oil retention valve and an external drip shield inside the housing to eliminate or minimize oil spills. Valve shall close when fuse holder is removed and an external drip shield is installed.

5. Provide a conspicuously displayed warning adjacent to bayonet fuse(s), cautioning against removing or inserting fuses unless transformer has been de-energized and tank pressure has been released.

E. High-Voltage Section: Dead-front design.
1. To connect primary cable, use separable insulated connectors; coordinated with and complying with requirements of Section 26 05 13 "Medium-Voltage Cables." Bushings shall be one-piece units, with ampere and BIL ratings the same as connectors.
2. Bushing inserts and feed-through inserts:
   a. Conform to the requirements of IEEE 386.
   b. Rated at 200 A, with voltage class matching connectors. Provide a parking stand near each bushing well. Parking stands shall be equipped with insulated standoff bushings for parking of energized load-break elbow connectors on parking stands.
   c. Provide insulated protective caps for insulating and sealing out moisture from unused bushing inserts and insulated standoff bushings.
3. Bushing wells configured for loop-feed application.
5. Dead-front surge arresters.
6. Tap-changer operator.
7. Ground pad or ground bus as required below.

F. Low-Voltage Section:
1. Bushings with spade terminals drilled for terminating the number of conductors indicated on the Drawings, and the lugs that comply with requirements of Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

G. Capacities and Characteristics:
1. Power Rating (kVA): As indicated on drawings.
2. Voltage Ratings: As indicated on drawings.
3. Taps: Comply with IEEE C57.12.26 requirements.
4. Transformer BIL (kV): Comply with IEEE C57.12.26 requirements.
5. Minimum Tested Impedance (Percent at 85 deg C): ANSI Standard impedance for 750 kVA and above, manufacturer's standard 500 kVA and below.
6. Comply with UL listing.

H. Transformer Accessories:
1. Drain and filter connection
2. Filling and top filter press connections.
3. Pressure-vacuum gauge.
4. Dial-type analog thermometer.
5. Magnetic liquid level indicator.
6. Automatically resetting pressure-relief device. Device flow shall be as recommended by manufacturer.
7. Copper ground bus with minimum dimension of 14” x 4” x ¼”.

2.04 SERVICE CONDITIONS
A. Transformers shall be suitable for operation under service conditions specified as usual service conditions in IEEE C57.12.00, except for the following:
1. Altitudes above 4500 feet.

2.05 WARNING LABELS AND SIGNS
A. Comply with requirements for labels and signs specified in Section 26 05 53 "Identification for Electrical Systems."

19386100 / UDC_FBI FIRING  26 12 19 - 4  PAD-MOUNTED, LIQUID-FILLED, RANGE & TRAINING FACILITY  MEDIUM-VOLTAGE TRANSFORMERS
1. High-Voltage Warning Label: Provide self-adhesive warning signs on outside of high-voltage compartment door(s). Sign legend shall be "DANGER HIGH VOLTAGE" printed in two lines of nominal 2-inch- (50-mm-) high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background.

2. Arc Flash Warning Label: Provide self-adhesive warning signs on outside of high-voltage compartment door(s), warning of potential electrical arc flash hazards and appropriate personal protective equipment required.

2.06 SOURCE QUALITY CONTROL

A. Provide manufacturer's certificate that the transformer design tests comply with IEEE C57.12.90.

1. Perform the following factory-certified routine tests on each transformer for this Project:
   a. Resistance.
   b. Turns ratio, polarity, and phase relation.
   c. Transformer no-load losses and excitation current at 100 percent of ratings.
   d. Transformer impedance voltage and load loss.
   e. Operation of all devices.
   f. Lightning impulse.
   g. Low frequency.
   h. Leak.
   i. Transformer no-load losses and excitation current at 110 percent of ratings.
   j. Insulation power factor.
   k. Applied potential, except that this test is not required for single-phase transformers or for three-phase Y-Y-connected transformers.
   l. Induced potential.
   m. Resistance measurements of all windings on rated voltage connection and at tap extreme connections.
   n. Ratios on rated voltage connection and at tap extreme connections.
   o. Polarity and phase relation on rated voltage connection.
   p. No-load loss at rated voltage on rated voltage connection.
   q. Exciting current at rated voltage on rated voltage connection.
   r. Impedance.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine pad-mounted, liquid-filled, medium-voltage transformers upon delivery.

1. Upon delivery of transformers and prior to unloading, inspect equipment for any damage that may have occurred during shipment or storage.

2. Verify that tie rods and chains are undamaged and tight, and that all blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.

3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.

4. Verify that there is no evidence of insulating-liquid leakage on transformer surfaces, at weld seams, on high- or low-voltage bushing parts, and at transformer base.

5. Verify that there is positive pressure or vacuum on tank. Check pressure gauge; it is required to read other than zero.

6. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.

7. Verify presence of polychlorinated biphenyl content labeling.

8. Unload transformers carefully, observing all packing label warnings and handling instructions.
9. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Handling:
1. Handle transformers carefully, in accordance with manufacturer recommendations, to avoid damage to enclosure, termination compartments, base, frame, tank, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
2. Protect transformer termination compartments against entrance of dust, rain, and snow.
3. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and to prevent trapping air in windings. Do not tilt or tip transformers.
4. Verify that transformer weights are within rated capacity of handling equipment.
5. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use all lifting lugs when lifting transformers.
6. Use jacks only at corners of tank base plate.
7. Use nylon straps of same length to balance and distribute weight when handling transformers with a crane.
8. Use spreaders or a lifting beam to obtain a vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
9. Exercise care not to damage tank base structure when handling transformer using skids or rollers. Use skids to distribute stresses over tank base when using rollers under large transformers.

C. Storage:
1. Store transformers in accordance with manufacturer's recommendations.
2. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure transformer is level.
3. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.
4. Store transformers with compartment doors closed.
5. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting any discrepancies or adverse conditions. Verify that an effective pressure seal is maintained using pressure gauges. Visually check for insulating-liquid leaks and rust spots.

D. Examine areas and space conditions for compliance with requirements for pad-mounted, liquid-filled, medium-voltage transformers and other conditions affecting performance of the Work.

E. Examine roughing-in of conduits and grounding systems to verify the following:
   1. Wiring entries comply with layout requirements.
   2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will cross section barriers to reach load or line lugs.

F. Examine concrete bases for suitable conditions for transformer installation.

G. Pre-Installation Checks:
   2. Remove a sample of insulating liquid according to ASTM D 923. Insulating-liquid values shall comply with NETA ATS, Table 100.4. Sample shall be tested for the following:
      b. Acid Neutralization Number: ASTM D 974.
      c. Specific Gravity: ASTM D 1298.
      d. Interfacial Tension: ASTM D 971.
      e. Color: ASTM D 1500.
g. Water in Insulating Liquids: Comply with ASTM D 1533.
h. Power Factor or Dissipation Factor: ASTM D 924.

H. Verify that ground connections are in place and that requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at transformer location.

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

3.02 INSTALLATION

A. Install transformers on cast-in-place concrete equipment pad/vault(s). Comply with requirements for equipment bases and foundations.

B. Transformer shall be installed level and plumb and shall tilt less than 1.5 degrees while energized.

C. Comply with requirements for vibration isolation and seismic control devices specified in Section 26 05 29 "Hangers and Supports for Electrical Systems" and Section 26 05 48.16 "Seismic Controls for Electrical Systems."

D. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and IEEE C2.

3.03 CONNECTIONS

A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

1. For counterpoise, use tinned bare copper cable not smaller than No. 4/0 AWG, buried not less than 30 inches (765 mm) below grade interconnecting the grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable, with no kinks or sharp bends.

2. Fence and equipment connections shall not be smaller than No. 4 AWG. Ground fence at each gate post and corner post and at intervals not exceeding 10 ft. (3050 mm). Bond each gate section to fence post using 1/8 by 1 inch (3 by 25 mm) tinned flexible braided copper strap and clamps.

3. Make joints in grounding conductors and loops by exothermic weld or compression connector.

4. Terminate all grounding and bonding conductors on a common equipment grounding terminal on transformer enclosure.

5. Complete transformer tank grounding and lightning arrester connections prior to making any other electrical connections.

B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.

2. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.

C. Terminate medium-voltage cables in incoming section of transformers according to Section 26 05 13 "Medium-Voltage Cables."

3.04 SIGNS AND LABELS

A. Comply with installation requirements for labels and signs specified in Section 26 05 53 "Identification for Electrical Systems."

B. Install warning signs as required to comply with 29 CFR 1910.269.
3.05 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:

1. General Field-Testing Requirements:
   b. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
   c. After installing transformer but before primary is energized, verify that grounding system at the transformer is tested at specified value or less.
   d. After installing transformer and after electrical circuitry has been energized, test for compliance with requirements.
   e. Visual and Mechanical Inspection:
      1) Verify equipment nameplate data complies with Contract Documents.
      2) Inspect bolted electrical connections for high resistance using one of the following two methods:
         a) Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
         b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.
   f. Remove and replace malfunctioning units and retest.
   g. Prepare test and inspection reports. Record as-left set points of all adjustable devices.

2. Medium-Voltage Surge Arrester Field Tests:
   a. Visual and Mechanical Inspection:
      1) Inspect physical and mechanical condition.
      2) Verify arresters are clean.
      3) Verify that ground lead on each device is individually attached to a ground bus or ground electrode.
   b. Electrical Test:
      1) Perform an insulation-resistance test on each arrester, phase terminal-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to comply with recommended minimum insulation resistance listed in that table.
      2) Perform a watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.

3. Liquid-Filled Transformer Field Tests:
   a. Visual and Mechanical Inspection:
      1) Test dew point of tank gases if applicable.
      2) Inspect anchorage, alignment, and grounding.
      3) Verify bushings are clean.
      4) Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
      5) Verify that liquid level in tanks is within manufacturer's published tolerances.
      6) Perform specific inspections and mechanical tests recommended by manufacturer.
      7) Verify presence of transformer surge arresters and that their ratings are as specified.
      8) Verify that as-left tap connections are as specified.
   b. Electrical Tests:
1) Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; the value of the index shall not be less than 1.0.

2) Perform power-factor or dissipation-factor tests on all windings according to test equipment manufacturer's published data. Maximum winding insulation power-factor/dissipation-factor values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.3.

3) Measure core insulation resistance at 500-V dc if the core is insulated and the core ground strap is removable. Core insulation-resistance values shall not be less than 1 megohm at 500-V dc.

4) Perform a power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV.

5) Perform turns-ratio tests at tap positions. Turns-ratio test results shall not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.

6) Perform an excitation-current test on each phase. The typical excitation-current test data pattern for a three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if test shows a different pattern.

7) Measure resistance of each winding at each tap connection, and record temperature-corrected winding-resistance values in the Operations and Maintenance Manual.

8) Perform an applied-voltage test on high- and low-voltage windings-to-ground. Comply with IEEE C57.12.91, Sections 10.2 and 10.9. This test is not required for single-phase transformers and for three-phase Y-Y-connected transformers.

9) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

10) Remove a sample of insulating liquid according to ASTM D 923, and perform dissolved-gas analysis according to IEEE C57.104 or ASTM D 3612.

3.06 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: After Substantial Completion, when requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each transformer. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch (25 mm) per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during test period, is unacceptable.

2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
   a. Adjust transformer taps.

3. Retests: Repeat monitoring, after corrective action is performed, until satisfactory results are obtained.

4. Report:
   a. Prepare a written report covering monitoring performed and corrective action taken.

END OF SECTION 26 12 19
SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.

1.03 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.04 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Include evidence of NRTL listing for series rating of installed devices.
   6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   7. Include wiring diagrams for power, signal, and control wiring.
   8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

C. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field Quality-Control Reports:
   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. Panelboard Schedules: For installation in panelboards
F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.05 QUALITY ASSURANCE
A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
D. Comply with NEMA PB 1.
E. Comply with NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.07 PROJECT CONDITIONS
A. Environmental Limitations:
   1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) to plus 104 deg F (plus 40 deg C).
B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet (2000 m).
C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Engineer and Owner no fewer than two days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Engineer's and Owner's written permission.
   3. Comply with NFPA 70E.

1.08 COORDINATION
A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces.
B. Maintain required workspace clearances and required clearances for equipment access doors and panels.
C. Coordinate with work of other trades so that piping, ductwork or any equipment foreign to the electrical installation is not located directly above panelboards.

D. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.09 EXTRA MATERIALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Keys: Two spares for each type of panelboard cabinet lock.
   2. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PANELBOARDS
A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Flush- and surface-mounted cabinets as indicated.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
      b. Outdoor Locations: NEMA 250, Type 3R.
      c. Kitchen Areas: NEMA 250, Type 4X.
      d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
      e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
   2. Hinged Front Cover: Entire front trim hinged to box and with standard door within door cover.
   3. Finishes:
      a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

C. Incoming Mains Location: Top and bottom.

D. Phase, Neutral, and Ground Buses:
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
   3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
   4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

E. Conductor Connectors: Suitable for use with conductor material and sizes.
   2. Lugs: rated for copper only.
   3. Main and Neutral Lugs: Mechanical type.
   4. Ground Lugs and Bus-Configured Terminators: Mechanical type.
   5. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
   6. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
   7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.


I. 208 Volt Panels- All 208 volt panels and distribution boards shall include both a bonded and insulated ground bus. The insulated ground bus is intended to provide an isolated ground system for sensitive equipment.

### 2.02 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
   1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.


E. Branch Overcurrent Protective Devices 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.

F. Branch Overcurrent Protective Devices: Fused switches.

### 2.03 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Doors: Door within door style. Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

E. Covers: Hinged front cover (door-in-door) type.

### 2.04 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
   3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
a. Instantaneous trip.
b. Long- and short-time pickup levels.
c. Long- and short-time time adjustments.
d. Ground-fault pickup level, time delay, and \( I_{t} \) response.

4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).

6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
   d. Ground-Fault Protection: Integrrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
   f. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
   g. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
   h. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

B. For all circuit breaker overcurrent devices with frames rated 1200A or more, provide adjustable instantaneous time delay and interconnect into the arc energy reduction system.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
   1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."
   2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
   3. Auxiliary Contacts: One normally open and normally closed contact(s) that operate with switch handle operation.

2.05 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

2.06 ARC ENERGY REDUCTION SYSTEM

A. For each overcurrent device with a frame size of 1200A or higher, provide an arc energy reduction system complying with 2014 NEC 240.87.

B. System shall consist of an energy-reducing switch with local status indication. Status shall indicate whether the switch is on or off via illuminated blue LED indication lamp. Status indication shall be clearly and permanently marked.

C. Provide permanent label with instruction for operating the arc energy reduction system and warning that any coordination that has been designed into the system may not exist while the arc energy reduction system in "ON."

D. When the arc energy reduction switch is turned “ON” (placed in the “ON” position), the system shall bypass the overcurrent protection device delay settings so that the time delay is “OFF” (0 seconds) and illuminate the switch “ON” indication lamp. When the arc energy reduction switch is turned “OFF” (placed in the “OFF” position), the system shall revert back to the standard overcurrent protection device settings and appropriate delay.

E. Provide all required components for a complete and fully functional arc energy reduction system.
PART 3 - EXECUTION

3.01 APPLICATION
A. Circuit Breaker Types:
2. Circuit Breakers less than 400A: Molded case with instantaneous adjustments.

3.02 EXAMINATION
A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 INSTALLATION
A. Install panelboards and accessories according to NEMA PB 1.1.
B. Equipment Mounting: Install floor-mounted panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section “Cast-in-Place Concrete.”
1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Comply with mounting and anchoring requirements specified in Division 26 Section “Vibration and Seismic Controls for Electrical Systems.”

E. Mount top of trim 80 inches above finished floor unless otherwise indicated.
F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed.
1. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.
I. Stub five 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub five 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade. Include pull strings in empty conduits.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

K. Comply with NECA 1.

L. Fuse Selection and Installation: Verify connected load(s) and selection of fuse sizes for each disconnect switch prior to selection and installation.
3.04 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads and location in the building; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. 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.

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

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

3.06 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated

END OF SECTION 26 24 16
SECTION 26 27 13
ELECTRICITY METERING

PART 1 - GENERAL

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

1.02 SUMMARY
A. Section Includes:
   1. Electricity meters.
B. Meters shall be connected to the Building Automation System (BAS) utilizing modbus protocol
   for building wide metering in compliance with the Utah State High Performance Building
   Standard requirements.

1.03 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: Dimensioned plans and sections or elevation layouts and wiring diagrams.

1.04 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data. In addition to items specified in Section 01 78 23 "Operation
   and Maintenance Data," include the following:
   1. Application and operating software documentation.
   2. Software licenses.
   3. Software service agreement.
   4. Hard copies of manufacturer’s operating specifications, design user’s guides for software
      and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

1.06 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70,
   by a qualified testing agency, and marked for intended location and application.

1.07 SOFTWARE SERVICE AGREEMENT
A. Technical Support: Beginning with Substantial Completion, provide software support for two
   years.
B. Upgrade Service: Update software to latest version at Project completion. Install and program
   software upgrades that become available within two years from date of Substantial Completion.
   Upgrading software shall include operating system. Upgrade shall include new or revised
   licenses for use of software.
   1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow
      Owner to upgrade his computer equipment if necessary.

PART 2 - PRODUCTS

2.01 ELECTRICITY METERS
A. Basis-of-Design Product: Subject to compliance with requirements, provide the following or
   prior approved equal.
   1. Schweitzer Engineering Laboratories (SEL) SEL-734 or SEL-735 Power Quality Meter
B. General Requirements for Electricity Meters:
1. Comply with UL 1244.
2. Meters shall meet or exceed accuracy in compliance with ANSI C12.20.
3. The meter shall support 3-Element Wye, 2.5 Element Wye, 2 Element Delta, 4 wire Delta systems.
4. The meter shall accept universal voltage input.
5. Meter shall be designed for operation with 60 HZ system.
6. The meter's surge withstand shall conform to IEEE C37.90.1.
7. The meter shall be user programmable for voltage range to any PT ratio.
8. The meter shall accept a burden up to 0.36VA per phase, Max at 600V, and 0.014VA at 120 Volts.
9. The meter shall accept a voltage input range of up to 300 Volts Line to Neutral, and up to 520 Volts Line to Line.
10. The meter shall accept a current reading of up to 11 Amps continuous.
11. The meter shall have color-coordinated voltage and current inputs.
12. The meter shall have a phasor diagram that clearly shows wiring status.
13. Enclosure: Type 1 where enclosure is required. Meter shall be installed integral with switchboard or panelboard wherever possible.
14. Identification: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."
15. Sensors: Current-sensing type, with current output, selected for optimum range and accuracy for meters indicated for this application.
16. Type: solid core or split core with ratio accuracy of at least +/- 1% full scale.

C. General Requirements for main service and main switchboard metering Electricity Meters:
   1. Memory Backup: Unit shall have data-logging capability.
   2. Provide sampling at 400+ samples per cycle on all channels measured readings simultaneously.
   3. Meter shall provide Harmonics %THD (% of total Harmonic Distortion), including current, voltage, and power harmonics to the 63rd order harmonic.

D. General Requirements for sub metering Electricity Meters:
   1. Memory Backup: Unit shall have 32 MB of memory/data-logging capability.
   2. Provide sampling at 16+ samples per cycle on all channels measured readings simultaneously.

E. Kilowatt-hour/Demand Meter: Electronic three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.
   1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
   2. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kilowatt-hours, current time and date, current demand, and historic peak demand. Retain accumulated kilowatt-hour and historic peak demand in a nonvolatile memory, until reset. The display shall be capable of displaying all three phases simultaneously and have a selection button on the face of the meter to cycle through the measured parameters.

F. CT’s shall be 5 amp secondary and shall be secured with appropriate brackets.

G. Provide neutral CT in all distribution systems where a neutral exists.

H. The meter shall have an accuracy of +/- 0.1% or better for volts and amps, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC62053-22 (Class 0.2%) and ANSI C12.201(Class 0.2%).
   1. The meter shall provide true RMS measurements of voltage, phase to neutral and phase to phase; current, per phase and neutral.

I. Meter shall be a traceable revenue meter, which shall contain a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its rated accuracy.
J. The main meter for each distribution voltage (both 480/277 and 208/120) shall include a test switch with inline fusing. Test switch shall be capable of access from the front of the switchboard without exposure to bus and main switchboard interior through a separate door or cover that only exposes the test switch and fusing.
   1. Test block shall be equivalent to Milbank TS10-0111.
   2. Provide inline fuse holder and fuses for between bus taps and meter test block.
   3. Provide solid core CT’s wherever possible.

K. Meter shall include 2 independent communications ports on the back and face plate, with advanced features.
   1. One port, through backplate, shall be an RJ45 port, providing 100BaseT Ethernet communication speaking Modbus TCP, and a Web server.
   2. The meter shall provide an optical IrDA port (through faceplate), as the second communication port, which shall allow the unit to be set up and programmed using a remote laptop PC without need for a communication cable.

L. The meter shall provide user configured fixed window or rolling window demand. This shall allow user to set up the particular utility demand profile.
   1. Readings for kW, kVAR, kVA and PF shall be calculated using utility demand features.
   2. All other parameters shall offer max and min capability over the user selectable averaging period.
   3. Voltage shall provide an instantaneous max and min reading displaying the highest surge and lowest sag seen by the meter.

M. The meter shall support power supply of 90 to 265 Volts AC and 100 to 370 Volts DC. Universal AC/DC Supply shall be available.
   1. Meter power supply shall accept burden of 10VA max.
   2. Meter shall provide upgrade rate of 100msec for Watts, Var and VA. All other parameters shall be 1 second.

N. Communication: Meter shall have native MODBUS protocol.
   1. Meter shall provide a minimum of 40 embedded MODBUS Objects consisting of standard voltage, current, and power parameters, including kW and kWh.

O. Communication: Meter shall have native BACNET/IP protocol.
   1. Meter shall provide a minimum of 40 embedded BACnet Objects consisting of standard voltage, current, and power parameters, including kW and kWh. Objects shall be readily identifiable.
   2. The meter shall have an embedded Web interface for configuration and viewing.
      a. The Web interface shall have a Home page with power and energy snapshot information.
      b. The Web interface shall have a page for configuring the BACnet/IP settings, including IP address, Network mask, Default Gateway, and the like.
      c. The Web interface shall allow the user to activate the new configuration and reboot the meter.
      d. The Web interface shall have a feature that lets the user download BACnet Object data as a .csv file that can be viewed in MS Excel© or saved as an MS Excel© file.
      e. The Web interface shall have a webpage that displays the BACnet objects, their readings, and information about the objects.
      f. The Web interface shall have a webpage displaying statistics for the unit, e.g., the number of meter reboots, and the number of BACnet/IP packets sent and received.
      g. The Web interface shall allow the user to discard any changes and return to the saved configuration, or return to the factory default configuration.
      h. The Web interface shall be viewable with any standard Internet browser.
      i. The meter shall be configurable on the Host PC through LAN configuration.
      j. The meter’s BACnet/IP shall integrate with any BACnet applications or servers including the BAS BACnet server.
k. The meter shall also have an open socket for Modbus TCP that shall be simultaneously available through the LAN interface.

P. Compatibility with other devices or systems: The electricity meter is intended to be a part of the building wide BAS. As such it is required to be fully compatible with the BAS. This requires that all the variables indicated in the schedule below can be accessed from the BAS.

Q. Schedule of required electrical metering points:

<table>
<thead>
<tr>
<th>R.</th>
<th>Parameter (Metering Point)</th>
<th>S.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.</td>
<td>Energy Consumption</td>
<td>U.</td>
<td>kWh</td>
</tr>
<tr>
<td>V.</td>
<td>Real Power</td>
<td>W.</td>
<td>kW</td>
</tr>
<tr>
<td>X.</td>
<td>Reactive Power</td>
<td>Y.</td>
<td>kVAR</td>
</tr>
<tr>
<td>Z.</td>
<td>Apparent Power</td>
<td>AA.</td>
<td>kVA</td>
</tr>
<tr>
<td>BB.</td>
<td>Power Factor</td>
<td>CC.</td>
<td></td>
</tr>
<tr>
<td>DD.</td>
<td>Voltage, Line to Line</td>
<td>EE.</td>
<td>Volts</td>
</tr>
<tr>
<td>FF.</td>
<td>Voltage, Line to Neutral</td>
<td>GG.</td>
<td>Volts</td>
</tr>
<tr>
<td>HH.</td>
<td>Current</td>
<td>II.</td>
<td>Amps</td>
</tr>
<tr>
<td>JJ.</td>
<td>Real Power Phase A</td>
<td>KK.</td>
<td>kW</td>
</tr>
<tr>
<td>LL.</td>
<td>Real Power Phase B</td>
<td>MM.</td>
<td>kW</td>
</tr>
<tr>
<td>NN.</td>
<td>Real Power Phase C</td>
<td>OO.</td>
<td>kW</td>
</tr>
<tr>
<td>PP.</td>
<td>Voltage Phase A-B</td>
<td>QQ.</td>
<td>Volts</td>
</tr>
<tr>
<td>RR.</td>
<td>Voltage Phase B-C</td>
<td>SS.</td>
<td>Volts</td>
</tr>
<tr>
<td>TT.</td>
<td>Voltage Phase C-A</td>
<td>UU.</td>
<td>Volts</td>
</tr>
<tr>
<td>VV.</td>
<td>Voltage A-N</td>
<td>WW.</td>
<td>Volts</td>
</tr>
<tr>
<td>XX.</td>
<td>Voltage B-N</td>
<td>YY.</td>
<td>Volts</td>
</tr>
<tr>
<td>ZZ.</td>
<td>Voltage C-N</td>
<td>AAA.</td>
<td>Volts</td>
</tr>
<tr>
<td>BBB.</td>
<td>Current Phase A</td>
<td>CCC.</td>
<td>Amps</td>
</tr>
<tr>
<td>DDD.</td>
<td>Current Phase B</td>
<td>EEE.</td>
<td>Amps</td>
</tr>
<tr>
<td>FFF.</td>
<td>Current Phase C</td>
<td>GGG.</td>
<td>Amps</td>
</tr>
<tr>
<td>HHH.</td>
<td>Present Demand (subinterval)</td>
<td>III.</td>
<td>kW</td>
</tr>
<tr>
<td>JJJ.</td>
<td>Present Demand</td>
<td>KKK.</td>
<td>kW</td>
</tr>
<tr>
<td>LLL.</td>
<td>Peak Demand</td>
<td>MMM.</td>
<td>kW</td>
</tr>
<tr>
<td>NNN.</td>
<td>Present Reactive Power (subinterval)</td>
<td>OOO.</td>
<td>kVAR</td>
</tr>
<tr>
<td>PPP.</td>
<td>Present Reactive Power</td>
<td>QQQ.</td>
<td>kVAR</td>
</tr>
<tr>
<td>RRR.</td>
<td>Peak Reactive Power</td>
<td>SSS.</td>
<td>kVAR</td>
</tr>
</tbody>
</table>

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with all manufacturers equipment installation instructions.
B. Comply with requirements for identification specified in Section 26 05 53 “Identification for Electrical Systems.”

C. Where current transformers are used, provide an engraved label with 3/8” minimum high letters indicating CT ratio and multiplier. Attach label to electrical panel or meter enclosure next to meter.

D. Provide a ¾” conduit from the meter to the nearest building telecomm room.

3.02 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Provide a current transformer test record for each CT which includes:
   1. Ratio
   2. Ratio correction factor at 10% and 100% load
   3. Serial Number
   4. Date of test

C. Tests and Inspections:
   1. Verify proper operation and measurement of current transformers and document CT ratios for each electricity meter.
   2. Verify proper operation and measurement of BTU meters. Provide calibration certificates to owner after start-up is completed.

Metering will be considered defective if it does not pass tests and inspections.

D. Document all settings for all metering devices and include with test and inspection reports.

E. Prepare test and inspection reports.

3.03 TRAINING

A. Provide a minimum of 2 hours of training for the Owners maintenance staff. Coordinate the time of this training with the owner at the time of project close-out.

END OF SECTION 26 27 13
SECTION 262726
WIRING DEVICES

PART 1 - GENERAL

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

1.02 SUMMARY
A. This Section includes the following:
   1. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Twist-locking receptacles.
   3. Snap switches and wall-box dimmers.
   4. Pendant cord-connector devices.
   5. Cord and plug sets.
   6. Floor service outlets, poke-through assemblies, and multioutlet assemblies.

1.03 DEFINITIONS
A. GFCI: Ground-fault circuit interrupter.
B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.04 SUBMITTALS
A. Product Data: For each type of floor service outlet, poke-through assembly, and multi-outlet assembly.
B. Field quality-control test reports.
C. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.05 QUALITY ASSURANCE
A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Comply with NFPA 70.

1.06 COORDINATION
A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
   1. Cord and Plug Sets: Match equipment requirements.

1.07 EXTRA MATERIALS
A. Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Service/Power Poles: One for every 10, but no fewer than one.
   2. Poke-Through, Fire-Rated Closure Plugs: One for every ten floor service outlets installed, but no fewer than two.
PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles and in the Wiring Device Schedule:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.02 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide products from the manufacturers listed in the Wiring Device Schedule.

2.03 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped. UL listed for weather-resistant with "WR" listing marked visibly on face.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide products from the manufacturers listed in the Wiring Device Schedule.

2.04 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; L520R.
   b. Hubbell; HBL2310.
   c. Leviton; 2310.
   d. Pass & Seymour; L520-R.

B. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; IG2310.
   b. Leviton; 2310-IG.

2. Description: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.05 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.

### 2.06 CORD AND PLUG SETS

**A.** Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. **Cord:** Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.

2. **Plug:** Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

### 2.07 SNAP SWITCHES

**A.** Comply with NEMA WD 1 and UL 20.

**B.** Switches, 120/277 V, 20 A:

1. **Products:** Subject to compliance with requirements, provide products from the manufacturers listed in the Wiring Device Schedule.

**C.** Pilot Light Switches, 20 A:

1. **Products:** Subject to compliance with requirements, provide one of the following:
   
   a. Cooper; 2221PL for 120 V and 277 V.
   
   b. Hubbell; HPL1221PL for 120 V and 277 V.
   
   c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
   
   d. Pass & Seymour; PS20AC1-PLR for 120 V.

2. **Description:** Single pole, with neon-lighted handle, illuminated when switch is "ON."

**D.** Key-Operated Switches, 120/277 V, 20 A:

1. **Products:** Subject to compliance with requirements, provide one of the following:
   
   a. Cooper; 2221L.
   
   b. Hubbell; HBL1221L.
   
   c. Leviton; 1221-2L.
   
   d. Pass & Seymour; PS20AC1-L.

2. **Description:** Single pole, with factory-supplied key in lieu of switch handle.

**E.** Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. **Products:** Subject to compliance with requirements, provide one of the following:
   
   
   b. Hubbell; HBL1557.
   
   c. Leviton; 1257.
   
   d. Pass & Seymour; 1251.

**F.** Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

1. **Products:** Subject to compliance with requirements, provide one of the following:
a. Cooper; 1995L.
b. Hubbell; HBL1557L.
c. Leviton; 1257L.
d. Pass & Seymour; 1251L.

2.08 WALL PLATES
A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: Provide full range of finished metal wall plates as selected by the Architect. satin-finished stainless steel.
   4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover. Weatherproof while in use type.

2.09 FLOOR SERVICE FITTINGS
A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
B. Compartments: Barrier separates power from voice and data communication cabling.
C. Finish: brushed aluminum metal cover finish. Provide carpet insert where used in carpet installations.
D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.
E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 Category 5e jacks for UTP cable.

2.10 POKE-THROUGH ASSEMBLIES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Incorporated; Wiring Device-Kellems.
   2. Pass & Seymour/Legrand; Wiring Devices & Accessories.
   3. Square D/ Schneider Electric.
   4. Thomas & Betts Corporation.
   5. Wiremold Company (The).
B. Description: Factory-fabricated and wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.
   1. Service Outlet Assembly: Flush type with four simplex receptacles and space for four RJ-45 jacks.
   2. Size: Selected to fit nominal 6-inch cored holes in floor and matched to floor thickness.
   3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
   4. Closure Plug: Arranged to close unused 6-inch (75-mm) cored openings and reestablish fire rating of floor.
   5. Finish: Brushed aluminum metal cover finish.
2.11 MULTIOUTLET ASSEMBLIES
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Hubbell Incorporated; Wiring Device-Kellems.
      2. Wiremold Company (The).
   B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
   C. Raceway Material: Metal, with brushed aluminum metal finish.
   D. Wire: No. 10 AWG.

2.12 FINISHES
   A. Color: Wiring device catalog numbers in Section Text do not designate device color.
      1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
      3. Isolated-Ground Receptacles: As specified above, with orange triangle on face.

PART 3 - EXECUTION
3.01 INSTALLATION
   A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
   B. Coordination with Other Trades:
      1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
      2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
      3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
      4. Install wiring devices after all wall preparation, including painting, is complete.
   C. Conductors:
      1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
      2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
      3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
      4. Existing Conductors:
         a. Cut back and pigtail, or replace all damaged conductors.
         b. Straighten conductors that remain and remove corrosion and foreign matter.
         c. Pigtailing existing conductors is permitted provided the outlet box is large enough.
   D. Device Installation:
      1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
   1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.
   2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the bottom.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:
   1. Install dimmers within terms of their listing.
   2. Install unshared neutral conductors on line and load side of dimmers according to manufacturers’ device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on bottom. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.02 IDENTIFICATION
A. Comply with Division 26 Section “Identification for Electrical Systems.”
   1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
   2. Emergency Outlets: Outlets installed on emergency power circuits shall be red. Other permanent identification of emergency outlets is acceptable only upon written approval from someone having authority in that jurisdiction.

3.03 FIELD QUALITY CONTROL
A. Perform tests and inspections and prepare test reports.
   1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
   2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 26 27 26
### Wiring Device Schedule

Note to Bidders: Comply with Section 26 27 26 of the specifications. The catalog numbers listed below have been carefully prepared with the assistance of the manufacturer’s representatives with the objective of assisting the bidders in determining the quality and ratings of the wiring device specified; however, the catalog numbers may not be complete or accurate. In addition, the color of the wiring device is not intended to be determined by the catalog numbers listed below, but shall be selected by the Architect as indicated in the specification. Each manufacturer prior to bidding shall compare catalog numbers shown with the description and shall notify the Architect/Engineer of any discrepancies.

<table>
<thead>
<tr>
<th>NEMA</th>
<th>DESCRIPTION</th>
<th>CATALOG NUMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEMA 5-20R GFCI</td>
<td>20A, 125V 2 pole 3 wire duplex feed thru GFCI receptacles UL-listed and marked &quot;WR&quot; weather resistant; with indicator light. Nylon or Lexan decorator faces. Back and side wired. Internal components shall comply with FS W-C-596 where applicable. Comply with UL 498 and UL 493.</td>
<td>Bryant GFR53FT, Hubbell GF5352, Leviton 6898, P&amp;S 2091 S</td>
</tr>
<tr>
<td>NEMA 5-20R Waterproof (Weatherproof in use) GFCI</td>
<td>20A, 125V 2 pole 3 wire duplex feed thru GFCI receptacles with UL-listed and marked &quot;WR&quot; weather resistant; indicator light; Comply with FS W-C-596 and UL 498. Fully gasketed, metal weatherproof while in use enclosure. Plastic covers are not acceptable.</td>
<td>Leviton M5979-0GY cover. With the following devices: Hubbell GFTR20, Bryant GFTR20</td>
</tr>
<tr>
<td>NEMA 5-20R Weatherproof GFCI</td>
<td>20A, 125V 2 pole 3 wire duplex feed thru GFCI receptacles with UL-listed and marked &quot;WR&quot; weather resistant; Nylon or Lexan Faces. Back and side wired. Comply with FS W-C-596 and UL 498. Cast aluminum and UL listed for wet locations.</td>
<td>Appleton U-Line/Contender ENRC 21201. With the following devices: Hubbell GFTR20, Bryant GFTR20</td>
</tr>
<tr>
<td>NEMA 5-20R With USB</td>
<td>20A, 125V 2 pole 3 wire grounding, dead-front duplex receptacle with 2 USB ports at 3 amp, 5 VDC, Type A, 2.0.</td>
<td>Hubbell USB20X2</td>
</tr>
<tr>
<td>20A Single Pole</td>
<td>20A single pole 125V-277V standard toggle switch labeled as complying UL standard 20 and with Federal Specification W-S-896. Provide Nylon or Lexan face, back and side wired. Rated 1 HP 120V.</td>
<td>Hubbell CS1221, Leviton 1221, P &amp; S 521, Bryant 4901</td>
</tr>
<tr>
<td>20A Three-way</td>
<td>20A three-way 125V-277V standard toggle switch labeled as complying UL standard 20 and with Federal Specification W-S-896. Provide Nylon or Lexan face, back and side wired.</td>
<td>Hubbell CS1223, Leviton 1223, P &amp; S 523, Bryant 4903</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Manufacturers</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>20A Four-way</td>
<td>wired. Rated 1 HP 120V. 20A four-way 125V-277V standard toggle switch labeled as complying UL standard 20 and with Federal Specification W-S-896. Provide Nylon or Lexan face, back and side wired. Rated 1 HP 120V.</td>
<td>Hubbell CS1224, Leviton 1224, P &amp; S 524, Bryant 4904</td>
</tr>
<tr>
<td>20A Double Pole</td>
<td>wired. Rated 2 HP 240V. Double pole. 20A double pole 125V-277V standard toggle switch labeled as complying UL standard 20 and with Federal Specification W-S-896. Provide Nylon or Lexan face, back and side wired.</td>
<td>Hubbell CS1222, Leviton 1222, P &amp; S 522, Bryant 4902</td>
</tr>
</tbody>
</table>

END OF SECTION 26 27 26.1
SECTION 26 28 13

FUZZES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers and motor-control centers.

2. Spare-fuse cabinets.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
   a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
   b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.


4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.

5. Coordination charts and tables and related data.

6. Fuse sizes for elevator feeders and elevator disconnect switches.

B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.

2. Current-limitation curves for fuses with current-limiting characteristics.

3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.

4. Coordination charts and tables and related data.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Comply with NEMA FU 1 for cartridge fuses.
D. Comply with NFPA 70.
E. Comply with UL 248-11 for plug fuses.

1.05 PROJECT CONDITIONS
A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer’s ambient temperature adjustment factors to fuse ratings.

1.06 COORDINATION
A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.07 EXTRA MATERIALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS
2.01 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.

2.02 CARTRIDGE FUSES
A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.03 SPARE-FUSE CABINET
A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION
3.01 EXAMINATION
A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.02 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Feeders: Class J, time delay.
   2. Motor Branch Circuits: Class RK5, time delay.
   3. Other Branch Circuits: Class J, time delay.
   4. Control Circuits: Class CC, time delay.

3.03 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Fuse Selection and Installation: Verify connected load(s) and selection of fuse sizes for each disconnect switch prior to selection and installation.

C. Install spare-fuse cabinet(s). Locate in the vicinity of the building main distribution panel.

3.04 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13
SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

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

1.02 SUMMARY
A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Shunt trip switches.
   4. Molded-case circuit breakers (MCCBs).
   5. Molded-case switches.
   7. Elevator Power Module Shunt-Trip Fused Disconnects

1.03 DEFINITIONS
A. NC: Normally closed.
B. NO: Normally open.
C. SPDT: Single pole, double throw.

1.04 PERFORMANCE REQUIREMENTS
A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.05 SUBMITTALS
A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers’ technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Include evidence of NRTL listing for series rating of installed devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
   6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

C. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Manufacturer's field service report.

F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
   2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.06 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.07 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).

B. Comply with NFPA 70E.

1.08 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.09 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Fuse Pullers: Two for each size and type.
PART 2 - PRODUCTS

2.01 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
   1. All lugs shall be rated copper only.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
   5. Hookstick Handle: Allows use of a hookstick to operate the handle.
   6. Lugs: Mechanical type, suitable for number, size, and conductor material.
   7. Service-Rated Switches: Labeled for use as service equipment.

2.02 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
   1. All lugs shall be rated copper only.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
   4. Hookstick Handle: Allows use of a hookstick to operate the handle.
   5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.03 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.
B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.


D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
   1. Instantaneous trip.
   2. Long- and short-time pickup levels.
   3. Long- and short-time time adjustments.
   4. Ground-fault pickup level, time delay, and I^2t response.

F. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

G. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

H. Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
   3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
   4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
   5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
   6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

2.04 MOLDED-CASE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:
   1. Standard frame sizes and number of poles.
   2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
   3. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.

2.05 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.
   3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2.06 ELEVATOR SHUNT-TRIP FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc. - Power Module PS

B. Provide shunt-trip fused disconnect switch with all necessary relay(s), control transformer and other options, as shown on drawings and listed below:
   1. Ampere rating of the switch shall be based upon the elevator manufacturer requirements.
   2. Short-circuit current rating of 200,000A.
   3. Interlocks to prevent the opening of the cover when the switch is in the ON position. Interlock shall be defeatable for testing purposes.
   4. Handle lockable in OFF position.
   5. 100VA/120V control power transformer with primary and secondary fuses.
   6. Isolation relay (3PDT, 10amp, 120V). A normally open dry contact shall be provided by the Fire Alarm Safety System to energize the isolation relay and activate the shunt trip solenoid (140VA inrush at 120V). (Note: if 24V DC coil is selected, a separate 24V DC source and contact must be provided by the Fire Alarm Safety System.)
   7. Provide additional options as indicated below:
      a. Key to Test Switch
      b. “On” Pilot Light (Green, Red or White)
      c. Isolated Full Capacity Neutral Lug
      d. 1P NC Mechanical Interlock (required for hydraulic elevators with automatic recall).
      e. Fire Alarm Voltage Monitoring Relay (Comply with NFPA 72)
      f. NEMA 1 Enclosure.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.02 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices. Verify connected load(s) and selection of fuse sizes for each disconnect switch prior to selection and installation.

E. Location: Equipment disconnecting means shall be immediately next to the equipment which it services.

F. Comply with NECA 1.

3.03 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.
3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

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

END OF SECTION 26 28 16
SECTION 26 29 13
ENCLOSED CONTROLLERS

PART 1 - GENERAL

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

1.02 SUMMARY
   A. Section includes the following enclosed controllers rated 600 V and less:
      1. Full-voltage manual.
      2. Full-voltage magnetic.
      3. Reduced-voltage solid state.
      4. Multispeed.
   B. Related Section:
      1. Division 26 Section "Variable-Frequency Motor Controllers" for general-purpose, ac,
         adjustable-frequency, pulse-width-modulated controllers for use on variable torque loads in
         ranges up to 200 hp.

1.03 DEFINITIONS
   A. CPT: Control power transformer.
   B. MCCB: Molded-case circuit breaker.
   C. MCP: Motor circuit protector.
   D. N.C.: Normally closed.
   E. N.O.: Normally open.
   F. OCPD: Overcurrent protective device.
   G. SCR: Silicon-controlled rectifier.

1.04 PERFORMANCE REQUIREMENTS
   A. Seismic Performance: Enclosed controllers shall withstand the effects of earthquake motions
      determined according to ASCE/SEI 7.
      1. The term "withstand" means "the unit will remain in place without separation of any parts from
         the device when subjected to the seismic forces specified and the unit will be fully operational
         after the seismic event."

1.05 SUBMITTALS
   A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on
      features, performance, electrical characteristics, ratings, and enclosure types and finishes.
   B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections,
      details, and required clearances and service spaces around controller enclosures.
      1. Show tabulations of the following:
         a. Each installed unit's type and details.
         b. Factory-installed devices.
         c. Nameplate legends.
d. Short-circuit current rating of integrated unit.

e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.

f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.

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

C. Seismic Qualification Certificates: For enclosed controllers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

E. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for enclosed controllers and installed components.

2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.

3. Manufacturer's written instructions for setting field-adjustable overload relays.

4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

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

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

1.07 DELIVERY, STORAGE, AND HANDLING

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

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 250 W per controller.

1.08 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
1. Ambient Temperature: Not less than \textit{minus 22 deg F} (\textit{minus 30 deg C}) and not exceeding \textit{104 deg F} (\textit{40 deg C}).


B. Comply with NFPA 70E.

\textbf{1.09 COORDINATION}

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

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

\textbf{PART 2 - PRODUCTS}

\textbf{2.01 FULL-VOLTAGE CONTROLLERS}

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   c. Siemens Energy & Automation, Inc.
   d. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing.

3. Flush or surface mounting.


C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   c. Siemens Energy & Automation, Inc.
   d. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing.

3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.

4. Surface mounting.

5. Red pilot light.
D. Magnetic Controllers: Full voltage, across the line, electrically held.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
      c. Siemens Energy & Automation, Inc.
      d. Square D; a brand of Schneider Electric.
   2. Configuration: Nonreversing.
      a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
   4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
   5. Control Circuits: 24 or 120-V ac, as required by the control circuit; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
      a. CPT Spare Capacity: 100 VA.
   6. Solid-State Overload Relay:
      a. Switch or dial selectable for motor running overload protection.
      b. Sensors in each phase.
      c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
      d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
      e. Analog communication module.
   7. N.C./N.O., isolated overload alarm contact.
   8. External overload reset push button.

E. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
      c. Siemens Energy & Automation, Inc.
      d. Square D; a brand of Schneider Electric.
   2. Fusible Disconnecting Means:
      a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
      b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
      c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
3. Nonfusible Disconnecting Means:
   a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
   b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
   c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

4. MCP Disconnecting Means:
   a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
   b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
   c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
   d. N.C./N.O. alarm contact that operates only when MCP has tripped.
   e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

5. MCCB Disconnecting Means:
   a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
   b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
   d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
   e. N.C./N.O. alarm contact that operates only when MCCB has tripped.

2.02 MULTISPEED MAGNETIC CONTROLLERS

A. General Requirements for Multispeed Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Multispeed Magnetic Controllers: Two speed, full voltage, across the line, electrically held.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   c. Siemens Energy & Automation, Inc.
   d. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing; consequent pole or two winding types as required by the motor being controlled.

   a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

4. Power Contacts: Totally enclosed, double break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
5. Control Circuits: 24 or 120-V ac, as required by the control circuit; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
   a. CPT Spare Capacity: 100 VA.

6. Compelling relays shall ensure that motor will start only at low speed.

7. Accelerating timer relays shall ensure properly timed acceleration through speeds lower than that selected.

8. Decelerating timer relays shall ensure automatically timed deceleration through each speed.

9. Antiplugging timer relays shall ensure a time delay when transferring from FORWARD to REVERSE and back.

10. Solid-State Overload Relay:
   a. Switch or dial selectable for motor running overload protection.
   b. Sensors in each phase.
   c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
   d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

11. N.C./N.O., isolated overload alarm contact.

12. External overload reset push button.

2.03 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: Type 1.
   2. Outdoor Locations: Type 3R.
   4. Other Wet or Damp Indoor Locations: Type 4.
   5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.04 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
      a. Push Buttons: Covered, lockable types; maintained or momentary as indicated.
      b. Pilot Lights: LED types; colors as indicated; push to test.
      c. Selector Switches: Rotary type.

B. N.C./N.O. auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.


E. Cover gaskets for Type 1 enclosures.
PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

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

3.02 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Floor-Mounted Controllers: Install enclosed controllers on 4-inch (100-mm) nominal-thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in each fusible-switch enclosed controller.

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

G. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

H. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

I. Comply with NECA 1.

3.03 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved nameplate.

3. Label each enclosure-mounted control and pilot device.
3.04 CONTROL WIRING INSTALLATION
   A. Install wiring between enclosed controllers and remote devices and facility's central control system. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."
   B. Bundle, train, and support wiring in enclosures.
   C. Connect selector switches and other automatic-control selection devices where applicable.
      1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
      2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.05 FIELD QUALITY CONTROL
   A. Perform tests and inspections.
      1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
   B. Acceptance Testing Preparation:
      1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
      2. Test continuity of each circuit.
   C. Tests and Inspections:
      1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
      2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
      3. Test continuity of each circuit.
      4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect and Owner before starting the motor(s).
      5. Test each motor for proper phase rotation.
      7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
      8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
   D. Enclosed controllers will be considered defective if they do not pass tests and inspections.
   E. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 ADJUSTING
   A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect and Owner before increasing settings.

D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.

E. Set field-adjustable circuit-breaker trip ranges.

3.07 PROTECTION

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

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

END OF SECTION 26 29 13
PART 1 - GENERAL

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

1.05 SUMMARY
A. Section Includes:
   1. Interior lighting fixtures, lamps, and ballasts.
   2. Emergency lighting units.
   3. Exit signs.
   4. Lighting fixture supports.
B. Related Sections:
   1. Section 26 09 23 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
   2. Section 26 09 36 "Modular Dimming Controls" for architectural dimming systems.
   3. Section 26 09 43.13 "Addressable-Fixture Lighting Controls" and Section 26 09 43.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.03 DEFINITIONS
A. BF: Ballast factor.
B. CCT: Correlated color temperature.
C. CRI: Color-rendering index.
D. HID: High-intensity discharge.
E. LER: Luminaire efficacy rating.
F. Lumen: Measured output of lamp and luminaire, or both.
G. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.04 ACTION SUBMITTALS
A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Emergency lighting units including battery and charger.
   3. Ballast, including BF.
6. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Section 23.37.13 “Diffusers, Registers, and Grilles.”

7. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.

8. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
   a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
   b. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer’s laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

C. Seismic Qualification Certificates: For lighting fixtures, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Samples: For each lighting fixture indicated in the Interior Lighting Fixture Schedule. Each Sample shall include the following:
   1. Lamps and ballasts, installed.
   2. Cords and plugs.
   3. Pendant support system.

E. Installation instructions.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Lighting fixtures.
   2. Suspended ceiling components.
   3. Partitions and millwork that penetrate the ceiling or extends to within 12 inches (305 mm) of the plane of the luminaires.
   5. Structural members to which suspension systems for lighting fixtures will be attached.
6. Other items in finished ceiling including the following:
   a. Air outlets and inlets.
   b. Speakers.
   c. Sprinklers.
   d. Smoke and fire detectors.
   e. Occupancy sensors.
   f. Access panels.

7. Perimeter moldings.

B. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

C. Field quality-control reports.

D. Warranty: Sample of special warranty.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers’ codes.

1.07 MAINTENANCE MATERIAL SUBMITTALS

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

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.

3. Fluorescent-fixture-mounted, emergency battery pack: One for every 20 emergency lighting unit.

4. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.

5. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.08 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers’ laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

D. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

E. Mockups: Provide interior lighting fixtures for room or module mockups complete with power and control connections.

1. Obtain Architect's approval of fixtures for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.09 COORDINATION
A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.10 WARRANTY
A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

3. Acrylic Lenses, Anti- Yellowing: 5 years from date of Substantial Completion if acrylic lenses have any noticeable sign of yellowing.

4. Warranty Period for LED Luminaires: 5 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining 4 years.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. Products: Subject to compliance with requirements, provide one of the products indicated.

2.02 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS
A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

E. Metal Parts: Free of burrs and sharp corners and edges.

F. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

H. Diffusers and Globes:
1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
b. UV stabilized.

2. Glass: Annealed crystal glass unless otherwise indicated.

I. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp and ballast characteristics:
   a. "USE ONLY" and include specific lamp type.
   b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
   c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
   d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
   e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
   f. CCT and CRI for all luminaires.

2. 2.03 LED LAMPS AND DRIVERS

A. Approved Manufacturers for Luminaires shall be as scheduled.

B. Approved Manufacturers- LEDs
   1. General Electric
   2. Philips
   3. Osram
   4. Cree
   5. Xicato
   6. Nichia

C. Approved Manufacturers- Drivers
   1. General Electric.
   2. Philips.
   3. Osram / Sylvania.
   4. Lutron
   5. EldoLED
   6. Thomas Research

D. Lumen output shall be Luminaire Lumens or Delivered Lumens. Source lumens shall not be used, per IES LM-79 and LM-80.

E. Inrush current shall be negligible. Maximum allowed is 30mAs.

F. THD: THD shall not exceed 20% at full load.

G. Minimum driver efficiency shall be 86% at 65% rated load.

H. Maximum off-state power consumption 0.5w.
I. Compliant with FCC 47 CFR Part 15 A for Residential applications and B for Commercial applications.

J. Luminaire shall be NRTL Listed at intended operating temperature.

K. Photometry shall be measured or absolute photometry. Derived or calculated photometry shall not be provided for consideration.

L. Drivers for Solid State Lighting Sources: Comply with UL 8750 and be so recognized.

M. Ballast Circuit: Constant-current or constant voltage as required by the LED assembly.

N. High power factor >.90

O. Driver and Led modules shall operate the solid state light source in a constant manner, performing without measurable flicker below 25kHz along entire range of dimming.

P. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C).

Q. Rated and UL / ETL tested ambient operating temperature: 104 deg F (40 deg C).

R. CRI (Ra) shall be based on CIE/IES definition using 8 color criteria. Comply with R9 value, if specified. Minimum CRI Ra- 82 or as specified.

S. Individual LEDs shall be tested in compliance with IES LM-79-08. The complete LM-79 report shall be available if requested.

T. Chromaticity tolerance shall be 2 MacAdam ellipses for interior applications and 6 MacAdam Ellipses for exterior applications. Rating shall be by ANSI/NEMA C78.377-2008.

U. Rated life shall be as determined by IES LM-80-08 and IES TM-21-11. These full reports shall be available if requested.

V. Only original Absolute Photometry in compliance with IES LM-79-08 shall be used to report solid state luminaire performance. Derived files are not acceptable.

W. Do not exceed scheduled drive current. Open-circuit operation that will not reduce driver life.

X. Dimming by DMX, DALI, PWM or CCR methods are approved, must be compatible with the control systems on the projects. Dimming range shall be from 100% to 1% of measured light output.

Y. Dimming drivers shall be compatible with the control method shown on the drawings. All dimmed drivers shall use 0-10vdc control unless specified differently. Minimum level shall be 1% or as scheduled.

Z. Low-Noise Ballasts: manufacturers’ standard epoxy-encapsulated or noise suppressed modules designed to minimize audible fixture noise.

AA. LED modules and drivers shall be replaceable in the field, LED modules shall have digitally traceable matching modules.

2.04 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
   a. Battery: Sealed, maintenance-free, nickel-cadmium type.
   b. Charger: Fully automatic, solid-state type with sealed transfer relay.
c. **Operation:** Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

d. **Test Push Button:** Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

e. **LED Indicator Light:** Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

f. **Remote Test:** Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

g. **Integral Self-Test:** Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

3. **Master/Remote Sign Configurations:**

   a. **Master Unit:** Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply battery for power connection to remote unit.

   b. **Remote Unit:** Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.05 **EMERGENCY LIGHTING UNITS**

A. **General Requirements for Emergency Lighting Units:** Self-contained units complying with UL 924.

   1. **Battery:** Sealed, maintenance-free, lead-acid type.

   2. **Charger:** Fully automatic, solid-state type with sealed transfer relay.

   3. **Operation:** Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

   4. **Test Push Button:** Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

   5. **LED Indicator Light:** Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

   6. **Wire Guard:** Heavy-chrome-plated wire guard protects lamp heads or fixtures.

   7. **Integral Time-Delay Relay:** Holds unit on for fixed interval of 15 minutes when power is restored after an outage.

   8. **Remote Test:** Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

   9. **Integral Self-Test:** Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
2.06 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).

F. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Lighting fixtures:
   1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
   2. Install lamps in each luminaire.

B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

C. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

D. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
   1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches (150 mm) from at least two diagonal corners of lighting fixture and attach to building structure.
   2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
   3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
   4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

E. Suspended Lighting Fixture Support:
   1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
   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. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
5. Safety Cables: to prevent the fixture from falling if swaying breaks the pendant.

F. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.02 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.03 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Verify that self-luminous exit signs are installed according to their listing and the requirements in NFPA 101.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.04 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION 26 51 00
PART 1 - GENERAL

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

1.02 SUMMARY
   A. Section Includes:
      1. Exterior luminaires with lamps and ballasts.
      2. Poles and accessories.
   B. Related Sections:
      1. Division 26 Section “Interior Lighting” for exterior luminaires normally mounted on exterior surfaces of buildings.

1.03 DEFINITIONS
   A. CCT: Correlated color temperature.
   B. CRI: Color-rendering index.
   C. HID: High-intensity discharge.
   D. LER: Luminaire efficacy rating.
   E. Luminaire: Complete lighting fixture, including ballast housing if provided.
   F. Pole: Luminaire support structure, including tower used for large area illumination.
   G. Standard: Same definition as "Pole" above.

1.04 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION
   A. Dead Load: Weight of luminaire and its horizontal and vertical supports, and supporting structure, applied as stated in AASHTO LTS-4-M.
   B. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4-M.
   C. Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied as stated in AASHTO LTS-4-M Ice Load Map.
   D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
      1. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is 100 mph (45 m/s) with a 1.3 gust factor, and minimum design life of 30 years.

1.05 SUBMITTALS
   A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
      1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
      2. Details of attaching luminaires and accessories.
      3. Details of installation and construction.
      4. Luminaire materials.
      5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
         a. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
      6. Ballasts, including energy-efficiency data.
7. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
8. Materials, dimensions, and finishes of poles.
9. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
10. Anchor bolts for poles.
11. Manufactured pole foundations.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
   3. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
   4. Wiring Diagrams: For power, signal, and control wiring.

C. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.

D. Pole bases: Provide deferred submittal of pole base design signed and stamped by a structural engineer licensed in the state of Utah based on the project conditions and submitted pole and light combination.

E. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

F. Field quality-control reports.

G. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

H. Warranty: Sample of special warranty.

1.06 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.


D. Comply with NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
1. Warranty Period for Luminaires including LED’s: Five years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer’s standard warranty period, but not less than three years from date of Substantial Completion.

1.09 EXTRA MATERIALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: One for every 10 of each type and rating installed. Furnish at least one of each type.
   2. Glass and Plastic Lenses, Covers, and Other Optical Parts: One for every 20 of each type and rating installed. Furnish at least one of each type.
   3. Ballasts: One for every 10 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS
2.01 BASIS OF DESIGN
A. Bollard Fixture (OB-1): Lumux BL350
B. Wall Pack (OC32): Elcast 8002
C. Recessed Step Lights (OR-1): Elcast 1235
D. Parking Lot Pole Lights (ZX-1): Kim Alt 120

2.02 MANUFACTURERS
A. Products: Subject to compliance with requirements, provide one of the products indicated.

2.03 GENERAL REQUIREMENTS FOR LUMINAIRES
A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
   1. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.
   2. LER Tests Fluorescent Fixtures: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
   3. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.
B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
C. Metal Parts: Free of burrs and sharp corners and edges.
D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
G. Exposed Hardware Material: Stainless steel.
H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
   2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
      a. Color: As selected by Architect from manufacturer's full range.

N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
   2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
   3. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
      a. Color: As selected by Architect from manufacturer's full range.

O. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp and ballast characteristics:
      a. "USES ONLY" and include specific lamp type.
      b. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
      c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
      d. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
      e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
      f. CCT and CRI for all luminaires.

P. Exterior Lighting Fusing:
   1. Manufacturer:
      a. Cooper Bussman.
1) Type: KTK-6, 6A 600V.
2) Fuse Holder: HEB-JJ in-line with rubber insulating boots.
3) Note: Crimp style fuses shall not be allowed.
2. Each fixture shall have fusing inside of hinged pole base.
3. Fusing shall be provided for each ungrounded conductor.

2.04 LED LAMPS AND DRIVERS:
A. Minimum CRI Ra- 82 or as specified.
B. Lumen output shall be Luminaire Lumens or Delivered Lumens. Source lumens shall not be used, per IES LM-79 and LM-80.
C. Color Consistency 3 MacAdams Ellipse or better.
D. LED Rated life L70 of 50,000 hours per (IES TM-21). Luminaire shall maintain LED operating temperature to achieve this rating per TM-21.
E. Flicker: No visible or detectable flicker, operating on all dimmed intensities.
F. Dimming drivers shall be compatible with the control method shown on the drawings. All dimmed drivers shall use 0-10vdc control unless specified differently. Minimum level shall be 1% or as scheduled.
G. Inrush current shall be negligible. Maximum allowed is 30mAs.
H. THD: THD shall not exceed 10% at full load.
I. Minimum driver efficiency shall be 86% at 65% rated load.
J. Maximum off-state power consumption 0.5w.
L. LED module shall be replaceable in the field using modules with digitally traceable matching modules.
M. Luminaire shall be NRTL Listed at intended operating temperature.
N. Photometry shall be measured or absolute photometry. Derived or calculated photometry shall not be provided for consideration.
O. Approved Manufacturers- Drivers
1. General Electric.
2. Philips.
3. Osram / Sylvania.
4. Lutron
5. EldoLED
6. Thomas Research
P. Approved Manufacturers- LEDs
1. General Electric
2. Philips
3. Osram
4. Cree
5. Xicato
6. Nichia

2.05 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS
A. Structural Characteristics: Comply with AASHTO LTS-4-M.
1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
   1. Materials: Shall not cause galvanic action at contact points.
   3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

G. Hinged Bases:
   1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
      a. Sterner Lighting; Hubble Lighting.
      b. LSI Industries, Inc.
   2. The folding direction of hinged base shall allow for a full 90 degree tilt.

2.06 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.
   1. Shape: As indicated.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
   3. Hinged pole base assembly where indicated.

B. Steel Mast Arms: configurations and types indicated, continuously welded to pole attachment plate. Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
   1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless-steel bolts.
   2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
   3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

E. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

F. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
G. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
   2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
   3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
      a. Color: As selected by Architect from manufacturer's full range.

2.07 ALUMINUM POLES
A. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.
   1. Shape: as indicated.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
B. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
C. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
D. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
   1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
   2. Finish: Same as pole and luminaire.
E. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
   2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
   3. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
      a. Color: As selected by Architect from manufacturer's full range.

2.08 POLE ACCESSORIES
A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION
3.01 LUMINAIRE INSTALLATION
A. Install lamps in each luminaire.
B. Fasten luminaire to indicated structural supports.
   1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

D. [Where existing pole lights are specified to be removed and/or relocated, the Contractor shall replace lost or damaged lights and/or poles with new equipment at no additional cost to the Owner].

3.02 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
   1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
   2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
   3. Trees: 15 feet (5 m) from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
   1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
   2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
   3. Install base covers unless otherwise indicated.
   4. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25 mm) below top of concrete slab.

F. Raise and set poles using web fabric slings (not chain or cable).

G. Hinged Pole Bases:
   1. Install hinged pole base on each pole light.

H. Hinge direction shall not be directed onto a slope or into traffic.

3.03 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.04 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems."
   In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.05 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
3. Copper-clad ground rods shall not be installed under concrete pole base.

### 3.06 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
   1. Verify operation of photoelectric controls.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 56 00
SECTION 27 11 00 TELECOMMUNICATIONS PATHWAYS AND SPACES

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. Telecommunications vertical and horizontal pathways.
   2. Backboards and mounting elements.
   3. Telecommunications equipment racks and cabinets.
   4. Telecommunications service entrance pathways.
   5. Grounding.

B. Related Sections:
   1. Division 27 Section "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
   2. Division 27 Section "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.


C. LAN: Local area network.

D. RCDD: Registered Communications Distribution Designer.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Floor-mounted cabinets and cable pathways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7, (Zone 4).
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
1.5  SUBMITTALS

A.  Product Data:  For each type of product indicated.  Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.  Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B.  Shop Drawings:  For communications equipment room fittings.  Include plans, elevations, sections, details, and attachments to other work.
   1.  Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2.  Equipment Racks and Cabinets:  Include workspace requirements and access for cable connections.
   3.  Grounding:  Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

C.  Qualification Data:  For each qualified layout technician, installation supervisor, and field inspector.

D.  Seismic Qualification Certificates:  For floor-mounted cabinets, accessories, and components, from manufacturer.
   1.  Basis for Certification:  Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2.  Dimensioned Outline Drawings of Equipment Unit:  Identify center of gravity and locate and describe mounting and anchorage provisions.  Base certification on the maximum number of components capable of being mounted in each rack type.  Identify components on which certification is based.
   3.  Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6  QUALITY ASSURANCE

A.  Qualified Contractors:

B.  Installer Qualifications:  Cabling Installer must have personnel certified by BICSI on staff.
   1.  Layout Responsibility:  Preparation of Shop Drawings shall be under the direct supervision of an RCDD.
   2.  Installation Supervision:  Installation shall be under the direct supervision of a Registered Technician (BICSI), who shall be present at all times when Work of this Section is performed at Project site.
   3.  Field Inspector:  Currently registered by BICSI as an RCDD, or certified by the manufacturer to perform the on-site inspection.

C.  Electrical Components, Devices, and Accessories:  Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
D. Telecommunications Pathways and Spaces: Comply with ANSI/TIA/EIA-569-B.


1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and associated construction work on the subfloor and raised floor supports is substantially complete.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with ANSI/TIA/EIA-569-B.

B. Cable Support (J-Hook): Cable installation that does not require basket cable tray management, but shall require support of cables with J-Hooks. J-Hook pathway support will be spaced no more than 60” between supports.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Erico Caddy
      b. B-Line
      c. CTS
      d. Stiffy
      e. Panduit
   2. Cable Support Materials (J-Hook) shall meet or exceed the below characteristics of construction and features.
      a. Provide broad based support for cabling to aid in maintaining overall system performance.
      b. Be available in 50.8mm (2”) and 101.6mm (4”) options
      c. Come equipped with a cable retention clip
      d. Offers a full line of mounting accessories.

C. Ladder Rack:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Chatsworth
   2. Description:
      a. Size: 1.5 inches high by 0.4 inches wide high tubular steel with 0.065 inch wall thickness.
      b. Stringers: 9 feet 11-1/2 inches long.
      c. Cross Members: Welded in between stringers on 12 inch intervals/centers begin-
ning 5-3/4 inches with 10 cross members per ladder rack. Open space of 10-1/2 inches between each cross member.

d. Finish and Color: Powder coat paint in black.
e. Provide cable tray widths as noted, 12” – 24” wide.

D. Conduit Sleeves: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems".

E. Innerduct: Smooth wall, multi colored with pre-installed pull-line.
1. Outside Plant: Rated for outdoor duct installation.
2. Acceptable Sizes:
   a. 1-1/4” Diameter
3. Acceptable manufacturers:
   a. Dura-line
   b. Or approved equal

2.2 BACKBOARDS

A. Backboards: Provide plywood, fire-retardant treated, 3/4 by 48 by 96 inches, on at least two of the full non-door walls of each telecommunications room, or as noted. Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry."

2.3 WALL MOUNT CABINET

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Chatsworth Cube-iT
2. Approved Equal

B. General Frame Requirements:

1. Distribution Frames: Wall mounted, modular-metal units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
3. Finish: Manufacturer's standard, baked-polyester powder coat. Black
4. 24” W x 48” H x 30” D, 26RU
5. Door style tempered glass.

2.4 CABLE MANAGEMENT

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

B. Cable Management for Equipment Frames:
1. Shall consist of a metal backbone, with cable fingers that align with EIA rack spacing.
2. Baked-polyester powder coat finish.
3. Fingers will be molded plastic, and shall provide integral bend radius control.
4. Horizontal cable management panels shall have front channels with covers, and shall be a minimum height of two rack units each.
5. Horizontal cable management panels will be high capacity, and capable of managing Category 6A patch cords.

2.5 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Telecommunications Main Ground Bus Bar:
   1. Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
   2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.
   3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with ANSI-J-STD-607-A.

2.6 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Install underground pathways complying with recommendations in TIA/EIA-569-B, "Entrance Facilities" Article.

3.2 INSTALLATION

A. Install underground entrance pathway complying with Division 26 Section "Raceway and Boxes for Electrical Systems.” Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
C. Cable Trays: Provide overhead cable runway (ladder rack) as noted. Comply with NEMA VE 2 and TIA/EIA-569-B.

D. Bundle, wrap, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install management bars and distribution spools.

3.3 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping." Comply with TIA/EIA-569-B, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. See Section 271300 "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion of TIA/EIA standard as it applies to this Section.

D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 4 level of administration, including optional identification requirements of this standard.

E. Labels shall be preprinted or computer-printed type.

END OF SECTION 271100
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. Pathways.
   2. 8.3/125 – 9/125 micron, singlemode fiber optical cabling.
   3. Cable connecting hardware, termination panels, and cross-connects.

B. Related Sections:
   1. Division 27 Section "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS


B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. RCDD: Registered Communications Distribution Designer.

D. UTP: Unshielded twisted pair.

E. eABF: Enterprise Air Blown Fiber-optics system composed of bundled MicroDuct pathways and MicroCable fiber that is push-jetted with air-assistance for maximum distance.

F. Jetted Fiber: MicroCable that is typically no more than 4.5mm OD, with striations (ribs) on the outside jacket … available in 1 to 96 strand density.

G. OSP: Outside Plant.

1.4 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system.
structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects shall be located in termination rooms (telecom) and at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 PERFORMANCE REQUIREMENTS

A. ANSI/TIA-568-C.0 - Generic Telecommunications Cabling For Customer Premises

B. ANSI/TIA-568-C.1 - Commercial Building Telecommunications Cabling Standard

C. ANSI/TIA-568-C.3 - Optical Fiber Cabling Components Standard

D. TIA-569-B - Commercial Building Standard for Telecommunications Pathways and Spaces

E. ANSI/TIA-606-B - Administration Standard for Commercial Telecommunications Infrastructure

F. ANSI-J-STD-607-B - Telecommunications Grounding (Earthing) and Bonding for Customer Premise

G. ANSI/TIA-758-A - Customer Owned Outside Plant Telecommunications Infrastructure Standard

H. ANSI/NFPA-70 – National Electrical Code

I. All applicable State and Local Electrical Codes

J. NEMA, and ANSI/TIA Standards where applicable standards have been established.

K. Telcordia Standards and Specifications


1.6 SUBMITTALS

A. Provide point-by-point statement of any deviations or exceptions with specifications, in accordance with Section 260500.1.5B.

B. Product Data: For each type of product indicated.

1. For all cable, include the following installation data for each type used:
   a. Nominal OD.
   b. Minimum bending radius.
   c. Maximum pulling tension.

C. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.

2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the
cabling and asset identification system of the software.

3. Cabling administration drawings and printouts.

4. Wiring diagrams to show typical wiring schematics including the following:
   b. Patch panels.
   c. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

D. Qualification Data: For all qualified layout technicians, installation supervisors, and field inspectors.

E. Source quality-control reports.

F. Field quality-control reports.

G. Maintenance Data: For splices and connectors to include in maintenance manuals.

H. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On magnetic media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

A. Qualified Contractors:

B. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician (BICSI), who shall be present at all times when Work of this Section is performed at Project site.
   3. Testing Supervisor: Currently certified by BICSI as an RCDD to review all test procedures and test results.

C. Testing Agency Qualifications:
   1. Testing Agency’s Field Supervisor: Currently certified by BICSI as an RCDD or manufacturer certified installer to supervise on-site testing.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-B.

1.8 DEELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
   2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
   3. Test each pair of multi pair cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner’s telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-C.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements in Division 06 Section "Rough Carpentry" for plywood backing panels.

2.3 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. General Cable
   2. Berk Tek
   3. Commscope
   4. Equal

B. Description: 25 or 50 pair, 100-ohm, multipair UTP (quantity as noted), formed into 25-pair binder groups covered with a filled foam skin jacket.
   1. Comply with ICEA S-84-608-2007
2. Comply with TIA/EIA-568-C.1 for performance specifications.
3. Comply with TIA/EIA-568-C.2, Category 3.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
   a. Communications: Type OSP, PE89, complying with NFPA 262.

2.4 UTP CABLE HARDWARE

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

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Riser Patch Panel: Provide Cat 5e, 24 or 48 port patch panels for backbone copper cable as indicated in drawings.
   1. Number of Terminals per Field: One pair for each 8p8c connector.

D. Jacks and Jack Assemblies: Molded receptacle units with integral IDC-type terminals.

2.5 BUILDING ENTRANCE PROTECTION EQUIPMENT

A. Voice Backbone Copper Building Entrance Terminals (BETs): Complete with lockable covers and plug-in protector modules for each pair terminated on the chassis. Gas-tube protector modules shall provide 350V over-voltage and sneak current protection. BEPs and protectors shall be manufactured by the following manufacturers:

B. Manufacturers:
   1. Circa Enterprises
   2. Or equal
      a. 1880ECA1 Series
         1) Single pair (for Emergency Phone): 1360B
         2) Less than or equal to 25-pair to be terminated: 1880ECA1-25GT2
         3) 26-pair to 50-pair to be terminated: 1880ECA1-50GT2
      b. Protectors shall be:
         1) 4B1E (PTC)

2.6 OPTICAL FIBER CABLE OSP

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

B. Description: Single mode fiber optic cable 24, or 48 strand fiber, MiniXtend, loose tube micro cable as indicated in drawings.
   1. Comply with ICEA S-83-596 for mechanical properties.
   2. Comply with TIA/EIA-568-C.3 for performance specifications.
3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
   a. OSP, Nonconductive: Type PE, complying with NFPA 262.

C. Jacket:
   1. Jacket Color: Black
   2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-C.

D. Imprinted with fiber count, fiber type, and aggregate length at regular intervals

2.7 OPTICAL FIBER CABLE HARDWARE

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

B. Cross-Connects and Termination Panels: Pigtailed splice cassette housing multiple-numbered, SC/APC simplex cable connectors, or SC duplex cable connectors.
   1. Number of Connectors per Field: One for each fiber strand or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
   2. Fiber Count: 12
   3. Cable Connecting Hardware:
      5. Quick-connect, simplex, Type SC/APC connectors. Insertion loss not more than 0.75 dB.
      6. Quick-connect, duplex, Type SC connectors. Insertion loss not more than 0.75 dB.

2.8 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.9 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.10 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing personnel or a qualified testing agency to evaluate cables.
B. Factory test cables on reels according to TIA/EIA-568-C.1.
C. Factory test UTP cables according to TIA/EIA-568-C.2.
D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-C.3.
E. Cable will be considered defective if it does not pass tests and inspections.
F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within cabinets. Conceal raceway and cables except in unfinished spaces.
   1. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."
B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-B.
B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Section 271100 "Telecommunications Pathways and Spaces." Drawings indicate general arrangement of pathways and fittings.
C. Comply with TIA/EIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.
D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.
E. Install manufactured conduit sweeps and long-radius elbows whenever possible.
F. Pathway Installation in Termination Rooms (Telecom):

   1. Position vertical conduit ends adjacent to a corner where plywood backboard is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter
walls of room.
2. Secure conduits to backboard when entering room from overhead.
3. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
   2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
   3. For UTP cable, install 110-style IDC termination hardware unless otherwise indicated.
   4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
   7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
   8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   9. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
   10. In the communications equipment room, install a 15-foot long service loop on the station end of cable.
   11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

D. Optical Fiber Cable Installation:
   2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60” apart.
   3. Cable shall not be run through structural members or in contact with pipes, ducts, or
other potentially damaging items.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

3.5 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping. "Comply with TIA/EIA-569-B, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Administration Class: 4.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion about TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration.

D. Comply with requirements in Section 271500 "Communications Horizontal Cabling" for cable and asset management software.

E. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

G. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
   a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
   b. Label each unit and field within distribution racks and frames.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.
3.8 FIELD QUALITY CONTROL

A. Testing Agency: Agency/Contractor to have BICSI trained, or manufacturer certified personnel to perform all tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.2. Perform tests with a tester that complies with performance requirements in “Test Instruments (Normative)” Annex, complying with measurement accuracy specified in “Measurement Accuracy (Informative)” Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical Fiber Cable Tests:

   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

   b. Link End-to-End Attenuation Tests:

      1) Horizontal and backbone link measurements: Test at 1310 and 1550 nm in both directions according to ANSI/TIA/EIA 568-C standards.

      2) Horizontal and backbone link measurements: Test at 850 and 1300 nm in both directions according to ANSI/TIA/EIA 568-C standards.

      3) Attenuation test results for backbone links shall be less than 2.0 dB.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION 271300
SECTION 271500
COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cabling.
3. Cable connecting hardware, patch panels, and cross-connects.
4. Telecommunications outlet/connectors.
5. Cabling system identification products.
6. Cable management system.

B. Related Sections:

1. Section 271100 "Telecommunications Pathways and Spaces" for voice and data cabling associated with system panels and devices.
2. Section 271300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.


C. EMI: Electromagnetic interference.

D. LAN: Local area network.

E. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

F. RCDD: Registered Communications Distribution Designer.

G. UTP: Unshielded twisted pair.
1.4 HORIZONTAL CABLEING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications termination room (Telecom). This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.

1. TIA/EIA-568-C.2 requires that a minimum of two telecommunications outlet/ connectors be installed for each work area, however, some locations designated by the owner shall have a single data outlet/connector.
2. Horizontal cabling shall contain no more that one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.
4. Splitters shall not be installed as part of the optical fiber cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the telecommunications outlet/ connectors to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet in the horizontal cross-connect.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-C.1, when tested according to test procedures of this standard.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

1. For all cable, include the following installation data for each type used:
   a. Nominal OD.
   b. Minimum bending radius.
   c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics, including the following:
   b. Patch panels.
   c. Patch cords.
5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
6. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
   a. Vertical and horizontal offsets and transitions.
   b. Clearances for access above and to side of cable trays.
   c. Vertical elevation of cable trays above the subfloor.

C. Samples: For workstation outlets, jacks, jack assemblies, in specified finish, one for each size and outlet configuration.

D. Qualification Data: For all qualified layout technicians, installation supervisors, and field inspector.

E. Source quality-control reports.

F. Field quality-control reports.

G. Maintenance Data: For splices and connectors to include in maintenance manuals.

H. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On magnetic media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician (BICSI), who shall be present at all times when Work of this Section is performed at Project site.
   3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
   4. Contractor: Contractor must be a Commscope certified installer at time of bid and must be able to provide the system warranty.

B. Testing Agency Qualifications:
   1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-B.

1.8 DELIVERY, STORAGE, AND HANDLING
   
   A. Test cables upon receipt at Project site.
      1. Test each pair of UTP cable for open and short circuits.

1.9 PROJECT CONDITIONS
   
   A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION
   
   A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

   B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area. This coordination will generally involve the placement of the raised floor floorboxes and the outlet arrangements therein.

PART 2 - PRODUCTS

2.1 PATHWAYS
   
   A. General Requirements: Comply with TIA/EIA-569-B.

   B. Cable Support: NRTL labeled for support of Category 6A cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
      1. Basket cable tray.
      2. Lacing bars, spools, J-hooks, and D-rings.
      3. Straps and other devices.

   C. Basket Cable Trays:
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. WBT
         b. Cablofil Inc.
         c. Cooper B-Line, Inc.
         d. GS Metals Corp.
      2. Cable Tray Materials: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch thick.
a. Basket Cable Trays: Width as noted – 2 - 24 inches - and 4 inch deep. Wire mesh spacing shall not exceed 2 by 4 inches.

D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." Minimum size of conduit shall be 1 inch.
   1. Wall outlet boxes shall be 2 gang, with a single gang trim ring.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements in Division 06 Section "Rough Carpentry" for plywood backing panels.

2.3 UTP CABLE

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

B. Description: 100-ohm, 4-pair UTP.
   1. Comply with ICEA S-90-661 for mechanical properties.
   2. Comply with TIA/EIA-568-C.1 for performance specifications.
   3. Comply with TIA/EIA-568-C.2, Category 6A
   4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
      a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

2.4 UTP CABLE HARDWARE

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

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
   1. Number of Jacks per Field: One for each four-pair UTP cable indicated.

D. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

E. Patch Cords: Factory-made, four-pair cables in lengths determined by shop drawings of rack elevations (minimum length of 6 feet); terminated with eight-position modular plug at each end.
1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6A performance. Patch cords shall have latch guards to protect against snagging.

2.5 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-C.1.

B. Workstation Outlets: Provide with the number of ports as noted – 1, 2, or 4, ports - connector assemblies mounted in single faceplate.

   1. Floorbox Faceplate: Provide adapter plates to mount in the provided floorboxes for the appropriate cable solution being provided, ie. Commscope adapter plate for Commscope outlet connectors.
   2. Legend: Machine printed, in the field, using adhesive-tape label or snap-in, clear-label covers and machine-printed paper inserts.

2.6 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.7 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP cables on reels according to TIA/EIA-568-C.1.

C. Factory test UTP cables according to TIA/EIA-568-C.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.
PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES
A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS
A. Wiring Method: Install cables in raceways and cable trays except within cabinets. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in all spaces.
   2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."
B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer’s limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS
A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-B.
B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Section 271100 "Telecommunications Pathways and Spaces." Drawings indicate general arrangement of pathways and fittings.
C. Comply with TIA/EIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.
D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.
E. Install manufactured conduit sweeps and long-radius elbows whenever possible.
F. Pathway Installation in Termination Rooms (Telecom):
   1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
   2. Install basket cable trays to route cables from underfloor up into the floor mounted racks.
   3. Secure conduits to backboard when entering room from overhead.
   4. Extend conduits 3 inches above finished floor.
   5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
G. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.
3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
   2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
   3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches, not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
   6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
   7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   8. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
   9. For every horizontal cable pull, coil 5' 0" of excess cable at the MDF/IDF for future use.
   10. For every horizontal cable pull, coil 10' 0" of excess cable at the station end for future use.
   11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:
   2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
   3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Installation of Cable Routed Exposed under Raised Floors:
   1. Install plenum-rated cable only.
   2. Install cabling after the flooring system has been installed in raised floor areas.
   3. Coil cable 10 feet long not less than 12 inches in diameter at each feed point.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA/EIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING
A. Comply with requirements in Division 07 Section "Penetration Firestopping."
B. Comply with TIA/EIA-569-B, "Firestopping."
C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING
A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
B. Comply with ANSI-J-STD-607-A.
C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Administration Class: 4.
2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 4 level of administration.

E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications rooms, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

G. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
   a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
   b. Label each unit and field within distribution racks and frames.
4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-C.1.

2. Visually confirm Category 6 and Category 6A marking of outlets, cover plates, outlet/connectors, and patch panels.

3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. UTP Performance Tests:

a. Test for each outlet. Perform the following tests according to TIA/EIA-568-C.1 and TIA/EIA-568-C.2:

1) Wire map.
2) Length (physical vs. electrical, and length requirements).
3) Insertion loss.
4) Near-end crosstalk (NEXT) loss.
5) Power sum near-end crosstalk (PSNEXT) loss.
6) Equal-level far-end crosstalk (ELFEXT).
7) Power sum equal-level far-end crosstalk (PSELFEXT).
8) Return loss.
9) Propagation delay.
10) Delay skew.

D. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
F. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets. Include training in cabling administration software.

END OF SECTION 271500
SECTION 31 10 00
SITE CLEARING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Removal of trees, stumps, roots, and tree debris.
B. Clearing site of plant life, root systems and shrubs.
C. Removal of fences, fence posts, mailbox posts, and miscellany.

1.2 REFERENCES

A. NAA Standards:
   a. Pruning Standards for Shade Trees
B. Utah Shade Tree Pruning Standards

1.3 QUALITY ASSURANCE

A. Provide at least one person, who is familiar with NAA pruning standards for the type of tree involved, to be present during tree pruning operations.

1.4 SITE CONDITIONS

A. Repair or replace damaged trees and shrubs at no additional cost to OWNER.

1.5 PROTECTION

A. Protect roots and branches of trees to remain.
B. Construct temporary barricading at tree’s approximated drip line. Place continuous barricades at least three (3) feet high.
C. When setting posts, avoid damaging tree roots.
D. Do not permit heavy equipment or stockpiling of materials or debris within the barricaded area, or permit earth surface to be changed.
E. Provide water and fertilizer to maintain existing trees.

PART 2 - PRODUCTS

2.1 STUMP TREATMENT SOLUTION

A. Formulated to kill existing vegetation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The drawings do not purport to show all trees and shrubs existing on site.
B. Verify with ENGINEER which plantings are to be removed or to remain.
C. Tree root inspection:
   1. Assist ENGINEER by removing and replacing existing surface improvements.
   2. Cost of removals and replacements will be paid for using existing payment prices, or if none, then by using contract Modification prices.
3.2 PREPARATION

A. Locate utilities. Preserve utilities that are to remain in service, Section 31 23 16
B. Review work procedures with ENGINEER.
C. Schedule work carefully with consideration for property owners and general public.
D. Before starting, arrange for disconnection of all utility services that are to be removed or which interfere with work.

3.3 SITE CLEARING

A. Remove all vegetation outside of excavation, fill slope lines, and limits of slope rounding.
B. Remove fences, posts, appurtenances, and miscellaneous objects.

3.4 TREE REMOVAL

A. Remove branches, limbs, and debris.
B. Remove stumps and roots to 18 inches below proposed grade.
C. For stumps larger than six (6) inches caliper remove and treat as follows:
   1. Remove chips and debris from around remaining stump.
   2. Apply stump treatment solution in accordance with manufacturer's recommendations.
   3. Do not allow chemical solution to mist, drip, drift, or splash onto adjacent ground surfaces or desirable vegetation.
   4. Replace any existing vegetation damaged or killed through improper use of chemical at no additional cost to OWNER.

END OF SECTION
SECTION 31 20 00
EARTHWORK AND Dewatering

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section includes materials, testing and other requirements of earthwork for excavation, trenching, backfilling, compaction and grading necessary for the construction of the work. The excavation shall include the removal and disposal of materials of whatever material encountered, including all dewatering, and contaminated soils and groundwater removal, treatment and disposal, that would interfere with the proper construction and completion of the work.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The following is a list of standards which may be referenced in this section:

1. 29 CFR 1926, OSHA Safety and Health Standards for Construction.


5. ASTM C 618, Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.

6. ASTM D 75, Practice for Sampling Aggregates.

7. ASTM D 422, Test Method for Particle-Size Analysis of Soils.

8. ASTM D 1556, Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

9. ASTM D 1557, Test Method for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 \text{ft-lb/ft}^3).


12. ASTM D 2487, Classification of Soils for Engineering Purposes (Unified Soil Classification System).

13. ASTM D 2922, Test Methods for Density of Soil and Soil-Aggregate in
14. ASTM D 4253, Test Method for Maximum Index Density of Soils Using a Vibration Table.


1.3 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with the requirements of the submittals section.

B. Submit a description and location of proposed sources of imported material.

C. Submit samples of all materials proposed to be used in the Work to demonstrate material conformance with these Specifications. Sample sizes shall be as determined by the Construction Manager.

D. Test for conformance and submit certification and test records of all materials showing that they meet the applicable requirements. Obtain favorable review of test and certification submittals prior to commencing placement of the materials for the Work.

E. Perform material testing per this section.

F. Submit manufacturer catalog data, samples, and installation instructions for filter fabric, earth reinforcing systems with their related materials.

G. Submit property owner earthwork disposal site releases.

1.4 PROCESSED (OR IMPORTED) EARTH MATERIALS

A. Processed, or imported, earthen materials are subject to the following requirements:

1. Make all tests and other work necessary to locate acceptable processed materials. Submit certification(s) that the material conforms to the requirements along with copies of test results from a qualified commercial testing laboratory and representative samples of materials. Samples shall be representative and clearly marked to show material source and intended use. Sample processed materials per ASTM D75 or ASTM C136, with appendixes and provide compaction characteristics of
materials per ASTM D1557. Allowance of the processed material may be based on inspection of the source, processing method and/or certified test results. No processed materials shall be delivered to the site or used in the Work until the proposed source, processing methods, and materials tests have been allowed by the Construction Manager. Final allowance of materials will be based on tests made on samples of material taken from the installed and compacted material(s).

2. Make periodic tests on samples taken at the place of production prior to delivery to the site. Make tests at the rate of one test per day, one test per thirty trucks of material, or as requested by the Construction Manager, whichever is more. If tests show out of conformance materials, the Construction Manager may require increased frequency of tests. In addition, sample and test the finished in-place product. The Construction Manager may select the location of the samples and tests to be performed by the Contractor.

3. Submit gradation test results within 24 hours after sampling. Deliver other test results upon completion of the tests.

4. If tests conducted by the Contractor or the Construction Manager indicate that the material does not meet the requirements, the material placement shall be terminated until the requirements are met. Material that does not conform to the requirements and is placed in the Work shall be removed and replaced at no additional cost to the Owner. Sampling and testing performed by the Contractor shall be done at the Contractor’s expense.

1.5 MATERIALS TESTING

A. The Contractor shall perform and be responsible for all sampling and testing of materials as required for quality assurance/control of the Work. The Contractor shall pay for all costs associated with the day-to-day quality assurance/control to maintain all material within specified or approved limits. The Contractor shall retain a registered geotechnical engineer, independent from the Contractor, and a testing laboratory, whose qualifications are each acceptable to the Construction Manager by submittal, to perform all compliance testing described below. The Construction Manager may have an independent testing laboratory perform additional tests at no cost to the Contractor, however the Contractor shall provide materials for testing at no additional cost to the Owner.


C. Determine sand equivalent in accordance with ASTM D 2419. Unified Soil Classification System: References to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487. The Contractor shall be bound by all applicable provisions of ASTM D 2487 in the interpretation of soil classifications.

D. Where soil material is required to be compacted to a percentage of maximum
dry density, the maximum dry density at optimum moisture content will be determined in accordance with ASTM D 1557. In the field, determine the density of soil in place by the sand cone method, ASTM D 1556 or by nuclear methods, ASTM D 6938 and D 3017.

E. Apply rock correction factors as applicable. In case the test of the fill or backfill shows non-compliance with the required density, perform remedies as may be required to insure compliance. Subsequent testing to show compliance shall be by a testing laboratory selected by the Construction Manager and paid for by the Contractor.

F. Compaction tests shall be performed for each lift or layer. If nuclear methods are used for in-place density determination, verify the accuracy with one sand cone test, and one maximum laboratory dry density test, for every 2 weeks nuclear tests are used if the backfill material is processed fill or visually consistent. The Construction Manager shall be the sole judge of visual consistency. More sand cone and dry density tests will be required if the backfill material is visually variable. The minimum depth for the sand cone test hole shall be 12 inches. The minimum size shall be 8 inches and size 16/30 or 10/20 silica sand shall be used.

G. Determine laboratory moisture-density relations of soils by ASTM D 1557. If nuclear methods are used for in-place density determination, the compaction test results for maximum dry density and optimum water content shall be adjusted in accordance with ASTM D 4718. This will be required for determination of percent relative compaction and moisture variation from optimum.

H. Determine the relative density of cohesion-less soils by ASTM D 4253 and D 4254. Sample backfill materials by ASTM D 75. "Relative Compaction" is the ratio, expressed as a percentage, of the in-place dry density to the laboratory maximum dry density.

I. After an acceptable compaction procedure is established, compaction tests shall be taken at 300 foot intervals along the trench and at vertical intervals at random locations and not necessarily vertical in line. A minimum of two tests will be required for each production day in the trench. Tests shall also be taken near structures, manholes, etc., and where designated by the Construction Manager. Embankment and fill areas shall have at least one compaction test performed each production day and no fewer than one test for each 1,000 cubic yards. Copies of all test reports shall be submitted to the Construction Manager by the next working day.

J. Location for compaction tests shall be prepared and submitted to the Construction Manager for approval prior to testing.

K. Compaction and other tests may be taken by the Construction Manager at intervals along the trench as described above to verify compliance with these requirements. Accommodate the Construction Manager in conducting these tests. Provide access and exploratory excavation as required to collect samples or conduct tests. Allot sufficient time during construction for the performance of any such compaction testing.

L. Compaction shall be deemed to comply with the specifications when no
compaction test falls below the specified relative compaction. Pay the costs of any retesting of work not conforming to the specifications. Should the compaction methods used fail to achieve the required degree of compaction, revise compaction method to achieve the required compaction.

M. If a compaction fails to meet the specified requirements, remove and replace the backfill at proper density or bring the density up to specified level by other means acceptable to the Construction Manager. Pay for all subsequent tests required to confirm and verify that the reconstructed backfill has been brought up to specified density. Frequency of confirmation tests for remedial work shall be double that amount specified for initial confirmation tests.

1.6 DEFINITIONS

A. Pipe Zone: The pipe zone shall include the full width of trench from the bottom of the pipe bedding to a horizontal level above the top of the pipe, as specified below. Where multiple pipes or conduits are placed in the same trench, the pipe zone shall extend from the bottom of the lowest pipe bedding to a horizontal level above the top of the highest or topmost pipe. Thickness of pipe zone above the highest top of pipe or conduit shall be 12 inches unless otherwise shown in the Drawings or otherwise described in the specifications for the particular type of pipe installed.

B. Pipe Base or Bedding: The pipe bedding zone is defined as a layer of material immediately below the bottom of the pipe or conduit and extending over the full trench width on which the pipe is bedded. Thickness of pipe bedding zone shall be 6 inches minimum unless otherwise shown in the contract documents for the particular type of pipe installed.

C. Road Zone: The 12 inches of material immediately below the subgrade of existing and planned road pavements, shoulders, curbs and sidewalks.

D. Segregation: Nesting of larger particles in a soil mass such that finer particles do not completely fill the voids. Segregation also refers to lenses or layers of finer material that are not locally intermixed with coarser particles in accordance with the specified gradation.

E. Suitable Material: Suitable material is defined as selected or processed earth material free of expansive and deleterious material which conforms to these Specifications. Materials used shall meet the gradations and quality requirements of these Specifications.

F. Trench Zone: The trench zone includes the portion of the trench from the top of the pipe zone to the bottom of the road zone at gravel or asphalt surfaced roads or to the finished ground surface in areas without roads.

G. Unsuitable Materials: Unsuitable Materials include but are not limited to:

1. Soils which cannot be compacted sufficiently to achieve the density indicated for the intended use. See paragraph 2.06.C.

2. Soils which, when classified under ASTM D 2487, fall into the
3. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, and any material which may be classified as hazardous or toxic according to applicable regulations.

4. Soils that contain greater concentrations of chloride or sulfate ions, or have a soil resistivity or pH less than the existing on-site soils.

5. Topsoil, except as allowed below.

H. Well Graded: A earth material with a wide range of grain sizes so that the uniformity coefficient “Cu” is over 6.0. “Cu” is the ratio $(D_{60} / D_{10})$ = (the particle diameter at which 60% of the mass is finer than / the particle diameter at which 10% of the mass is finer than) with enough fines to bind the material together so that, when compacted, it produces a strong and relatively incompressible soil mass free of detrimental voids.

I. Dewatering: the pumping and/or draining, treatment and removal from construction site both groundwater and surface water (i.e. unwatering) to keep the construction work free from the deleterious effects of water in a manner that complies with all laws and regulations and does not damage adjacent lands and property. It includes water handling and conveying through the project site any water which comes into the site through rivers, creeks, sloughs, land drains, ditches (including irrigation ditches), springs, precipitation, groundwater, wells, and other means.

1.7 USE OF FILL AND BACKFILL TYPES

A. Fill and backfill types shall be used in accordance with the following provisions, unless otherwise shown on the Drawings:

1. Roadway or Fill Embankments: Use earth fill material.

2. Trench Backfill: Varies: see paragraph 2.5


4. Pipe Base or Bedding: Use pipe zone material.

5. Backfill Around Structures: Use structural backfill material.

6. Backfill beneath Structures: Use structural backfill under structures, unless noted otherwise.


8. For 20-feet outside vault walls, CLSM fill under pipelines the space above the excavated subgrade and the bottom of pipe zone.
PART 2 - MATERIALS

2.1 EARTH FILL/EARTH BACKFILL

A. Earth fill and earth backfill shall be excavated material that is free from organic matter, roots, debris, and rocks larger than 6-inches in the greatest dimension. Nested rocks larger than 3-inches are not allowed unless otherwise indicated on the plans and specifications. All fills shall be earth fills. Earth fill materials shall have an expansion index of not more than 40 when tested in accordance with ASTM D 4829.

2.2 STRUCTURAL BACKFILL

A. Structural backfill shall be free of clay balls and shall have a sand equivalent greater than 30 per ASTM D 2419 and have the following gradation:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 inch</td>
<td>100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>95—100</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>50—100</td>
</tr>
<tr>
<td>No. 4</td>
<td>20—65</td>
</tr>
<tr>
<td>No. 8</td>
<td>10—40</td>
</tr>
<tr>
<td>No. 40</td>
<td>0—20</td>
</tr>
<tr>
<td>No. 20</td>
<td>0—5</td>
</tr>
</tbody>
</table>

Material excavated onsite may be used for structural backfill provided it conforms to this specification.

2.3 PEA GRAVEL

A. Pea gravel shall be the same material as Drain Rock, except the maximum particle size shall be ½ inch.

2.4 PIPE ZONE MATERIAL

A. Use imported pipe zone material as follows: a processed, well-graded, compactible sand or gravel per AASHTO M145 A-1-a with 3/4-inch max particle size and between 5% and 15% fines (per ASTM C117) for binder. Compact pipe zone to 90% relative compaction per ASTM D1557.

B. Alternately, use controlled low strength material (CSLM) per paragraph 2.10.

2.5 TRENCH ZONE MATERIAL

A. Use imported pipe zone material.

2.6 DRAIN ROCK
A. Drain rock, or crushed rock, shall consist of hard, durable particles of stone, crushed to the required gradation shown below per AASHTO T-27 or ASTM C 136, and shall be free from organic matter, lumps of clay, and other deleterious matter:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch</td>
<td>100</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>90—100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>30—60</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>0—20</td>
</tr>
<tr>
<td>No. 4</td>
<td>0—5</td>
</tr>
</tbody>
</table>

2.7 SAND

A. Sand shall be granular material free from clay balls, organic matter, and other deleterious substances. Sand shall have a sand equivalent of 30 per ASTM D 2419 and conform to the following gradation:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>75—100</td>
</tr>
<tr>
<td>No. 30</td>
<td>12—50</td>
</tr>
<tr>
<td>No. 100</td>
<td>5—20</td>
</tr>
<tr>
<td>No. 200</td>
<td>0—10</td>
</tr>
</tbody>
</table>

B. Test sand to see that it is not salty or corrosive to steel as follows:

1. Electrical Resistivity shall be greater than 10,000 ohm-cm (per ASTM G-57, soil box method)
2. PH shall be greater than 7 (per ASTM G-52)
3. Chloride shall be less than 50 mg/kg of soil (EPA Test Method 325)
4. Sulfate shall be less than 100 mg/kg of soil (EPA Test Method 375)

2.8 WATER FOR COMPACTION

A. Water shall be free of organic materials, a pH of 7.0 to 9.0, a max chloride concentration of 500 mg/L, and a max sulfate concentration of 500 mg/L. Provide all work needed to transport water for earthwork including piping, valves, pumps and trucks, to convey water to the point of use.

2.9 CONTROLLED LOW STRENGTH MATERIAL (CLSM)
A. CLSM shall consist of a mixture of Portland cement, aggregate, fly ash, water, and admixtures conforming to the following:

1. Portland Cement: ASTM C 150, Type II.

2. Aggregate: Concrete sand, or processed material from the excavations meeting the requirements of sand as herein specified. Aggregate size shall be maximum 3/8 inch per ASTM C 33. The soluble sulfate content, shall not exceed 0.3 percent by dry weight.


4. Fly Ash: Class C per ASTM C 618.

5. The minus 200 sieve fraction shall be non-plastic.

B. CLSM shall be flowable, non-segregating, self-consolidating and non-shrink.

C. The unconfined compressive strength at 28 days shall be a minimum of 50 and a maximum of 150 psi per ASTM D 4832. For bidding, assume 100 pounds of cement and 100 pounds of fly ash per cubic yard of CLSM.

D. Sample CLSM at least once a day, four cylinders each time. Perform two cylinder breaks per four-cylinder sample at 7 days, the same as for concrete. Do not move cylinders for 72 hours after making.

E. The temperature of the CLSM discharged into the trench shall be below 70 degrees and above 45 degrees Fahrenheit. Do not place CLSM if ambient temperatures are below 10 degrees F.

F. The aggregate, cement, and water shall be proportioned either by weight or volume. The water content shall be sufficient to produce a fluid, workable mix that will flow and can be pumped without segregation of the aggregate while being placed. Prepare CLSM in accordance with ASTM C 94.

G. Water content shall match trial batch content. Do not add water after batching.

2.10 ROCK REFILL (OR TRENCH STABILIZATION MATERIAL)

A. Rock refill shall be crushed rock free from clay balls, organic material, and debris, and having the following gradation:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 inches</td>
<td>100</td>
</tr>
<tr>
<td>1-1/2 inches</td>
<td>80—100</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>5—30</td>
</tr>
<tr>
<td>No. 4</td>
<td>0—8</td>
</tr>
</tbody>
</table>
2.11 GEOTEXTILES

A. See Section 31 35 00, Geotextiles

2.12 NATIVE BACKFILL

A. Native material obtained from project excavations may not be used as backfill.

PART 3 - EXECUTION

3.1 GENERAL

A. Earth Stockpile Limitation to Protect Pipelines from Differential Settlement. Protect installed pipelines after installation from differential settlement of ground as follows. After backfilling water, sewer or storm drain pipelines, do not ever allow over 3-feet of stockpile or fill to be placed above existing grade within 15-feet horizontally of the pipe.

B. Prevent dust from damaging homes, businesses, public and private facilities, crops, cultivated fields, and other improvements, or causing a nuisance to persons. Perform dust control for the duration of the project.

C. Legally dispose of all excavated materials unsuitable for backfill, and other unused excavated materials. Excavated materials suitable for backfill may temporarily be stored at the site so as not to interfere with public traffic or concurrent work or to mix with other stockpiled material.

D. Provide adequate facilities for drainage of water from stockpiled excavated material and adequate facilities for handling of storm drainage from storage and other area.

3.2 DEWATERING

A. Contractor bid shall include all costs to plan, coordinate, and perform all dewatering and handle all groundwater and all surface water for the duration of the project work.

B. Perform all required dewatering and water handling regardless of quantity or quality of water encountered. Include all costs for water handling and dewatering in the project bid regardless of the quantity or quality of the water.

C. Provide and operate equipment adequate to keep excavations and trenches free of water. Dewater subgrade to below bottom of excavation. Keep trench dewatered until backfilling has been completed. Remove water during period when CLSM is being deposited, when pipe is being installed, and during the placing of backfill. Prevent settlement of pipe and all nearby pipes and structures.

D. Dispose of water in a manner that will not damage adjacent property. When dewatering open excavations, dewater from outside the structural limits and from
a point below the bottom of the excavation.

E. Obtain and comply with applicable UPDES discharge permits when discharging into any waterway.

F. Design, furnish, install, operate, monitor, maintain, and remove dewatering systems such that the dewatering system is sufficient to render and maintain required excavations in a dewatered and hydrostatically relieved condition (including at the bottom of the excavation), and allow required excavations and other construction operations to be performed in the dry.

G. The dewatering system shall include all equipment, appurtenances, and earthwork required to perform the function. Contractor is responsible for the dewatering system performance. Provide adequate pumping, piping and other equipment to accomplish dewatering. Such equipment shall include, but may not be limited to sumps, wells, motor and/or engine driven pumps with adequate lift capacity, discharge piping, hoses and pipelines, valves, intakes, and flow measuring devices.

H. Construct trenches with DIP fittings to prevent surface runoff from running into trenches and leaving salt deposits in trenches. Prevent excessive storm runoff and irrigation runoff from entering excavations and from damaging the work. Remove seepage water and precipitation water from excavations. In addition to dewatering of the trench excavation and adjacent areas, perform other dewatering as necessary to maintain the construction operations free of water and permit construction unhampered by the presence of water that may interfere with construction, damage in-place work or excavated surfaces, or cause other adverse effects.

I. Locate, construct and maintain ditches and/or sumps to collect and control seepage and runoff into excavations. Locate, construct and maintain ditches to prevent ponded water from seeping into, and adversely affecting, adjacent lands and facilities.

J. If Owner-provided lands are to be used for de-silting settling ponds, liners may be needed if native soils are porous and/or result in excessive infiltration into adjacent construction trenches.

K. Damage to the work, including work in place and excavations, including bottom heave, and floating of pipeline, resulting from negligence, inadequate performance, or mechanical or electrical failure of dewatering system components shall be repaired or replaced, including removal and replacement of material and pumping out excavations, by and at the expense of the Contractor, subject to approval by Construction Manager and SLCDPU.

L. Restore areas used for dewatering ditches and ponds, to their pre-construction condition (after the work is complete).

M. The dewatering systems shall be designed consistent with sound engineering principles and practices, in accordance with best modern practice, and in accordance with the following:

1. Experience: The dewatering systems shall be designed by a registered...
professional engineer or hydrogeologist with a minimum of five years of responsible experience in the design, installation, and operation of dewatering systems of complexity comparable to that required for this contract. All designs drawings, calculations, data, and other documents shall bear the designer’s seal.

N. Submittal of the dewatering systems is required. The dewatering systems shall be designed consistent with sound engineering principles and practices, in accordance with best modern practice, and in accordance with the following:

1. Experience: The dewatering systems shall be designed by a registered professional engineer or hydrogeologist with a minimum of five years of responsible experience in the design, installation, and operation of dewatering systems of complexity comparable to that required for this contract. All designs drawings, calculations, data, and other documents shall bear the designer’s seal.

2. Data: Logs of borings and other soil and water-level data are addressed in the geotechnical report. It shall be the Contractor's responsibility to gather any additional data necessary to properly design the dewatering systems, and the work shall be performed at the Contractor's expense.

3. Dewatering:
   a. Portable electric generators utilized shall have 100 percent standby electric-generating equipment.
   b. The electrical system and controls shall be designed so that failure of any one pump, or the need to disconnect a pump, does not adversely affect operation of any other pump.
   c. Petroleum-fueled (diesel, liquid petroleum gas, gasoline) driven units utilized shall have 100% standby equipment.

4. Facilities for dewatering shall include discharge lines, flow-measuring devices, settling ponds, treatment facilities, and supplemental pumping capacity to provide the necessary lifts to discharge water as needed.

O. Installation and operation of the dewatering system shall be under the direct supervision of qualified personnel with a minimum of five years of responsible experience in the installation and operation of dewatering systems of complexity comparable to that required for this contract. The dewatering representative shall be responsible for ensuring that all materials, equipment, methods, and procedures utilized in the installation, operation, and maintenance of dewatering system conform to the requirements of:

1. The UDWQ approved dewatering plan, and
2. All State and local statutes; conducting all required testing, inspection, and monitoring of the dewatering system.

P. System maintenance shall include, as a minimum, 24-hour supervision by
personnel skilled in the operation, maintenance, and repair and replacement of system components, and sufficient standby and spare equipment and features to effectively prevent interruption in dewatering operations.

Q. Desilting ponds and dewatering operations shall not interrupt the ability of the land owner to irrigate or drain their land of irrigation, precipitation, and artesian groundwater / spring water.

R. De-silting pond inverts shall not be more than about 18 inches below original ground. Stockpile topsoil removed for de-silting pond construction and restore it to pre-construction depth and location when ponds are removed. Provide adequate freeboard for all de-silting ponds. Maintain de-silting ponds by removing sediment when pond is 30 percent full of sediment.

S. Incorporate erosion control SOPs into trench dewatering and de-silting facilities to avoid or minimize adverse ground and surface water quality impacts.

T. Maintain ditches downstream of de-silting ponds free of debris and sediment to prevent flooding or other adverse impacts downstream.

3.4 SUPPORT OF EXCAVATIONS

A. See Section 31.20.01, UTILITY TRENCHES.

3.5 EXCAVATION

A. Excavation is unclassified.

B. Perform all excavation (including dewatering and rock removal) – as part of the work in the Bid Schedule - regardless of the type, nature, or condition of the material encountered to accomplish the Work.

C. Where trenching or excavation occurs in paved areas, saw cut the pavement, regardless of the thickness, and curbs, gutters, and sidewalks prior to excavation of the trenches with a pavement saw or pavement cutter. Remove and dispose of pavement and concrete materials off the site in accordance with local regulations. Do not use for backfill.

D. Perform excavation for structures and pipelines to comply with the dimensions, clearances and grades indicated for the structures and pipelines. Excavate to such width outside the lines of the structure to be constructed as may be required for proper and safe working methods, the erection of forms, and the protection of the work.

E. At excavation subgrades for structures compact the top 12 inches of subgrade to 95 percent relative compaction. Fill holes and depressions to the required line, grade, and cross sections with structural backfill or other material approved by the Construction Manager.

F. The finished subgrade for structures shall be within a tolerance of plus or minus 0.10 of a foot of the grade and cross section indicated, shall be smooth and free from irregularities, and shall be at the specified relative compaction.
subgrade shall be considered to extend over the full width and extend 1 foot beyond the edge of the structure foundation or the fill.

G. Notify the Construction Manager when excavations for structures are complete. Do not place forms, reinforcing steel, concrete, or precast structure until the excavated area has been inspected by the Construction Manager.

H. Excavation shoring systems shall be designed consistent with sound engineering principles and practices, in accordance with best modern practice, and in accordance with the following:

- Experience: The shoring systems shall be designed by a registered professional engineer with a minimum of five years of responsible experience in the design, installation, and operation of shoring systems of complexity comparable to that required for this contract. All designs drawings, calculations, data, and other documents shall bear the designer’s seal.
- Submittal of the shoring systems shall is required.

3.6 TRENCH EXCAVATION

A. Remove and stockpile native soils and topsoils separately.

B. Construct the trench to the grades and shapes as indicated on the plans. Accurately grade the bottom of the trenches to provide uniform bedding areas for each section of pipe except for portions of pipe sections where bell holes are required to weld joints. Excavate bell holes and depressions to the depth and width required to properly complete and inspect the joint. Remove stones and hard objects protruding above grade as necessary to avoid point bearing.

C. Locate trench stockpiled material at least 15 feet away from the tops of open trench excavation slopes.

D. Place excavated material within the construction limits or within another location acceptable to Construction Manager. Do not obstruct any roadways or streets. Conform to federal, state, and local codes governing the safe loading of trenches with excavated material and equipment.

E. After setting pipe to grade, do not jerk or move shoring in such a way as to cause pipe to be out of grade. After pipe is welded and initial CLSM is placed, such that pipe will not move, slide rail shoring may be moved.

F. Provide room (typically 18-inches min) between pipe and trench invert/walls/shoring - to allow for manned entry for welding, joint coating, and inspection.

G. Pipe zone and compacted trench zone materials shall extend to edge of excavated trench, not to inside face of shoring. Fill gaps left when shoring is removed. If trench is excavated beyond that required, refill over excavated trench at no additional cost to the Owner with the pipe zone and trench zone materials required in specs.
3.7 LENGTH OF OPEN TRENCH
A. Limit open trench length to 600 feet or the amount of pipe installed in 1 day, whichever is less.
B. During nonworking hours, cover trenches or fence-enclose them.
C. Native slope and trench wall collapses into an open excavation during construction are the complete responsibility of the Contractor. This includes any clean-up work, re-excavation, re-backfill and compaction or related work to complete the pipeline as it is required in the plans and specifications.

3.8 OVEREXCAVATION
A. Wrap trench bottom stabilization material in geotextile to prevent fines migration into the open graded rock. Over-excavation is always allowed as required to construct trench dams.
B. No additional payments will be made for over excavation and placement of structural backfill, rock refill, or other suitable material not required by the contract or directed by the Construction Manager. No compensation will be made for over excavation and placement of such material for the Contractor’s convenience.

3.9 COLD WEATHER LIMITATIONS IN PLACING FILL AND BACKFILL
A. Unless allowed in the authorized Cold Weather Construction Plan, earth fills and backfills requiring 95 percent or higher relative compaction shall not be placed when either atmospheric temperature, or the temperature of the existing ground or the fill being placed, are below 35 degrees Fahrenheit unless both the existing ground and the fill being placed are both non-frost susceptible materials.
B. Earth fills and backfills requiring 90 percent or lower relative compaction may be placed when temperatures are below 35 degrees Fahrenheit if the required compaction is achieved. If the required compaction is not achieved, the work shall be removed and re-compacted.
C. Do not place any fill or backfill materials which require 95 percent, or higher, relative compaction if the excavation or subgrade contains frozen moisture (snow, ice, sleet, etc.), frozen earthen materials, or earthen materials which have been deposited in the excavation due to freezing, thawing, precipitation, or other inappropriate means.
D. Do not place fill materials which contain frozen moisture (snow, ice, sleet, etc.) except as allowed in the paragraphs above.
E. Work performed outside the required temperature limitations is subject to rejection, removal and replacement.

3.10 PLACING AND COMPACTING FILL
A. Remove form materials and trash from excavation before placing fill material. Remove un-compacted fill, loose and disturbed soils until firm soils or formational material are exposed. Removed materials may be used as compacted fill if they meet specifications.

B. Under earth fills, scarify the exposed surface to a depth of 6 inches, moisture condition to within 2 percent of optimum moisture content, and compact to at least 95 percent relative compaction.

C. Obtain Construction Manager inspection and authorization to begin backfill on the exposed surface before starting placement of fill.

D. Add water to the backfill material or dry the material, as necessary, to obtain a moisture content within 2 percent of optimum. Obtain a uniform moisture content throughout the material of each layer being compacted.

E. If the backfill material is saturated from groundwater, rains or any other source, remove and replace the unsatisfactory material with suitable material compacted to the specified density. No additional payment will be made for removal and replacement of unsatisfactory material.

F. Where earth fills are to be constructed on slopes steeper than 5:1, excavate an equipment width keyway beneath the toe at the base of the fill. The keyway will have a minimum width of 10 feet and slope at least 2 percent into the slope. Continue benching into competent material as the fill progresses up slope. All benching shall be inspected and authorized by the Construction Manager before fill placement begins.

G. Place all fills in 6- to 8-inch lifts, brought to within 2 percent of optimum moisture content, and compacted to 90 percent min relative compaction. Do not place rocks larger than 6 inches in maximum dimension in the fills.

H. Provide special attention to compaction along the top and outer edge of the earth fill slopes during construction. Back roll fill slopes after each fill lift is completed. Perform additional rolling and trimming as may be required at the finish of the slope construction to correct local surficial slumping.

3.12 PLACING AND COMPACTING STRUCTURAL BACKFILL

A. Place structural backfill material around structures, channels, vaults, manholes, and other structures to the lines and grades shown or specified. Limit loose lift depths to 8 inches or less, or, if hand compaction equipment is used, limit loose lift depths to 6-inches or less.

B. Compact each lift as hereinafter specified. Stop structural backfill at least 6 inches below finished grade in areas where topsoil is to be replaced.

C. Do not operate earthmoving equipment within 5 feet of any concrete structure. Structural backfill shall not be placed until the concrete has developed to at least 75 percent of the minimum 28-day compressive strength, and in all cases not less than 24 hours after the last pour.

D. Place and compact fill or backfill adjacent to concrete structures using hand-
operated tampers, roller wheels, or other equipment that shall not damage structure.

3.13 BACKFILL OF TRENCHES (AND FILLS) AND COMPACTION

A. Unless otherwise shown in the plans or specifications, relative compaction in shall conform to ASTM D 1557 (modified proctor) and shall be as follows:

<table>
<thead>
<tr>
<th>Location or Use of Fill</th>
<th>Relative Compaction (Unless Noted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trench Zone not under structures, pavement or roads</td>
<td>90 percent (but do not compact for 6&quot; below topsoils)</td>
</tr>
<tr>
<td>Trench Zone if pipes are under paved (AC or conc) or gravel roads and within 10-feet horizontally of paved or gravel roads (i.e. existing and future road shoulders), under future roads and future fills, sidewalks, curbs, beside structures and below slopes 2:1 or steeper.</td>
<td>95 percent or 80 percent relative density</td>
</tr>
<tr>
<td>CLSM Pipe Zone - sewer or water pipes</td>
<td>50 psi to 150 psi</td>
</tr>
<tr>
<td>Granular Pipe Zone (AASHTO M145 A-1-a) alternate pipe zone for water pipes</td>
<td>95 percent or 80 percent relative</td>
</tr>
<tr>
<td>Trench Bottom Stabilization</td>
<td>85 percent, or 75 percent relative density</td>
</tr>
<tr>
<td>Drain Rock under concrete structures</td>
<td>95 percent or 80 percent relative</td>
</tr>
<tr>
<td>Backfill and fill around structures</td>
<td>95 percent</td>
</tr>
<tr>
<td>Topsoils</td>
<td>Uncompacted</td>
</tr>
<tr>
<td>Aggregate base (road base) &amp; aggregate surfacing for access roads &amp;</td>
<td>97 percent</td>
</tr>
<tr>
<td>Road Zone</td>
<td>95 percent</td>
</tr>
</tbody>
</table>

B. Place bedding and backfill materials to the lines, grades, and cross sections indicated on the Plans. Place bedding and backfill materials in horizontal, uncompacted lifts not exceeding 8 inches in thickness. The difference in level on either side of a pipe shall not exceed 12 inches.

C. Protect the pipe from damage during construction. Replace or repair broken or damaged pipe or pipe coatings. For tamping of backfill over the pipe, use tampers, vibratory rollers, and other equipment that shall not injure or disturb the pipe. Carefully place backfill around and over the pipe and do not allow it to fall directly upon the pipe to prevent coating damage. Place backfill material carefully and evenly onto the backfill previously placed in the pipe zone to prevent lateral movement of the pipe. Do not permit free fall of the material until
at least 2 feet of cover is provided over the top of the pipe. Do not drop sharp, heavy pieces of material directly onto the pipe or the tamped material around the pipe.

Backfilling of the trench above the pipe zone shall not proceed until the required strength of CLSM in pipe zone has been tested, verified, and accepted by the Construction Manager. Do not allow construction traffic over the pipe trench until the trench backfill has been compacted to a depth of over 3 feet above the top of pipe.

### 3.14 CLSM PLACEMENT AND SLIDE RAIL SHORING REMOVAL

A. After surveying and setting pipe to grade, and before welding joints, do not pull up lower slide rail panels as this causes rock refill material (under pipe zone) to flow under panel and the pipe drops and becomes out of grade.

B. Complete pipe joint field welding and joint coating.

C. Place a CLSM “stiff mix” saddle over (to top of pipe zone) and around pipe at intervals that leave bottom of pipe zone with no CLSM between “stiff mix” saddles. Obtain initial set of “stiff mix” saddles. This helps lock WSP into surveyed grade before placing the rest of the CLSM.

D. Place “fluid mix” CLSM in lower part of pipe zone in a way that prevents the pipe from floating. While it is fluid, pull up lower slide rail panels to just below top of the CLSM just placed. Obtain initial set of initial “fluid mix” CLSM.

E. Place additional CLSM “fluid mix” layers in a way that prevent the pipe from floating. While it is fluid, pull up lower slide rail panels to just below top of CLSM just placed. Obtain initial set of each CLSM layer before placing the next layer.

F. When CLSM placement is complete to top of pipe zone, place and compact trench zone material while raising upper slide rail panels so that voids left below removed slide rail panels are filled with material compacted to trench zone requirements.

G. As upper slide rail panels are removed, remove disturbed native earth materials (used as backfill outside slide rail shoring) at the upper sides of trench and replace them with trench zone material compacted to trench zone compaction requirements.

### 3.15 OTHER CLSM PLACEMENT REQUIREMENTS

A. Do not place CLSM when ambient daytime air temperatures in trench exceed 95 degrees Fahrenheit. If daytime ambient air temperatures in trench exceed 95 degrees Fahrenheit, Contractor shall submit a written plan to the Construction Manager that identifies how Contractor will address temperature control issues when placing the CLSM.

B. Deliver the CLSM to the trench in ready mix trucks and use pumps or chutes to place the CLSM in the trench. Do not add water after batching. Submit strength break data for both the CLSM “stiff mix” and the CLSM “fluid mix”.

C. Maintain stability of pipe and conduit throughout CLSM placement and curing.
CLSM will likely require placement in lifts to prevent pipe flotation. No movement of the pipe caused by flotation will be allowed. If any movement occurs, the CLSM material shall be removed and the pipe placed back on line and grade. Any damage to the pipeline system caused by movement of the pipe shall be removed and/or repaired in full conformance with these Contract Documents at no additional cost to Owner. Remove all sloughed material or other debris from top of previously placed CLSM.

D. Prior to placing pipe zone or trench zone material above CLSM the CLSM shall be allowed to cure a minimum of 24 hours and achieve enough strength such that when walking on CLSM produces no indentations. A shorter cure period will be allowed if it can be demonstrated to the Construction Manager that it will perform its functions (to prevent pipe flotation and/or support pipe and trench zone material).

3.16 COLD WEATHER CLSM PLACEMENT AND CURING

A. Comply with cold weather placement of CLSM submittals. CLSM placed or cured outside the temperature limitations identified herein is subject to rejection, removal and replacement.

B. If freezing temperatures are imminent, maintain CLSM at a temperature above 40°F for seven (7) days after placement. CLSM mix and native trench soils (to 12-inches below trench face, floor and walls) must all be 40°F or greater at time of placement. Determine temperature by placing thermometer in CLSM or native soils immediately after sampling CLSM at placement site.

C. When freezing weather appears imminent, make ready at the placement site insulation and other materials for CLSM protection which have been identified in the cold weather placement of CLSM submittal accepted by Construction Manager. Delay placement of CLSM until adequate provisions for protection against weather are made. Do not place CLSM bedding when the trench bottom or walls are frozen or contain frozen material.

D. CLSM Curing: If during CLSM curing, temperatures are below 40 degrees, protect CLSM by insulation as allowed in the cold weather placement of CLSM submittal. Do not place CLSM if ambient temperatures are below 10 degrees F. If CLSM is kept above 40 degrees F until at least 18-inches fill or backfill is placed over the curing CLSM, no further cold weather protection is required if ambient temperatures are over 10 degrees F and no ambient forced air is circulating through pipe. The native earth temperatures typically keep both the buried pipe and the CLSM above 40 degrees F.

3.18 SITE GRADING

A. Perform earthwork to the lines and grades shown on the Plans. Shape, trim, and finish slopes to conform with the lines, grades, and cross sections as shown. Remove exposed roots and loose rocks exceeding 3 inches in diameter. Round tops of banks to smooth curves to not less than a 6-foot radius. Neatly and smoothly trim rounded surfaces. Over excavation and backfilling to achieve the proper grade shall not be permitted.

B. Shape, trim, and finish slopes around structures as shown on Plans. Maintain a 2 percent grade away from all structures for a minimum of 2 feet all around.
C. Provide positive drainage away from all structures.

D. Except where new finished grades are specifically shown, grade the right-of-way to the contours of the original ground and match the adjacent undisturbed ground. Make surfaces free of all cleared vegetation, rubbish, and other construction wastes. Dispose of all excess excavation, surface rocks, and spoil.

3.19 DISPOSAL OF EXCESS MATERIALS

A. Haul excavated materials from the work site to approved disposal location(s) during the hours permitted in accordance with local traffic control regulations. Provide traffic control as required by the agency having jurisdiction. Material may be stockpiled temporarily at locations on the work site if approved in writing by Construction Manager.

3.20 TOPSOIL REPLACEMENT

A. Replace topsoil after completion of backfilling, compaction, and site grading. With the exception of at the working platform, permanent access roads, structures and rip rap, replace topsoil in the same areas and to the same depths from where the topsoil was originally removed except where imported topsoil is required by the Construction Manager per Sections 31 11 00. Replace topsoils after construction.

END OF SECTION
SECTION 31 20 01
UTILITY TRENCHES

SECTION 31 20 01 – UTILITY TRENCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Earthwork shall include all structural excavation and trench excavation activities as required to complete the Work under wet and dry conditions in whatever material or class of material is encountered, including all of the following:

1. Contacting and notifying underground utilities, no less than 48-hours before excavating.
2. Compliance with State and Federal safety regulations.
3. Designing, furnishing, placing, and removing all sheeting, shoring and bracing needed to safely support sides of utility trenches.
4. Compliance with applicable agencies’ permit conditions for work in public or railroad right-of-way, and for work on private property.
5. Loosening, excavating, removing, loading, and transporting excess soil from excavations.
6. Stockpiling, exporting and importing material.
7. Pumping, ditching, draining, and other required measures to remove or exclude water.
8. Supporting and protecting structures above and below ground.
9. Maintaining trees which are not permitted to be removed.
10. Preparing and stabilizing subgrade for pipe and structures.
11. Backfilling around structures and all backfilling of trenches.
12. Compaction testing.
13. Legal disposal of cleared, grubbed and excess excavated materials.
14. Restoring fences and other disturbed property.
15. All other incidental earthwork and supplementary operations needed to complete the Work.

B. Except as modified herein, earthwork shall conform to Standard Specifications for Public Works Construction (Greenbook) Section 300.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES

A. ASTM C143 Slump of Hydraulic Cement Concrete
B. ASTM C136 Sieve Analysis of Fine and Coarse Aggregates

C. ASTM D1556 Density and Unit Weight of Soil in Place by the SandCone Method

D. ASTM D1557 Laboratory Compaction Characteristics of Soil Using Modified Effort

E. ASTM D2922 Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)

F. ASTM D4253 Maximum Index Density and Unit Weight of Soils Using Vibratory Table

G. ASTM D4254 Maximum Index Density and Unit Weight of Soils and Calculation of Relative Density

1.4 DEFINITIONS

A. Pipe Zone: The pipe zone shall include the full width of trench from the bottom of the pipe bedding to a horizontal level above the top of the pipe, as specified below. Where multiple pipes or conduits are placed in the same trench, the pipe zone shall extend from the bottom of the lowest pipe bedding to a horizontal level above the top of the highest or topmost pipe. Thickness of pipe zone above the highest top of pipe or conduit shall be 12 inches unless otherwise shown in the Drawings or otherwise described in the specifications for the particular type of pipe installed.

B. Pipe Base or Bedding: The pipe bedding zone is defined as a layer of material immediately below the bottom of the pipe or conduit and extending over the full trench width on which the pipe is bedded. Thickness of pipe bedding zone shall be 6 inches minimum unless otherwise shown in the contract documents for the particular type of pipe installed.

C. Road Zone: The 12 inches of material immediately below the subgrade of existing and planned road pavements, shoulders, curbs and sidewalks.

D. Trench Zone: The trench zone includes the portion of the trench from the top of the pipe zone to the bottom of the road zone at gravel or asphalt surfaced roads or to the finished ground surface in areas without roads.

E. Unsuitable Materials: Unsuitable Materials include but are not limited to:

1. Soils which cannot be compacted sufficiently to achieve the density indicated for the intended use. See paragraph 2.06.C.

2. Soils which, when classified under ASTM D 2487, fall into the classifications of Pt, OH, CH, MH or OL.

3. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, and any material which may be classified as hazardous or toxic according to applicable regulations.

4. Soils that contain greater concentrations of chloride or sulfate ions, or have a soil resistivity or pH less than the existing on-site soils.

5. Topsoil, except as allowed below.

F. Dewatering: the pumping and/or draining, treatment and removal from construction site both groundwater and surface water (i.e. unwatering) to keep the construction work free
from the deleterious effects of water in a manner that complies with all laws and regulations and does not damage adjacent lands and property. It includes water handling and conveying through the project site any water which comes into the site through rivers, creeks, sloughs, land drains, ditches (including irrigation ditches), springs, precipitation, groundwater, wells, and other means.

1.5 SUBMITTALS

A. Furnish the following submittals.

<table>
<thead>
<tr>
<th>SUBMITTAL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catalog Data</td>
<td>Required for soil sterilants per catalog data requirements.</td>
</tr>
<tr>
<td>Certificate of Compliance</td>
<td>Submit affidavit of compliance with OSHA requirements prior to beginning excavation on any trench or excavation. Affidavit shall certify compliance with all shoring, bracing, sloping or other protective system provisions required by OSHA for worker protection from the hazard of caving ground during excavation.</td>
</tr>
<tr>
<td>Pipe warnings and markings</td>
<td>Submit pipe warning tape manufacturer data. Submit magnetic marker manufacturer data.</td>
</tr>
</tbody>
</table>

1.6 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary trades and crafts and who are completely familiar with the specified requirements and methods needed for proper performance of the work of this section.

1.7 USE OF FILL AND BACKFILL TYPES

A. Fill and backfill types shall be used in accordance with the following provisions, unless otherwise shown on the Drawings:

1. Trench Backfill: Varies: see paragraph 2.07.
2. Pipe Zone: Use pipe zone material.
3. Pipe Base or Bedding: Use pipe zone material.
4. Backfill around Structures: Use structural backfill material.
5. Backfill beneath Structures: Use structural backfill under structures, unless noted otherwise.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Refer to Section 31 20 00 for basic requirements for products and materials.

B. Soil and backfill materials shall be prepared to the following specifications:
<table>
<thead>
<tr>
<th>ITEM</th>
<th>MATERIAL</th>
<th>SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granular soil</td>
<td>Sand or gravel</td>
<td>Minimum sand equivalence of 30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not more than 20% of the material shall pass through a 200-mesh sieve.</td>
</tr>
<tr>
<td>Imported sand</td>
<td>Sand</td>
<td>Minimum sand equivalence of 30</td>
</tr>
<tr>
<td>Suitable soil material</td>
<td>Imported or excavated</td>
<td>Material free from shale, sod, stones, concrete and clods over (2 inches / 4 inches) in diameter, roots, trash, lumber, organic material, ashes and other debris considered unsuitable by the Owner. Material shall have no unusual color or sulfide odor. Compact to specified densities.</td>
</tr>
<tr>
<td>Backfill for over-exca-vation beneath pipes</td>
<td>Concrete slurry</td>
<td>1-sack cement-sand slurry mix</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maximum 6-inch slump per ASTM C143</td>
</tr>
<tr>
<td>Backfill for over-exca-vation beneath structures</td>
<td>Concrete</td>
<td>Section 31 23 33 Class A</td>
</tr>
<tr>
<td>Backfill for over-exca-vation beneath general excavation</td>
<td>Suitable soil material</td>
<td>ASTM D1557 or 90% compaction</td>
</tr>
<tr>
<td>Loose ground remaining after stripping</td>
<td>Suitable soil material</td>
<td>ASTM D1557 or 90% compaction</td>
</tr>
<tr>
<td>Structural excavation and fill</td>
<td>Suitable soil material</td>
<td>ASTM D1557 or 90% compaction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Place in 8-inch maximum lifts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remove stones larger than 6 inches in diameter.</td>
</tr>
<tr>
<td>Pipe Zone and Pipe Bedding material</td>
<td>See Below</td>
<td></td>
</tr>
<tr>
<td>Trench zone material</td>
<td>See Below</td>
<td></td>
</tr>
<tr>
<td>Surface zone material</td>
<td>Topsoil</td>
<td>ASTM D1557 80% compaction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maximum lifts vary with equipment. See below.</td>
</tr>
</tbody>
</table>

C. The following product design and physical criteria are required:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-site material</td>
<td>Material obtained from required site excavations</td>
</tr>
<tr>
<td>Import material</td>
<td>Owner approved material obtained from off-site borrow areas.</td>
</tr>
<tr>
<td>Structure backfill</td>
<td>When material for the excavation is unsuitable for use in backfill, it shall be disposed of off-site and suitable material that is capable of being compacted to the required relative density shall be arranged for and furnished by the Contractor at his expense.</td>
</tr>
<tr>
<td>Structure bedding</td>
<td>Slabs shall be underlain by a vapor barrier and a layer of clean sand or aggregate as shown on drawings.</td>
</tr>
<tr>
<td>Pipe zone material</td>
<td>Pipe zone backfill shall be imported soil</td>
</tr>
<tr>
<td>(Material less than 12 inches above top of pipe)</td>
<td></td>
</tr>
<tr>
<td>Trench zone material</td>
<td>May contain stones, asphalt pavement or concrete of up to 6-inches in largest dimension so long as such solids are completely surrounded by fines so that no voids are present in the backfill as placed. No material greater than two inches in any dimension shall be placed within one foot of</td>
</tr>
<tr>
<td>ITEM</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>and below any street zone</td>
<td>any pipe, valve, or structure. All backfill within 24-inches of ductile-iron fittings or valves shall be clean, washed sand.</td>
</tr>
<tr>
<td>Cement-sand Slurry</td>
<td>Cement (94-lb sacks per cubic yard of mix) 1 sack per cubic yard minimum and not less than that required by applicable agency encroachment permits</td>
</tr>
<tr>
<td>Maximum Slump</td>
<td>6 inches per ASTM C143</td>
</tr>
</tbody>
</table>

### 2.2 STRUCTURAL BACKFILL

A. Structural backfill shall be free of clay balls and shall have a sand equivalent greater than 30 per ASTM D 2419 and have the following gradation:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 inch</td>
<td>100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>95 – 100</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>50 – 100</td>
</tr>
<tr>
<td>No. 4</td>
<td>20 – 65</td>
</tr>
<tr>
<td>No. 8</td>
<td>10 – 40</td>
</tr>
<tr>
<td>No. 40</td>
<td>0 – 20</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 – 5</td>
</tr>
</tbody>
</table>

B. Material excavated onsite may be used for structural backfill provided it conforms to this specification.

### 2.3 PIPE ZONE MATERIAL

A. Use imported pipe zone material as follows: a processed, well-graded, compactible sand or gravel per AASHTO M145 A-1-a with 3/4-inch max particle size and between 5% and 15% fines (per ASTM C117) for binder. Compact pipe zone to 90% relative compaction per ASTM D1557. A 3/4-inch UDOT road base gradation (per paragraph 2.04) is acceptable.

### 2.4 TRENCH ZONE MATERIAL

A. Use imported pipe zone material.

### 2.5 WATER FOR COMPACTION

A. Water shall be free of organic materials, a pH of 7.0 to 9.0, a max chloride concentration of 500 mg/L, and a max sulfate concentration of 500 mg/L. Provide all work needed to transport water for earthwork including piping, valves, pumps and trucks, to convey water to the point of use.

### 2.6 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

A. CLSM shall consist of a mixture of Portland cement, aggregate, fly ash, water, and admixtures conforming to the following:

Portland Cement: ASTM C 150, Type II.
1. Aggregate: Concrete sand, or processed material from the excavations meeting the requirements of sand as herein specified. Aggregate size shall be maximum 3/8 inch per ASTM C 33. The soluble sulfate content, shall not exceed 0.3 percent by dry weight.


3. Fly Ash: Class C per ASTM C 618.

4. The minus 200 sieve fraction shall be non-plastic.

B. CLSM shall be flowable, non-segregating, self-consolidating and non-shrink.

C. The unconfined compressive strength at 28 days shall be a minimum of 50 and a maximum of 150 psi per ASTM D 4832 For bidding, assume 100 pounds of cement and 100 pounds of fly ash per cubic yard of CLSM.

D. Sample CLSM at least once a day, four cylinders each time. Perform two cylinder breaks per four-cylinder sample at 7 days, the same as for concrete. Do not move cylinders for 72 hours after making.

E. The temperature of the CLSM discharged into the trench shall be below 70 degrees and above 45 degrees Fahrenheit. Do not place CLSM if ambient temperatures are below 10 degrees F.

F. The aggregate, cement, and water shall be proportioned either by weight or volume. The water content shall be sufficient to produce a fluid, workable mix that will flow and can be pumped without segregation of the aggregate while being placed. Prepare CLSM in accordance with ASTM C 94.

G. Water content shall match trial batch content. Do not add water after batching.

2.7 ROCK REFILL (OR TRENCH STABILIZATION MATERIAL)

A. Rock refill shall be crushed rock free from clay balls, organic material, and debris, and having the following gradation:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 inches</td>
<td>100</td>
</tr>
<tr>
<td>1-1/2 inches</td>
<td>80 - 100</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>5 - 30</td>
</tr>
<tr>
<td>No. 4</td>
<td>0 - 8</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 - 2</td>
</tr>
</tbody>
</table>

2.8 GEOTEXTILES

A. See Section 31 35 00 Geotextiles
PART 3 - EXECUTION

3.1 PREPARATION

A. The Contractor's attention is directed to the possible existence of pipe and other underground improvements which may or may not be shown on the Plans. Preserve and protect any such improvements whether shown or not. Where necessary to remove and replace or to relocate such improvements in order to prosecute the Work, they shall be removed, maintained, and permanently replaced by the Contractor at his expense, except as otherwise provided in the Contract Documents.

B. Contact and notify underground utilities, no less than 48-hours before excavating. Notify Underground Service Alert at 1-800-422-4133.

C. Control of runoff and groundwater shall comply with the following:
   1. Control grading to prevent water running into excavations. Do not obstruct surface drainage. Provide swales, gutters temporary drains or other means of channeling flow without interruption around excavations.
   2. Preserve existing drainage patterns except as otherwise shown. Where construction methods cause temporary obstruction of drainage patterns, provide temporary facilities adequate for expected flows and a means of emergency removal of the obstruction.
   3. Procure permit from appropriate Regional Water Quality Control Board for all groundwater dewatering operations.
   4. Provide and maintain ample means and devices and promptly remove and properly dispose of all water from any source entering the excavation or other parts of Work. Dewatering methods shall ensure preservation of final lines and grades of bottoms of excavations. Said methods may include well points, sump points, suitable rock or gravel placed below required bedding for drainage and pumping purposes, temporary pipelines, and other means that will not be detrimental to the proposed construction. Contractor is responsible for obtaining all water discharge permits required.
   5. Dewatering for the structures and pipelines shall commence when groundwater is first encountered and shall continue until water can be allowed to rise in accordance with the provision of this section.
   6. Do not place concrete footings or floors in water. Do not allow water to rise over Work until concrete or mortar has set at least eight hours. Do not allow water to rise unequally against walls for a period of 28 days. Do not allow groundwater to rise around the pipe until jointing compound in the joints has set hard.
   7. Dispose of water in a suitable manner without damage to adjacent property. Do not drain water into Work built or under construction without prior consent of Owner’s Representative. Dispose of water according to permits and in such manner as not to be a menace to public health and public or private property.

D. Nothing contained in these Contract Documents shall be construed as relieving the Contractor of full responsibility for providing shoring, bracing, sloping or other provisions adequate to guarantee worker protection and safety.
E. No material shall cause undue interference with public travel. Provide free access to all fire hydrants, water valves, meters, and private drives, or other property or facilities that may have routine or emergency use.

F. Obtain written permission from Owner prior to any blasting or use of explosives. Explosives, if used, shall be of such quantity and power and shall be used in such locations so as to minimize opening of seams and disturbing of the material outside the prescribed limits of excavation. As excavation approaches its final limits, the depths of holes for blasting and the quantity of explosives used for each hole shall be reduced so that the underlying or adjacent material will be disturbed or shattered as little as possible.

3.2 INSTALLATION

A. Refer to Section 31 20 00 for basic execution and installation requirements.

B. Trench excavation and backfill for pipelines and conduits shall proceed as follows:

1. **Alignment and Grades:** Alignment and grade for pipe shall be as shown. When flow line is shown, it shall be the invert or interior bottom of pipe. When top of pipe is shown, it shall be the exterior of pipe barrel. In absence of such profile grade, pipe shall be laid on a straight grade to permit complete drainage and to provide a minimum of 36-inches of cover to finish ground or street subgrade unless otherwise shown.

2. Locate trench stockpiled material at least 15 feet away from the tops of open trench excavation slopes.

3. After setting pipe to grade, do not jerk or move shoring in such a way as to cause pipe to be out of grade. After pipe is welded or fused and initial CLSM is placed, such that pipe will not move, shoring may be moved.

4. Pipe zone and compacted trench zone materials shall extend to edge of excavated trench, not to inside face of shoring. Fill gaps left when shoring is removed. If trench is excavated beyond that required, refill over excavated trench at no additional cost to the Owner with the pipe zone and trench zone materials required in specs.

5. Where natural ground above pipeline trench has been overexcavated and/or pipeline is to be placed in new embankment, place and compact embankment material to an elevation of not less than one foot above the top of pipe prior to trench excavation.

6. **Length of Open Trench:** Except where specified otherwise in Contract Documents or permits, the maximum length of open trench shall be 600-feet or the distance necessary to accommodate the amount of pipe installed in a single day, whichever is the greater. The distance is the collective length at any location, including open excavation, pipe laying, and appurtenance construction and backfill which has not been temporarily resurfaced.

7. **Trench Width:** Refer to recommendations in the Geotechnical Investigation

C. Trench bottom preparation shall proceed as follows:

1. Grade trench bottom to provide smooth, firm, and stable foundation at every point throughout length of pipe. Transfer construction stake grades into trench as
needed to ensure trench bottom is accurately graded. Place any special bedding required by Contract Documents.

2. Prepare pipe subgrade at trench bottom for specific type of pipe material being installed in accordance with Specifications for said pipe.

3. Should large gravel and cobbles be encountered at the trench bottom or pipe subgrade, remove such items from beneath pipe and replace with granular material compacted to provide uniform support and a firm foundation.

4. Whenever trench bottom does not afford a sufficiently solid and stable base to support pipe or appurtenances, excavate below normal trench bottom and replace it with crushed rock or gravel of sufficient thickness to form an unyielding foundation.

5. If excessively wet, soft, spongy, unstable, or similarly unsuitable material is encountered at subgrade, remove unsuitable material and replace with crushed rock or gravel of sufficient thickness to form an unyielding foundation.

6. Accurately shape pipe subgrade to fit pipe bottom using drag template or other suitable method. At each pipe joint, recess trench bottom to relieve pipe bells, couplings or flanges of all load.

7. Payment for removal of material and additional backfill required shall be in accordance with Contract Documents. However, if necessity for such additional bedding material has been occasioned by an act or failure to act on the part of the Contractor, Contractor shall bear expense of additional excavation and backfill to required depth.

8. The Contractor's attention is called to his responsibilities in maintaining adequate dewatering procedures to ensure that an otherwise stable foundation will not be rendered unfit due to accumulation of water in trench.

9. Where rock is found, removed rock below grade and backfill trench with clean imported sand to provide a compacted foundation cushion with a minimum allowable thickness of 6 inches under the outside diameter of the pipe barrel and a clear space of 6 inches under the pipe bell. Payment for removal of rock and additional backfill shall be in accordance with Contract Documents.

D. Backfill over pipe shall proceed as follows:

1. After pipe has been properly laid, exterior joints grouted and inspected, begin backfilling operations using material as specified above.

2. Contractor will be held responsible for any displacements of pipes or other structures, any damage to them or any instability caused by improper depositing of backfill material or improper use or handling of tools or equipment.

3. Backfill pipe located in public traveled right-of-way at end of each day's operations in accordance with applicable permit requirements. Remove spoil piles from traffic lanes by end of working day.

4. Mechanical densification or compaction of backfill shall use rolling, vibrating or impact means, or a combination thereof. Method or methods used shall result in obtaining the compaction of the backfill in the various specified zones and within the maximum lifts specified. Densification or compaction method or methods used shall not damage pipe, adjacent ground, existing improvements, or improvements installed as part of Work.
5. Place material for mechanically compacted backfill in lifts which, prior to compaction, shall not exceed the depths specified for the various types of equipment.
   a. Hand directed mechanical tampers - maximum lift depth of 6-inches in pipe zone, 8 inches elsewhere.
   b. Impact, free-fall, or “stomping” equipment - maximum lift depth of 3-feet. Not appropriate over rigid or cement-mortar lined pipe or PVC.
   c. Vibratory equipment with smooth contact surface - maximum lift depth of 2-feet.
   d. Rolling equipment, including, vibratory interrupted surface equipment - maximum depth of 1-foot.

6. Water settling may not be used in pipe zone and trench.

7. Control of Trench Backfill by Zones: Whether mechanical compaction or densification by water saturation is employed, backfill shall be constructed by zones, and the compaction requirement for each zone followed unless otherwise specified.

E. Backfill in pipe zone shall be hand-placed simultaneously on each side of pipe for full trench width, moistened as required to achieve specified compaction. In placing and compacting backfill, give particular attention to underside of pipe and fittings to provide firm support along full pipe length. Take care in backfilling to avoid damage to pipe coating, locating wires, and any conduits that may be installed in the pipe zone. Complete pipe zone compaction before covering it with trench zone material.

F. Backfill in trench zone shall use either mechanical compaction or water settling, depending on nature of material. Complete trench zone compaction before covering it with street zone material.

G. Backfill in street zone shall occur as follows:

1. Backfill in traveled ways and public streets shall be in accordance with the right-of-way agreement, encroachment permit or applicable regulations of the agency having jurisdiction over the traveled way. In the absence of such provisions, compact soil by approved hand-, pneumatic or mechanical-type tampers.

2. Water consolidation will not be permitted.

3. Construct pavement section in accordance with Contract Documents.

3.3 COLD WEATHER LIMITATIONS IN PLACING FILL AND BACKFILL

A. Unless allowed in the authorized Cold Weather Construction Plan, earth fills and backfills requiring 95 percent or higher relative compaction shall not be placed when either atmospheric temperature, or the temperature of the existing ground or the fill being placed, are below 35 degrees Fahrenheit unless both the existing ground and the fill being placed are both non-frost susceptible materials.

B. Earth fills and backfills requiring 90 percent or lower relative compaction may be placed when temperatures are below 35 degrees Fahrenheit if the required compaction is
achieved. If the required compaction is not achieved, the work shall be removed and re-compacted.

C. Do not place any fill or backfill materials which require 95 percent, or higher, relative compaction if the excavation or subgrade contains frozen moisture (snow, ice, sleet, etc.), frozen earthen materials, or earthen materials which have been deposited in the excavation due to freezing, thawing, precipitation, or other inappropriate means.

D. Do not place fill materials which contain frozen moisture (snow, ice, sleet, etc.) except as allowed in the paragraphs above.

E. Work performed outside the required temperature limitations is subject to rejection, removal and replacement.

3.4 BACKFILL OF TRENCHES (AND FILLS) AND COMPACTION

A. Unless otherwise shown in the plans or specifications, relative compaction in shall conform to ASTM D 1557 (modified proctor) and shall be as follows:

<table>
<thead>
<tr>
<th>Location or Use of Fill</th>
<th>Relative Compaction (Unless Noted Otherwise)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trench Zone not under structures, pavement or roads</td>
<td>90 percent (but do not compact for 6” below topsoils)</td>
</tr>
<tr>
<td>Trench Zone if pipes are under paved (AC or conc) or gravel roads and within 10-feet horizontally of paved or gravel roads (i.e. existing and future road shoulders), under future roads and future fills, sidewalks, curbs, beside structures and below slopes 2:1 or steeper.</td>
<td>95 percent or 80 percent relative density</td>
</tr>
<tr>
<td>CLSM Pipe Zone - sewer or water pipes</td>
<td>50 psi to 150 psi</td>
</tr>
<tr>
<td>Granular Pipe Zone (AASHTO M145 A-1-a) alternate pipe zone for water pipes</td>
<td>95 percent or 80 percent relative density</td>
</tr>
<tr>
<td>Trench Bottom Stabilization</td>
<td>85 percent, or 75 percent relative density</td>
</tr>
</tbody>
</table>

B. Place bedding and backfill materials to the lines, grades, and cross sections indicated on the Plans. Place bedding and backfill materials in horizontal, uncompacted lifts not exceeding 8 inches in thickness. The difference in level on either side of a pipe shall not exceed 12 inches.

C. Protect the pipe from damage during construction. Replace or repair broken or damaged pipe or pipe coatings. For tamping of backfill over the pipe, use tampers, vibratory rollers, and other equipment that shall not injure or disturb the pipe. Carefully place backfill around and over the pipe and do not allow it to fall directly upon the pipe to prevent coating damage. Place backfill material carefully and evenly onto the backfill previously placed in
the pipe zone to prevent lateral movement of the pipe. Do not permit free fall of the material until at least 2 feet of cover is provided over the top of the pipe. Do not drop sharp, heavy pieces of material directly onto the pipe or the tamped material around the pipe.

D. Backfilling of the trench above the pipe zone shall not proceed until the required strength of CLSM in pipe zone has been tested, verified, and accepted by the Construction Manager. Do not allow construction traffic over the pipe trench until the trench backfill has been compacted to a depth of over 3 feet above the top of pipe.

3.5 CLSM PLACEMENT AND SLIDE RAIL SHORING REMOVAL

A. After surveying and setting pipe to grade, and before welding joints, do not pull up lower slide rail panels - as this causes rock refill material (under pipe zone) to flow under panels and the pipe drops and becomes out of grade.

B. Complete pipe joint field welding and joint coating.

C. Place a CLSM “stiff mix” saddle over (to top of pipe zone) and around pipe at intervals that leave bottom of pipe zone with no CLSM between “stiff mix” saddles. Obtain initial set of “stiff mix” saddles. This helps lock WSP into surveyed grade before placing the rest of the CLSM.

D. Place “fluid mix” CLSM in lower part of pipe zone in a way that prevents the pipe from floating. While it is fluid, pull up lower slide rail panels to just below top of the CLSM just placed. Obtain initial set of initial “fluid mix” CLSM.

E. Place additional CLSM “fluid mix” layers in a way that prevent the pipe from floating. While it is fluid, pull up lower slide rail panels to just below top of CLSM just placed. Obtain initial set of each CLSM layer before placing the next layer.

F. When CLSM placement is complete to top of pipe zone, place and compact trench zone material while raising upper slide rail panels so that voids left below removed slide rail panels are filled with material compacted to trench zone requirements.

G. As upper slide rail panels are removed, remove disturbed native earth materials (used as backfill outside slide rail shoring) at the upper sides of trench and replace them with trench zone material compacted to trench zone compaction requirements.

3.6 OTHER CLSM PLACEMENT REQUIREMENTS

A. Do not place CLSM when ambient daytime air temperatures in trench exceed 95 degrees Fahrenheit. If daytime ambient air temperatures in trench exceed 95 degrees Fahrenheit, Contractor shall submit a written plan to the Construction Manager that identifies how Contractor will address temperature control issues when placing the CLSM.

B. Deliver the CLSM to the trench in ready mix trucks and use pumps or chutes to place the CLSM in the trench. Do not add water after batching. Submit strength break data for both the CLSM “stiff mix” and the CLSM “fluid mix”.

C. Maintain stability of pipe and conduit throughout CLSM placement and curing. CLSM will likely require placement in lifts to prevent pipe flotation. No movement of the pipe caused by flotation will be allowed. If any movement occurs, the CLSM material shall be removed and the pipe placed back on line and grade. Any damage to the pipeline system caused
by movement of the pipe shall be removed and/or repaired in full conformance with these Contract Documents at no additional cost to Owner. Remove all sloughed material or other debris from top of previously placed CLSM.

D. Prior to placing pipe zone or trench zone material above CLSM the CLSM shall be allowed to cure a minimum of 24 hours and achieve enough strength such that when walking on CLSM produces no indentations. A shorter cure period will be allowed if it can be demonstrated to the Construction Manager that it will perform its functions (to prevent pipe flotation and/or support pipe and trench zone material).

3.7 COLD WEATHER CLSM PLACEMENT AND CURING

A. Comply with cold weather placement of CLSM submittals. CLSM placed or cured outside the temperature limitations identified herein is subject to rejection, removal and replacement.

B. If freezing temperatures are imminent, maintain CLSM at a temperature above 40°F for seven (7) days after placement. CLSM mix and native trench soils (to 12-inches below trench face, floor and walls) must all be 40°F or greater at time of placement. Determine temperature by placing thermometer in CLSM or native soils immediately after sampling CLSM at placement site.

C. When freezing weather appears imminent, make ready at the placement site insulation and other materials for CLSM protection which have been identified in the cold weather placement of CLSM submittal accepted by Construction Manager. Delay placement of CLSM until adequate provisions for protection against weather are made. Do not place CLSM bedding when the trench bottom or walls are frozen or contain frozen material.

D. CLSM Curing: If during CLSM curing, temperatures are below 40 degrees, protect CLSM by insulation as allowed in the cold weather placement of CLSM submittal. Do not place CLSM if ambient temperatures are below 10 degrees F. If CLSM is kept above 40 degrees F until at least 18-inches fill or backfill is placed over the curing CLSM, no further cold weather protection is required if ambient temperatures are over 10 degrees F and no ambient forced air is circulating through pipe. The native earth temperatures typically keep both the buried pipe and the CLSM above 40 degrees F.

3.8 PLACING WARNING TAPE AND MAGNETIC MARKERS

A. Install warning tape and magnetic markers over all plastic or polyethylene pressure pipelines.

B. Install continuous underground non-detectable warning tape indicating domestic water, fire water, condenser water and natural gas piping during backfilling of trench. Locate below finished grade, directly over piping, 2 ft. above the piping, 4 mil thick, 6 inches wide, Polyethylene, color as follows:

1. Culinary (Domestic) Water – Blue with black lettering “WARNING BURIED DOMESTIC WATER SERVICE LINE"

2. Fire Water – Red with black lettering “WARNING BURIED FIRE WATER SERVICE"

3. Condenser Water – Gray with black lettering “WARNING BURIED CONDENSER WATER SERVICE LINE”
4. Natural Gas – Yellow with black lettering "WARNING BURIED NATURAL GAS SERVICE LINE"

C. Install magnetic markers (Omniball or equivalent) on each pipe at 50 ft. maximum spacing and at all bends or changes of alignment. Magnetic markers shall be placed between 3 and 5 feet deep.

3.9 FIELD QUALITY CONTROL

A. Owner's Representative will provide continuous inspection of fill and will field test fill and earth backfill as placed and compacted, and inspect excavations and subgrade before concrete is placed and provide periodic inspection of open excavations, embankments, and other cuts or vertical surfaces of earth. The Owner's Representative will observe and test fills and based on laboratory results will determine whether fills have been placed in accordance with the Contract Documents.

B. Whenever excavated material is not suitable for backfill, Contractor shall at his expense arrange for and furnish suitable imported backfill material which is capable of attaining the specified relative density. Contractor shall also arrange for removal and off-site disposal of unsuitable excavated material at his own expense.

C. Make all necessary excavations for compaction and other soils tests as directed by the Owner's Representative.

D. "Relative compaction" is the ratio, expressed as a percentage, of the in-place dry density to the laboratory maximum dry density.

E. Compaction shall be deemed to comply with the Contract Documents when no more than one test of any three consecutive tests falls below the specified relative compaction. The one test shall be no more than three percentage points below the specified compaction. Contractor shall pay costs of any retesting of Work not conforming to Contract Documents.

F. Allow sufficient time for testing and evaluation of results before material is needed. Owner's Representative will be sole and final judge of suitability of all materials.

G. Do not use materials in question pending test results.

H. Contractor shall remove unsatisfactory material, recompact, adjust moisture or compaction methods, place new material, and perform other operations necessary to meet Contract requirements as directed by Owner's Representative whose decisions and directions will be considered final on these matters.

I. Owner's Representative will not provide and is not being paid to provide directions or submittal review regarding Contractor's excavation safety procedures. Any questions or concerns of Owner's Representative will be referred to OSHA whose decisions or directions shall be considered final.

3.10 ADJUSTING AND CLEANING

A. Make necessary arrangements for and remove and dispose of all surplus excavated material off-site, unless otherwise provided for in the Contract Documents. All costs for disposal of surplus waste material shall be borne by Contractor.
B. Dispose of all surplus material not required for backfill or fill. Disposal shall occur outside limits of public rights-of-way and/or easements. Disposal shall comply with applicable ordinances and regulations of governmental agencies having jurisdiction and shall be done at no cost or liability to Owner.

C. Do not deposit excavated material on private property unless written permission from property owner is secured by the Contractor. Before Owner will accept Work as being completed, Contractor shall file written release signed by all property owners with whom he has entered into agreements for disposal of surplus excavated material absolving Owner from any liability connected therewith.

D. Do not deposit excess material in water courses or other locations where disposed material will interfere with natural drainage.

E. After backfill is completed, dress site smooth and leave site in neat and presentable condition, free of all cleared vegetation, rubbish and other construction wastes. Haul away and legally dispose of surplus rock or other excavated material which cannot be used for backfill. Areas next to structures where blade-type equipment cannot reach shall be hand raked.

END OF SECTION
SECTION 31 23 33
EXCAVATION AND BACKFILL OPERATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements for trenching and backfilling for underground pipelines.
B. Excavating and backfilling operations adjacent to and under structures including boxes, headwalls, or other structures as required by Engineer.
C. Backfilling and compacting operation for construction and reconstruction of roadways, embankments, streets, parking lots, and other paved surface areas.
D. Excavation permit requirements.

1.2 DEFINITIONS

A. Pipe Zone: That zone in an excavation which supports, surrounds, and extends to 1 foot above the top of the pipe barrel.
B. Bedding: Process of preparing the trench bottom to receive the pipe and the backfilling on each side of the pipe to 12 inches over the top of the pipe.
C. Roadway: Area within the street right-of-way, including the area under the street and shoulder.

1.3 SUBMITTALS

A. Material Analysis Reports: In accordance with Sections 31 20 00 or 31 20 01
B. Density Test Reports: In accordance with Section 31 20 00
C. Depth of backfill lift. This information shall be contingent upon type of equipment used in compaction operation. The Engineer may order lesser thickness if compaction is not achieved.

1.4 STORAGE AND HANDLING

A. Stockpile excavated material in a manner as to cause a minimum of inconvenience to public travel and provide for emergency traffic as necessary.
B. Maintain free access to all existing fire hydrants, water and gas valves, and meters.
C. Maintain clearance for free flow of storm water in all bar ditches, conduits, and natural water courses.
D. Utilize appropriate traffic signs, markers, and procedures in all product storage and handling activities.

E. Promptly remove all other material from site.

1.5 SITE CONDITIONS

A. Unsuitable Weather Limitations: Do not place, spread, or roll any fill material during unsuitable weather conditions. Do not resume operations until moisture content of material is satisfactory.

B. Protection of Graded Areas: Protect graded areas from traffic and erosion. Keep free of trash and debris. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or unsuitable weather, scarify surface, reshape, and compact to required density prior to further construction.

D. Prior to excavation operations, photograph existing surfaces along which Work may take place in order to determine, after construction is completed, whether any damage of existing improvements occurred prior to construction operations.

E. Grading: In compaction operations, do not vary the surface of finished aggregate base course more than 1/4” above or below grade.

PART 2 - PRODUCTS

2.1 WATER

A. Make arrangements for source of water during construction and make arrangements for delivery of water to site. Comply with all local laws and regulations when securing water from water utility company at no additional cost to Owner.

2.2 SOIL MATERIALS

A. See Section 31 20 00

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify areas to be backfilled are free of debris, snow, ice, or water and ground surfaces are not frozen.

B. Verify foundation of basement walls are braced to support surcharge forces imposed by backfilling operations.
C. Immediately prior to suspension of construction operations for any reason, provide proper and necessary drainage of work area.

3.2 PREPARATION

A. For pipelines, use means necessary to avoid displacement, and injury to, pipe and structures while compacting soil or operating equipment next to pipeline.

B. Movement of construction machinery over a pipeline at any stage is solely at Contractors risk.

C. When excavation is required in jurisdictions other than Owners, satisfy all conditions of the appropriate agencies.

D. Identify required lines, grades, contours, and benchmarks.

E. Notify all affected utility companies and Blue Stakes prior to commencing excavation operation.

F. Support and protect from damage, until completion of the Work, any existing facilities and structures which exist in, pass through, or pass under the site.

3.3 CONTROL OF GROUNDWATER

A. All trenches shall be kept free from water during excavation, fine grading, pipe laying, jointing, and embedment operations.

B. Where the trench bottom is mucky or otherwise unstable because of the presence of groundwater, and in cases where the static groundwater elevation is above the bottom of any trench or bell holed excavation, such groundwater shall be lowered to the extent necessary to keep the trench free from water and the trench bottom stable when the work within the trench is in progress.

3.5 GENERAL EXCAVATION OPERATIONS

A. If topsoil is on site, remove and store it for later use on site.

B. Excavate site to required grade for Work. Use all means necessary to control dust on or near Work and on or near all off-site borrow and disposal areas.

C. Notify Engineer of unexpected subsurface conditions.

D. Underpin adjacent structure which may be damaged by excavation work, including service utilities and pipe chases.
E. If unstable material is encountered at the bottom or face of excavation, do not perform extra excavation without Engineer's written approval. Correct unauthorized extra excavations at no cost to Owner.

F. Provide necessary protection to excavation walls as required. If conditions permit, slope excavation side to maintain a safe and clean working area. Remove loose materials.

G. Correct excavation beyond the specified lines and grades by filling the resulting voids with approved compacted fill. If the fill is to become the subgrade for other fill, use material approved by Engineer. Do not proceed until Engineer has approved the material and the proposed method of backfilling for over excavation errors.

3.6 EXCAVATION AND BACKFILLING FOR PIPELINES

A. See Section 31 20 01

3.9 INSTALLING IMPERVIOUS BARRIERS

A. Construct impervious barriers in the pipe and trench zones, as shown in the plans and at 100-foot intervals on slopes exceeding 30% (16.7 degrees) and within 50 feet of vertical points of inflection on slopes exceeding 30%.

B. Construct concrete barriers such that the bottom of the collar extends at least 12 inches into the pipe base, at least 12 inches into each side of the walls of the trench, and at least 12 inches above the top of the pipe zone.

3.10 STRUCTURAL EXCAVATION

A. Provide all required shoring, cribs, cofferdams, and caissons including all pumping, bailing, draining, sheathing, bracing, and related items.

B. If conditions permit, slope excavation sides as excavation progress to maintain a safe and clean working area as required by OSHA.

C. Support excavation. Do not interfere with the bearing of adjacent foundations, pipelines, etc.

D. All unauthorized excavation below the specified structure subgrade shall be replaced with concrete, monolithic with that of the slab above or with coarse gravel thoroughly compacted into place.

E. Subgrade soil for all concrete structures shall be firm, dense, thoroughly compacted, and consolidated.

F. Subgrade soil shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workmen engaged in subgrade surfacing, laying reinforcing steel, and depositing concrete.
G. Coarse gravel or crushed stone may be used for subsoil reinforcement if results satisfactory to the Engineer can be obtained thereby.

1. Material shall be applied in lifts of 6" or less.

2. Each lift shall be embedded in the subsoil by thorough tamping.

3. All excess soil shall be removed to compensate for the displacement of the gravel or crushed stone and the finished elevation of any subsoil reinforced in this manner shall not be above the specified subgrade.

3.11 BACKFILLING FOR STRUCTURES

A. Do not fill adjacent to structures until approval is obtained from Engineer.

B. All forms shall be removed and the excavation shall be cleaned of all trash and debris.

C. Backfill areas to contours and elevations indicated. Do not use frozen materials.

D. Do not use compaction equipment adjacent to walls or retaining walls that may cause wall to become over stressed or moved from final alignment.

E. Place select fill a minimum of 3 feet around the outside of structures.

F. Place and compact select fill materials in continuous lifts not exceeding 12" loose depth.

G. Place and compact common fill material in continuous lifts not exceeding 8" loose depth.

H. Do not disturb or damage foundation perimeter drainage, foundation, dampproofing, foundation waterproofing and protective cover, or utilities in trenches.

I. Backfill against foundation walls simultaneously on each side. Do not backfill against walls until concrete has obtained 7 day strength.

J. Make smooth changes in grade. Blend slopes into level areas.

K. Remove surplus backfill materials from site.

L. Leave stockpile areas completely free of excess fill materials.

M. Slope grade away from structure at a minimum of 3" in 10 feet unless otherwise indicated.
N. Compaction: Each layer of material shall be compacted by hand or machine tampers or by other suitable equipment to a density equal to 95% of maximum dry density as measured by AASHTO T-99.

O. Restore any damaged structure to its original strength and condition and re-backfill to specifications.

3.12 ROADWAY EXCAVATIONS

A. In advance of setting line and grade stakes, clean subgrade area of brush, weeds, vegetation, grass, and debris. Drain all depressions or ruts which contain water.

B. A soils classification, as determined by AASHTO T-27, shall be made on the proposed subgrade, and the following shall be required based on that classification:

<table>
<thead>
<tr>
<th>Soil Classification</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1, A-2, or A-3</td>
<td>The subgrade shall be scarified to a depth of 8&quot; and the loosened material shall be moistened and compacted to the equivalent of 95% of maximum dry density as measured by AASHTO T-99.</td>
</tr>
<tr>
<td>A-4 or A-5</td>
<td>The subgrade shall be over-excavated a minimum of 8&quot; subgrade scarified and compacted, replaced with A-1 granular material, and be moistened and compacted as above.</td>
</tr>
<tr>
<td>A-6 or A-7</td>
<td>The subgrade shall be over-excavated a minimum of 12&quot; subgrade scarified and compacted, replaced with A-1 granular material, and be moistened and compacted as above.</td>
</tr>
</tbody>
</table>

C. No organic material, soft clay, spongy material, or other deleterious material will be permitted in the scarified or imported subgrade layer.

D. Rough subgrades shall be shaped and graded to within a tolerance of 0.15 feet of design grade and drainage shall be maintained at all times.

E. Moisture content of the subgrade layer shall be maintained at not less than 95% or more than 105% of optimum moisture content, during the compaction process. The entire roadbed, to one foot in back of curb, must be compacted to the specified density to a minimum depth of 8 inches.

F. If removal of boulders, rubble, or existing improvements, found within the excavated area results in a lower excavation elevation than indicated, backfill over excavation in a manner approved by the Engineer.
G. Remove all deposits susceptible to frost heave.

H. Excavations through or under streets, sidewalks, street shoulders, driveways, etc. shall comply with the following requirements:
   1. The trench shall be filled with select fill as per Section 31 20 01
   2. The trench shall be filled to the existing surface level.
   3. Within 10 days of the fill, sufficient fill material shall be removed and replaced with material comparable to the adjacent surface material shall meet the requirements of Section 31 20 00 of these specifications.
   4. The Engineer shall inspect all work.

3.13 SUBGRADE PREPARATION

A. Compact subgrade surfaces to density specified for overlying backfills. Refer to Section 31 20 00

B. If areas of subgrade not readily capable of in-situ compaction, secure Engineer's authorization for extra excavation and backfill.

C. Maintain minimum overburden cover of 2 feet over pipelines or conduits during subgrade preparation.

3.14 BACKFILLING FOR PAVEMENT

A. Before beginning backfilling operations obtain Engineer's approval of excavation operation.

B. Do not damage subsurface structures or service lines.

C. Process backfill and avoid segregation. Keep base course free from pockets of coarse or fine material.

D. Deposit base course on the roadbed in a uniform manner which will provide the required compacted thickness. Maintain moisture content.

E. Shoulders are an integral part of the embankment. Do not build shoulders to a grade higher than that of the adjacent granular base course. Maintain efficient surface runoff at all times.

F. Compaction: in accordance with Section 31 23 27.

G. Proof roll prior to placing pavements.
3.15 BLASTING

A. Blasting will not be allowed except by permission from the Engineer.

1. The Contractor shall comply with all laws, ordinances, and applicable safety code requirements and regulations relative to the handling, storage, and use of explosives and protection of life and property.

2. And he shall be fully responsible for all damage attributable to his blasting operations.

3. Excessive blasting or overshooting will not be permitted and any material outside the authorized cross-section which may be shattered or loosened by blasting shall be removed by the Contractor.

3.16 ROCK FACES

A. Scale rock cuts of all loose rocks and fragments and leave in a neat and safe condition.

3.17 COMPACTION OF BACKFILL

A. In accordance with Section 31 20 00.

3.19 DISPOSAL OF EXCESS MATERIALS

A. All excess material shall be hauled away from the construction site and disposed of by the Contractor.

END OF SECTION 31 23 33
SECTION 31 35 00
GEOTEXTILES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Materials and procedures for installing geotextiles of the type(s) shown on the drawings, and at other locations as directed by the Engineer.

1.2 REFERENCES

A. AASHTO M 288: Geotextile Specifications for Highway Applications.
B. ASTM D 4791: Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

1.3 SUBMITTALS

A. Submit prior to use: Manufacturer’s certificate that each fabric complies with requirements of this Section.

1.4 SAMPLING AND TESTING

A. Prior to shipment, test each individual shipment and lot of geotextile, and send testing reports with the shipment to the job site. Clearly label all rolls as being part of the same production run certified as meeting all material requirements.

1.5 PACKAGING, SHIPPING, AND STORING

A. Protect the geotextile from direct sunlight, chemicals, mud, dirt and debris during shipment and storage. Replace at the Contractor’s sole expense, any geotextile damaged or deteriorated during shipping, storage or construction.

B. Labeling and Tagging:

1. Identify each package by a tag or label securely affixed to the outside of the roll on at least one end.

2. Provide the following required information on the tag:
   a. Name of the geotextile manufacturer
   b. Brand name of the product, width, length, and package weight of geotextile

1.6 ACCEPTANCE

A. Owner or Engineer rejects geotextile at installation if it has defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transport, handling or storage.
PART 2 - PRODUCTS

2.1 EROSION CONTROL GEOTEXTILE
   A. Furnish as specified in AASHTO M 288.

2.2 DRAINAGE GEOTEXTILE
   A. Furnish non-woven drainage geotextile as specified in AASHTO M 288 with in-situ soil designations as shown on the drawings or as indicated by the Engineer.
   B. Notify Engineer if soil conditions are different than shown on the drawings.

2.3 SEPARATION GEOTEXTILE
   A. Furnish as specified in AASHTO M 288.

2.4 STABILIZATION GEOTEXTILE
   A. Furnish as specified in AASHTO M 288.

2.5 WEED BARRIER GEOTEXTILE
   A. Woven, needle-punched, polypropylene, 5.0 oz, weed barrier geotextile designed for commercial use.

PART 3 - EXECUTION

3.1 GENERAL
   A. Place geotextile on areas that are smooth, and free of projections or depressions. Do not drag the geotextile across the subgrade. Roll geotextile out as smoothly as possible in the direction of vehicle travel.
   B. Do not operate construction equipment or traffic directly on geotextile.
   C. When placed for construction, cover the geotextile with indicated cover material as soon as possible. Do not leave uncovered for more than 5 days.
   D. Place cover material on the geotextile in a manner that the geotextile is not torn, punctured, or shifted. Use a minimum 6 inches thick cover layer, or twice the maximum aggregate size, whichever is thicker. Do not end-dump cover material directly on the geotextile, except as a starter course.
   E. Limit construction vehicles in size and mass so rutting in the initial layer above the geotextile is not more than 3 inches deep, or half the layer thickness, whichever is the lesser. Turning of vehicles on the first layer is not permitted.
3.2 INSTALLING EROSION CONTROL GEOTEXTILE

A. Install at locations shown on the drawings.

B. Unless otherwise specified, overlap the geotextile a minimum of 2 feet at all longitudinal and transverse joints, or sew the geotextile. For sewing requirements, refer to this Section, article, “Sewing”.

C. If overlapped, place the geotextile so that the upstream sheet overlaps the downstream sheets.

D. For placement on slopes, overlap each sheet over the next downhill sheet.

E. Anchor the geotextile using key trenches or aprons at the crests and toes of the slope.

F. Pins, usually 18 inches in length may be helpful in securing the geotextile during installation.

G. Repair: Place patch over damaged area and extend 3 feet beyond the perimeter of the tear or damage.

3.3 INSTALLING DRAINAGE GEOTEXTILE FOR SUBSURFACE DRAINAGE

A. Excavate trench to size and depth indicated.

B. Cut geotextile to width required and place in trench. Prevent damage to geotextile.

C. Overlap geotextile 12 inches or the full width of the trench, whichever is less, at the top of the trench.

D. Overlap successive sheets of geotextile a minimum of 12 inches in the direction of flow.

E. Place fill beginning with the sheet(s) overlapped above subsequent sheet(s), to hold geotextile in place.

F. Repair any damage to geotextile by placing patches extending 3 feet in all directions beyond the damaged area.

3.4 INSTALLING SEPARATION GEOTEXTILE

A. Install for pavement sections or other applications at locations shown on the drawings.

B. Unless otherwise specified, overlap the geotextile a minimum of 1 foot at all longitudinal and transverse joints, or sew the geotextile. For sewing requirements, refer to this Section, article, “Sewing.”

C. Repair: Place patch over damaged area and extend 3 feet beyond the perimeter of the tear or damage.

D. Place fill, beginning with the sheet(s) overlapped above subsequent sheet(s), to hold geotextile in place.
E. Pins, usually 18 inches in length, may be helpful in securing the geotextile during installation.

3.5 INSTALLING STABILIZATION GEOTEXTILE

A. Install Stabilization Geotextile at locations shown on the drawings, or as designated by the Engineer.

B. Unless otherwise specified, overlap the geotextile a minimum of 2 feet at all longitudinal and transverse joints, or sew the geotextile. For sewing requirements, refer to this Section, article, “Sewing.”

C. For placement on slopes, overlap each sheet over the next downhill sheet.

D. Repair: Place patch over damaged area and extend 3 feet beyond the perimeter of the tear or damage.

E. Place fill, beginning with the sheet(s) overlapped above subsequent sheet(s), to hold geotextile in place.

F. Pins, usually 18 inches long, may be helpful in securing the geotextile during installation.

3.6 INSTALLING WEED BARRIER GEOTEXTILE

A. Preparation:
   1. Remove sharp objects, large stones and undesirable vegetation.
   2. If placing geotextile over an existing bed, cut an "X" over each plant and push geotextile under plant base. If placing over a new bed, roll geotextile over soil and cut an "X" for each plant hole. Fold excess geotextile under and cover with specified landscaping materials.

B. Surface Cover: Provide a minimum of 4 inches of cover on all areas on the geotextile unless otherwise specified by Engineer. If using large landscape rock, increase thickness of cover material over geotextile up to 3 times the diameter of the largest rock material based on Engineer=s recommendations. Do not leave any portion of geotextile exposed to direct sunlight.

C. Repair: Repair immediately if damaged. Remove the damaged area plus an additional 3 feet and apply geotextile patch.

D. Maintenance: Maintain surfaces and supply additional landscape materials where necessary, including areas affected by erosion.

3.7 SEWING


END OF SECTION 31 35 00
SECTION 32 17 23.13
PAINTED PAVEMENT MARKINGS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Firing Range Distance Lines (see site plan)

1.02 REFERENCE STANDARDS
   A. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators
      Association; Current Edition.
   B. FHWA MUTCD - Manual on Uniform Traffic Control Devices for Streets and Highways; U.S.
      Department of Transportation, Federal Highway Administration; Current Edition.

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Manufacturer's data sheets on each product to be used, including:
      1. Preparation instructions and recommendations.
      2. Storage and handling requirements and recommendations.
      3. Installation methods.

1.04 DELIVERY, STORAGE, AND HANDLING
   A. Deliver paint in containers of at least 5 gallons accompanied by batch certificate.
   B. Store products in manufacturer's unopened packaging until ready for installation.
   C. Store and dispose of solvent-based materials, and materials used with solvent-based materials,
      in accordance with requirements of local authorities having jurisdiction.

1.05 FIELD CONDITIONS
   A. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 MATERIALS
   A. Line Marking Paint: MPI (APL) No. 97 Latex Traffic Marking Paint; color(s) as indicated.

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.

3.02 PREPARATION
   A. Prepare surfaces using the methods recommended by the manufacturer for achieving the best
      result for the substrate under the project conditions.
   B. Clean surfaces thoroughly prior to installation.
      1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with
         compressed air, rinsing with water, or a combination of these methods.
   C. Where oil or grease are present, scrub affected areas with several applications of trisodium
      phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each
      application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the
      new paint.
   D. Establish survey control points to determine locations and dimensions of markings; provide
      templates to control paint application by type and color at necessary intervals.

3.03 INSTALLATION
   A. Begin pavement marking as soon as practicable after surface has been cleaned and dried.
B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F or more than 95 degrees F.

C. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.

D. Comply with FHWA MUTCD manual (http://mutcd.fhwa.dot.gov) for details not shown.

E. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.

F. Apply uniformly painted markings of color(s), lengths, and widths as indicated on drawings true, sharp edges and ends.
   1. Apply paint in one coat only.
   2. Wet Film Thickness: 0.015 inch, minimum.
   3. Width Tolerance: Plus or minus 1/8 inch.
   4. Multiple colors as selected by architect.

3.04 DRYING, PROTECTION, AND REPLACEMENT

A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.

B. Provide barricades, warning signs, and flags as necessary to prevent traffic crossing newly painted markings.

C. Allow paint to dry at least the minimum time specified by the applicable paint standard and not less than that recommended by the manufacturer.

D. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.

E. Remove markings in manner to avoid damage to the surface to which the marking was applied, using carefully controlled sand blasting, approved grinding equipment, or other approved method.

F. Replace removed markings at no additional cost to Owner.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Posts, rails, and frames.
B. Wire fabric.
C. Concrete.
D. Manual gates with related hardware.
E. Accessories.

1.02 REFERENCE STANDARDS


1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.
C. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components. See CLFMI CLF-SFR0111 for planning and design recommendations.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
B. Fence Installer: Company with demonstrated successful experience installing similar projects and products, with not less than five years of documented experience.

1.05 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MATERIALS

A. Posts, Rails, and Frames:
   1. Formed from hot-dipped galvanized steel sheet, ASTM A653/A653M, HSLAS, Grade 50, with G90 (Z275) zinc coating.
   2. Comply with CLFMI CLF-PM0610.
B. Wire Fabric:
   1. ASTM A392 zinc coated steel chain link fabric.
   2. Comply with CLFMI CLF-PM0610.
C. Concrete:
   1. Ready-mixed, complying with ASTM C94/C94M; normal Portland cement; 2,500 psi
      strength at 28 days, 3 inch slump; standard inch nominal size aggregate.

2.02 COMPONENTS
   A. Line Posts: 1.9 inch diameter.
   B. Corner and Terminal Posts: 2.38 inch diameter.
   C. Gate Posts: 3-1/2 inch diameter.
   D. Top and Brace Rail: 1.66 inch diameter, plain end, sleeve coupled.
   E. Bottom Rail: 1.66 inch diameter, plain end, sleeve coupled.
   F. Gate Frame: 1.66 inch diameter for welded fabrication.
   G. Fabric: 2 inch diamond mesh interwoven wire, 6 gage, 0.1920 inch thick, top selvage knuckle
      end closed, bottom selvage twisted tight.
   H. Tension Wire: 6 gage, 0.1920 inch thick steel, single strand.

2.03 MANUAL GATES AND RELATED HARDWARE
   A. Hardware for Double Swinging Gates: 180 degree hinges, 3 per gate; drop bolt on inactive leaf
      engaging socket stop set in concrete, active leaf latched to inactive leaf preventing raising of
      drop bolt, padlock hasp; keepers to hold gate in fully open position.
   B. Hinges: Finished to match fence components.
   C. Latches: Finished to match fence components.

2.04 ACCESSORIES
   A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.
   B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.

2.05 FINISHES
   A. Components (Other than Fabric): Galvanized in accordance with ASTM A123/A123M, at 1.7
      ounces per square foot.
   B. Hardware: Hot-dip galvanized to weight required by ASTM A153/A153M.
   C. Accessories: Same finish as framing.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verification of Conditions: Verify that areas are clear of obstructions or debris.

3.02 INSTALLATION
   A. Install framework, fabric, accessories and gates in accordance with ASTM F567.
   B. Place fabric on outside of posts and rails.
   C. Set intermediate posts plumb, in concrete footings with top of footing 2 inches above finish
      grade. Slope top of concrete for water runoff.
   D. Line Post Footing Depth Below Finish Grade: ASTM F567.
   E. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F567.
   F. Brace each gate and corner post to adjacent line post with horizontal center brace rail. Install
      brace rail one bay from end and gate posts.
   G. Do not stretch fabric until concrete foundation has cured 28 days.
   H. Position bottom of fabric 1 inches above finished grade.
   I. Install bottom tension wire stretched taut between terminal posts.
   J. Install hardware and gate with fabric to match fence.
3.03 TOLERANCES
   A. Maximum Variation From Plumb: 1/4 inch.

3.04 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.
   B. Layout: Verify that fence installation markings are accurate to design, paying attention to gate locations, underground utilities, and property lines.
   C. Fence Height: Randomly measure fence height at three locations or at areas that appear out of compliance with design.
   D. Gates: Inspect for level, plumb, and alignment.

3.05 CLEANING
   A. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.
   B. Clean fence with mild household detergent and clean water rinse well.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Seeding.
   2. Hydroseeding.
   3. Meadow grasses and wildflowers.
   4. Erosion-control material(s).

1.2 DEFINITIONS
A. Finish Grade: Elevation of finished surface of planting soil.
B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" and drawing designations for planting soils.
E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.3 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For landscape Installer.
B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
C. Product Certificates: For fertilizers, from manufacturer.
D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.5 CLOSEOUT SUBMITTALS
A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of meadows during a calendar year. Submit before expiration of required maintenance periods.

1.6 QUALITY ASSURANCE
A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf and meadow establishment.
   1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
   2. Experience: Five years' experience in meadow installation in addition to requirements in Section 014000 "Quality Requirements."
   3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the National Association of Landscape Professionals:
      a. Landscape Industry Certified Technician - Exterior.
      b. Landscape Industry Certified Lawn Care Manager.
c. Landscape Industry Certified Lawn Care Technician.
5. Pesticide Applicator: State licensed, commercial.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.
B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.8 FIELD CONDITIONS
A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion. Planting outside period will be at contractors risk.
   2. Fall Planting: October.
B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS
2.1 SEED
A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
B. Seed Species:
   1. Quality: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
C. Grass-Seed Mix: Proprietary seed mix as follows:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Applewood Seed Company. www.applewoodseed.com 303.431.7333
         1) Shortgrass Seed Mixture. (SGGR) @ 6lbs per acre grass only, @ 3lbs per acre with wildflowers.
         2) Intermountain Native Wildflower Seed Mix (IMNA) @ 16lbs per acre.

2.2 FERTILIZERS
A. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2.3 MULCHES
A. Fiber Mulch: Biodegradable, dried-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
B. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.
C. Asphalt Emulsion: ASTM D977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.
2.4 PESTICIDES
A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.5 EROSION-CONTROL MATERIALS
A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.
B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd. (0.5 kg/sq. m), with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.

PART 3 - EXECUTION
3.1 EXAMINATION
A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
   1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
   2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
   3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION
A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
   1. Protect adjacent and adjoining areas from hydroteeding and hydromulching overspray.
   2. Protect grade stakes set by others until directed to remove them.
B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 PREPARATION FOR EROSION-CONTROL MATERIALS
A. Prepare area as specified in "Turf Area Preparation" Article.
B. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
C. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.4 SEEDING
A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h).
   1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
2. Do not use wet seed or seed that is moldy or otherwise damaged.
3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate recommended by seed manufacturer
C. Rake seed lightly into top 1/8 inch (3 mm) of soil, roll lightly, and water with fine spray.
D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer’s written instructions.

3.5 HYDROSEEDING
A. Hydroseeding: Mix specified seed, slow-release fertilizer, and fiber mulch in water, using equipment specifically designed for hydroteed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
1. Mix slurry with fiber-mulch manufacturer’s recommended tackifier.
2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre (15.6-kg/92.9 sq. m) dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

3.6 MEADOW
A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h).
1. Before sowing, mix seed with seed carrier at a ratio recommended by supplier.
2. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
3. Do not use wet seed or seed that is moldy or otherwise damaged.
B. Brush seed into top 1/16 inch (1.6 mm) of soil, roll lightly, and water with fine spray.
C. Water newly planted areas and keep moist until meadow is established.

3.7 MEADOW MAINTENANCE
A. Maintain and establish meadow by watering, weeding, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable meadow. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.
1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and meadow damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep meadow and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
B. Watering: Install and maintain temporary piping, hoses, and meadow-watering equipment to convey water from sources and to keep meadow uniformly moist.
1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water meadow with fine spray at a minimum rate of 1/2 inch (13 mm) per week for eight weeks after planting unless rainfall precipitation is adequate.

3.8 PESTICIDE APPLICATION
A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer’s written recommendations.
3.9 CLEANUP AND PROTECTION
   A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of
   vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
   B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and
   debris, and legally dispose of them off Owner's property.
   C. Erect temporary fencing or barricades and warning signs as required to protect newly planted
   areas from traffic. Maintain fencing and barricades throughout initial maintenance period and
   remove after plantings are established.
   D. Remove nondegradable erosion-control measures after grass establishment period.

3.10 MAINTENANCE SERVICE
   A. Meadow Maintenance Service: Provide full maintenance by skilled employees of landscape
   Installer. Maintain as required in "Meadow Maintenance" Article. Begin maintenance
   immediately after each area is planted and continue until acceptable meadow is established, but
   for not less than maintenance period below.
      1. Maintenance Period: 40 days from date of Substantial Completion.

END OF SECTION 32 92 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Related Sections:
   1. 2017 APWA Standard Plans and Specifications

1.2 SUMMARY
A. This Section includes water-distribution piping and related components the buildings for combined water service and fire-service mains.

1.3 DEFINITIONS
A. EPDM: Ethylene propylene diene monomer rubber.
B. HDPE: High Density Polyethylene

1.4 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. Field quality-control test reports.
D. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE
A. Regulatory Requirements:
   1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
   2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
   3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
   4. All water piping shall meet current AWWA and State of Utah standards.
5. Valves shall conform with requirements of Manufacturer Standardization Society of the Valve and Fittings Industry (MSS) Standards.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

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. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

F. NSF Compliance: Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

G. All piping systems shall meet the site-specific requirements of engineering studies and recommendations including the necessary anchors, restraints, guides, thrust blocks, etc., required by code and to meet industry best practices.

H. All piping, fittings, materials etc. shall conform to the latest version of the international plumbing and mechanical code.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
   1. Ensure that valves are dry and internally protected against rust and corrosion.
   2. Protect valves against damage.
   3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
   1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
   2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

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

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.
PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS


B. All runs of plastic or other nonconductive pipe shall have magnetic markers and marker tape laid along the pipe to facilitate pipe location after installation.

2.2 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3 GATE VALVES

A. AWWA, Gate 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 or as approved by the engineer:


2.4 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches (125 mm) in diameter.

   1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

B. Manholes, Handholes, Valve pits etc.

   1. Manholes, handholes, valve pits, etc. located in areas accessible to inmates shall have cover frames of steel construction set in concrete. Covers shall be secured by spot welding of the lids to frames to restrict access.

2.5 FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product as approved by the Engineer.


   2. Description: Freestanding, with two 2-1/2-inch hose connections, and one 4-1/2-inch pumper connection, an underground isolation valve, and mechanical-joint inlet. Include
interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.

b. Pressure Rating: 250 psig (1725 kPa).

2.6 FIRE DEPARTMENT CONNECTION

A. Fire Department Connection

1. Fire department connections for buildings within the secure perimeter shall have a threaded Siamese-end connection with a hexagonal nipple attached to the pipe end with a chain.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Section 31 20 00 and 31 20 01 for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Contractor shall provide magnetic markers on each pipe at 50 ft. maximum spacing and at all bends or changes of alignment. Tape to top of pipe prior to burial.

C. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

3.3 PIPING INSTALLATION

A. Install HDPE piping according to section 331136 - Polyethylene Piping and Tubing

B. Bury piping with depth of cover over top at least 54 inches.

3.4 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

C. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.
3.5 FIRE HYDRANT INSTALLATION

A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints, and support in upright position.

B. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.

C. AWWA Fire Hydrants: Comply with AWWA M17.

D. UL/FMG Fire Hydrants: Comply with NFPA 24.

3.6 CONNECTIONS

A. Connect water-distribution piping to existing welded steel water main. Use flanged adapter with stainless steel backup ring.

B. Connect water-distribution piping to interior domestic water and fire-suppression piping.

C. Connect domestic water and fire suppression piping to pump station building shall be coordinated with contractor performing work in GMP 13.04.

3.7 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

1. Hydrostatic Tests: All water mains shall be tested to 200 psi for two hours in accordance with AWWA Standard C600-93. The tests need to be witnessed by the Professional Engineer.

B. Prepare reports of testing activities.

3.8 IDENTIFICATION

A. Install continuous underground non-detectable warning tape indicating plastic water service or fire service piping during backfilling of trench for water-distribution piping. Locate below finished grade, directly over piping, 2 ft. above the piping.

B. Provide magnetic markers on each pipe at 50 feet maximum spacing and at all ends of pipe segments, and at each change of alignment.

3.9 CLEANING

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.

2. Use purging and disinfecting procedure prescribed per AWWA C651.

3. Complete hydrostatic and disinfection tests before connecting to existing water system.
B. Prepare reports of purging and disinfecting activities.

END OF SECTION 33 11 00
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Polyethylene pipe, tubing, and fittings.

B. Related Sections:
   1. Section 23 21 13.13 - Underground Hydronic Piping and Specialties
   2. Section 33 11 00 – Culinary Water
   3. Section 33 51 13 – Natural Gas Piping and Fittings

1.2 REFERENCES

A. American National Standards Institute (ANSI):
   1. B 16.12 - Cast Iron Screwed Drainage Fittings

B. American Society for Testing and Materials (ASTM):


15. F 1248 - Test Method for Determination of Environmental Stress Crack Resistance (ESCR) of Polyethylene Pipe.

C. American Water Works Association (AWWA):
   1. C 901.
   2. C 906.

D. United States Department of Transportation

1.3 ABBREVIATIONS

A. ID: Inside diameter of piping or tubing.

B. PPI: Plastic Pipe Institute.

C. DR: Dimension ratio.

D. HDPE: High Density Polyethylene Pressure Pipe.

1.4 DEFINITIONS

A. Dimension Ratio (DR): Average outside diameter of pipe divided by the minimum wall thickness.

B. Code Designation: A rating of polyethylene pipe materials by the Plastic Pipe Institute. The designation PE 4710 designates the type of plastic pipe (PE) the grade (47) and the hydrostatic design stress measured in units of 100 psi (10).

1.5 SUBMITTALS

A. Product Data: Describe materials and installation equipment including fusion machine.

B. Manufacturer’s Published Installation Instructions.

C. Certificates:
   1. Submit manufacturer’s certificate attesting that plastic pipe, tubing, and fitting types meet specified requirements.
   2. Manufacturer’s certification of date of manufacture of plastic pipe and tubing for each lot delivered.
3. Product shall carry a standard warranty of one year from date of purchase and a copy shall be submitted from the manufacturer covering their standard terms and conditions of sale.

D. Pipe As-built Surveying. Contractor shall submit drawings indicating as-built conditions of all pipelines.

E. Submit experience (1 year minimum) and training (20 hours minimum) of all persons fusing HDPE pipe. Submit fusion parameters with recommended limits of criteria recorded by data logger.

F. Submit complete mated flanges, 316 SST bolting and SST follower rings, wax tape and filler materials.

G. Submit weekly report of all fused joints showing field quality control and testing for each joint.

H. Before beginning hydrostatic testing, submit a testing plan and schedule. Include proof from a testing lab (or proof of recent purchase of new gage) that pressure gages are accurately calibrated.

I. After hydrostatic testing, submit complete hydrostatic testing report of times, pressures, pumping, volumes, flows, etc.

1.6 QUALITY ASSURANCE

A. Provide pipe and tubing bearing NSF seal, except for drainage piping.

B. Potable water polyethylene pipe shall have a blue stripe.

C. Fire water polyethylene pipe shall have a red stripe.

D. Condenser water polyethylene pipe shall have a gray stripe.

E. Natural gas polyethylene pipe shall have a yellow stripe.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect piping materials from temperatures near or below freezing. Will affect polyethylene pipe by increasing stiffness and vulnerability to impact and damage.

B. Do not allow surface temperatures on pipe and fittings to exceed 160 degrees Fahrenheit.
PART 2 - PRODUCTS

2.1 MINIMUM HDPE PIPE WALL THICKNESSES FOR MAINLINES AND SERVICE LINES

A. All drinking water HDPE pipes shall be DR-11, 200 psi
B. All fire water HDPE pipes shall be DR-11, 200 psi
B. Condenser water HDPE pipes shall be DR-17, 100 psi
C. Natural gas HDPE pipes shall be DR-11, 200 psi

2.2 HIGH DENSITY POLYETHYLENE PIPE (HDPE) PRESSURE PIPE

A. Smooth Pipe Systems

1. Materials used for the manufacturing of high density polyethylene pipe and fittings shall comply with all requirements ASTM D 3350 and have a PPI recommended designation of PE 4710. The molecular weight category shall be extra high (250,000 to 1,500,000) as per the Gel Permeation Chromatography determination procedure with typical value of 330,000. Manufacturer shall be a member in good standing of the Plastic Pipe Institute with materials listed in TR4.

2. All pipe shall be made of virgin material. No rework except that obtained from the manufacturer’s own production of the same formulation shall be used.

3. Fittings: Shall be pressure rated to match the system piping to which they are joined.
   a. Flange Fittings: Shall conform to ANSI/AWWA C110, cast or ductile iron fittings as specified under Section 15061, sized for the dimensions of the pipe being used.

   a. Thermally welded butt fusion in accordance with ASTM F2620.
   b. Flanged, in accordance to AWWA C906.
   c. Electrofusion in accordance with ASTM F 1055, for service connections or pipe 2 inches and less, use with larger pipe will require approval of engineer.
   d. No extrusion welding will be permitted.

5. Concrete anchors: Concrete anchors will be installed on steep slopes and where called for in drawings.
   a. The concrete anchor can be a std. wall anchor, EF flex restraint, or Central’s Electrofusion Restraint Saddle.
   b. Whichever anchoring device is chosen and approved by the engineer will need to have the same pressure rating as the pipe it is fused to.
6. Pipe Markings
   a. Nominal Size and OD base (such as 12 in IPS)
   b. Standard material code designation (such as PE 4710)
   c. Dimension ratio (such as DR11)
   d. Pressure Class (such as PC 200)
   e. AWWA designation number (such as AWWA 90615)
   f. Manufacturer’s production code to include day, month, year, and additional manufacturer’s markings.
   g. Pipe striping shall conform to the following:
      i. Domestic Water – Blue Stripe
      ii. Fire Water – Red Stripe
      iii. Natural Gas – Yellow Stripe
      iv. Condenser Water – Gray Stripe

2.3 POLYETHYLENE TUBING

Polyethylene CTS tube shall be manufactured in accordance with the standard specification for Polyethylene (PEP plastic tubing as issued by the American Standard for Testing and Materials under ASTM D 2737 and AWWA C 901).

A. Material: Polyethylene PE 4710.

B. Plastic Extrusion Compound: PE4710 with a cell classification of PE445574C as defined by ASTM D3350.

C. Dimension ratio: DR 7, 335 psi pressure rating.

D. All tubing shall be cut and installed in a neat and workman like manner by a method recommended by the manufacturer.

E. All tubing shall be Vanguard PE 4710 or approved equal.

2.4 FLANGED HDPE JOINT REQUIREMENTS

A. Flanged HDPE pipe joints shall include 316 SST flange follower rings. Bolts, nuts and washers shall be 316 SST, fabricated per ASME B18.2.2. Buried HDPE flanges shall be wat tape coated (filler wax between bolts and flanges) per Section 09 97 10 and AWWA C217.

2.5 HDPE JOINT TYPES DISALLOWED

A. Electrofusion and grooved joints are not allowed on HDPE pipe on this project. Use butt fusion or flanged joints.
2.6 BOLTS AND NUTS

A. Nuts and Bolts: Stainless steel machined heavy hex heads, Class 2 fit in accordance with ASTM A 307, Grade B; threads in accordance with ASME B.1.1

B. Flange bolts must span the entire width of the flange joint, and provide sufficient thread length to fully engage the nut.

C. Extra-long and higher-strength bolts shall be used where ductile flanges are installed with polyethylene spacers on butterfly valves.

D. Apply wax tape coating on all buried bolts per Section 09 97 10 Cold Applied Wax Tape Coating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Where not otherwise specified, install piping in accordance with ASTM F 645, or manufacturer's published instructions for installation of piping, as applicable to the particular type of piping.

2. Provide molded transition fittings for transitions from plastic to metal or IPS pipe. Do not thread plastic pipe.

3. Locate unions where indicated on the Drawings, and elsewhere where required for adequate access and assembly of the piping system.

4. Provide serrated nipples for transition from plastic pipe to rubber hose.

5. Installation of HDPE PE 4710 Blue Stripe Pipe for Culinary and Green Stripe for Sewer

6. Install piping in accordance with AWWA C 901 and AWWA C 906 complemented with manufacturer’s published instructions.

7. Pipe Joining

a. The polyethylene pipe shall be assembled and joined at the site using the butt-fusion method to provide a leak proof joint. Threaded or solvent-cement joints and connections are not permitted. All equipment and procedures used shall be used in strict compliance with the manufacturer’s recommendations. Fusing shall be accomplished by personnel certified as fusion technicians by a certified fusion trainer.

b. The butt-fused joint shall be true alignment and shall have uniform roll-back beads resulting from the use of proper temperature and pressure. The joint shall be allowed adequate cooling time before removal of pressure. The fused joint shall be watertight and shall have tensile strength equal to that of the pipe. All joints shall be subject to acceptance by the engineer and/or his representative prior to insertion. All defective joints shall be cut out and replaced at no cost to the owner. Any section of the pipe with a gash, blister, abrasion, nick, crack, or other deleterious
fault greater in depth than ten percent (10%) of the wall thickness, shall not be used and must be removed from the site. However, a defective area of pipe may be cut out and the joint fused in accordance with the procedures stated above. In addition, any section of the pipe having other defects such as concentrated ridges, discoloration, excessive spot roughness, pitting, variable wall thickness or any other defect of manufacturing or handling as determined by the Engineer and/or his representative shall be discarded and not used.

c. A polyethylene flange assembly consists of a metal backup flange or ring and a polyethylene stud-end or flange adapter. The back-up flange is placed over the pipe profile, and the stub-end or flange adapter is then fused into the plain end pipe. Flange joining methods shall be used to join polyethylene pipe to valves, ductile iron fittings, fire hydrants and where shown on plans.

8. High Density Polyethylene Pipe is subject to expansion/contraction caused by changes in temperature. Contractor shall allow pipe to adjust to trench temperature prior to backfilling. Also install pipe loosely to accommodate for temperature change.

9. Avoid contacting HDPE Pipe with gasoline or other chemicals which the manufacturer suggests may be absorbed by the HDPE pipe.

B. Joint Fusion Report

1. Measure and log each joint fusion with an electronic monitoring device (data logger) on fusion a machine and retrieve it electronically.

2. Log the following information for each joint
   a. Station of joint fused
   b. Ambient temperature and humidity
   c. If internal bead was removed
   d. Pipe size and dimensions
   e. Machine model / size, operator ID, job # ID, weld #; fusion, heating, and drag pressure settings
   f. Heater plate temp
   g. Time stamp (when weld was done), heating and curing time of weld
   h. Curing temperature readings and time stamps of readings
   i. Error messages and warnings for out of range temperature or pressure settings

C. Joint Weld Testing

1. Contractor shall perform all tests and pay all testing costs.
2. Test Procedure: per ASTM D638.

3. Test Specimens: Cut pipe 12 inches on each side of field made joint. Rejoin ends and proceed with work.

4. Test Frequency: For first 500 feet fused: test 2 joints (Construction Manager to choose location), afterward, test one joint per 2000 feet fused (Construction Manager to choose location).

5. For each joint that fails, Construction Manager to choose two additional joints to test.

D. Certify HDPE wall anchor shear strength is equal to or exceeds the tensile strength of adjacent HDPE pipe

3.2 FIELD QUALITY CONTROL

A. Leakage Test for HDPE pipe and tubing

1. HDPE pipe and tubing: Subject to visible leaks test and to pressure test with maximum leakage allowance.

2. Do not test sections longer than ½ mile in total pipe length.

B. As-built Surveying

1. Survey 50 feet intervals and provide northing, easting and top of pipe elevations to the Engineer.

END OF SECTION 33 11 16
SECTION 33 11 25
PIPELINE TESTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Testing requirements for potable water piping systems.

1.2 DEFINITIONS

A. Leakage: The quantity of water required to maintain the specified hydrostatic test pressure after the pipeline has been filled with water and the air expelled.

B. Non-rigid Pipe: Any pipe which required bedding and backfill material for structural support.

1.3 SUBMITTALS

A. Pipeline Test Report: Include the following items:

1. Type of test.
2. Identification of pipe system.
3. Size, type, location and length of pipe in test section.
4. Test pressure and time.
5. Amount of leakage versus allowable.
6. Date of test approval.
7. Signature of test supervisor.
8. Signature of the Engineer or Inspector witnessing and approving the test.

1.4 PROJECT CONDITIONS

A. Repair pipeline system at no additional cost to Owner until it passes subsequent retesting.

B. Recording Equipment:

1. Supply all necessary equipment to perform pressure testing.
2. Secure Engineer’s approval of pressure gages.
3. Locate all gages and recording equipment away from effect of sunshine or other weather conditions.
4. Place, vents, pressure taps and drains for the test. Repair pipeline at the completion of the test at no cost to the Owner.

PART 2 - PRODUCTS

2.1 TESTING MATERIALS

A. Medium: Water as required by test.

B. Equipment: Temporary motors, pumps, pumping apparatus, pressure gages, connections, power, etc. for making the tests.

PART 3 - EXECUTION

3.1 PREPARATION

A. Pipeline pressure and leakage testing shall be done in accordance with AWWA standards. AWWA C600-99 for ductile iron pipes and AWWA C605-94 for PVC pipes.

B. Notify the Engineer 48 hours in advance of test.

C. Carry out tests as pipeline construction progresses to ensure construction methods are producing satisfactory results.

D. Perform testing in presence of Construction Manager.

E. Using potable water as test medium, water pipelines pipes shall successfully pass a leakage test prior to acceptance.

F. Furnish testing equipment and perform tests in manner satisfactory to Construction Manager. Testing equipment shall provide observable and accurate measurements of leakage under specified conditions. Provide calibrated pressure gauges, pipes, bulkheads, pumps, compressors, chart recorder, and meters to perform the hydrostatic testing.

G. Provide temporary piping to carry test fluid to the piping that is to be tested. After the test has been completed and demonstrated to comply with the specifications, disconnect and remove temporary piping and plug corp stops and taps or connections to the existing piping from which the test fluid was obtained.

H. Isolate new pipelines that are connected to existing pipelines.

I. Conduct field hydrostatic test on buried piping after trench has been completely backfilled. Testing may, as approved by Construction Manager, be done prior to placement of asphaltic concrete or roadway structural section.

J. Provide temporary drain lines needed to carry testing fluid away from the pipe being tested. Remove such temporary drain lines after completing the pressure testing. Pipes shall remain full after testing.
K. Thrust Blocks. Where any section of the piping contains concrete thrust blocks or encasement, do not make the pressure test until at least 10 days after concrete is placed.

L. Test pressure may be limited by valves, or other lower pressure rated components. Such components may not withstand the required test pressure. They should be either removed, or isolated from the test section to avoid possible damage, or failure of these devices. Isolated equipment should be vented.

M. Provide records of each piping installation during the testing. These records shall include:

1. Date and times of test.
2. Identification of process, pipeline, or pipeline section tested or retested, pipe material and pipe specification.
3. Test fluid.
4. Test HGL.
5. Remarks: Leaks identified (type and location), types of repairs, or corrections made.
6. Certification by Contractor that the leakage rate measured conformed to the specifications.

3.2 PRESSURE TEST

A. Maximum filling velocity shall not exceed 0.25 foot per second, calculated based on the full area of pipe.

B. Absorption Time. When testing mortar-lined (or PVC) piping, fill pipe with water and allow it to soak for at least 48 hours to absorb water before conducting pressure test.

C. Expel all air from the pipeline before applying the specified test pressure. Provide air release taps at points of highest elevations before testing. Insert permanent plugs after test has been completed. Contractor shall propose and provide all air release valves and other equipment he feels needed to successfully pass hydrotest.

D. Test Procedure:

1. Test Pressure: Maximum line operation pressure plus 50%.
2. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.

3. The total test time including initial expansion, and time at test pressure, must not exceed eight (8) hours. If the test is not completed due to leakage, equipment failure, etc., depressurize the test section, then allow it to “relax” for at least eight (8) hours before bringing the test section up to test pressure again.

4. The test procedure consists of initial expansion, and test phases. During the initial expansion phase, the test section is pressurized to the test pressure, and enough make-up liquid is added each hour for three (3) hours to return to test pressure.

5. The test phase follows immediately, and may be two (2), or three (3) hours. At the end of the test time, the test section is returned to test pressure by adding a measured amount of liquid.

6. After the test pressure is reached, use a meter to measure the additional water added to maintain the pressure. This amount of water is the loss due to leakage in the piping system.

7. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

8. If measured leakage exceeds allowable leakage or if leaks are visible, repair defective pipe section and repeat hydrostatic test.


10. Maximum Allowable Leakage is defined by:

\[
L = \frac{S \cdot D \cdot \sqrt{\frac{P}{148,000}}}{}
\]

where:
- \(L\) = Allowable leakage, in gallons per hour.
- \(S\) = Length of Pipe, in feet
- \(D\) = Nominal diameter of pipe, in inches.
- \(P\) = Average test pressure during leakage test, in pounds per square inch.

11. If the actual leakage exceeds the allowable on any test, locate and correct the faulty work and repeat the test. Restore the work and all damage resulting from the leak and its repair. Pay for water needed for retesting.

12. An alternate leakage test consists of initial expansion, and test phases. For the initial expansion phase, make-up water is added as required to
maintain the test pressure for three (3) hours. For the test phase, the test pressure is reduced by 10 psi. If the pressure remains steady (within 5% of the target value) for an hour, no leakage is indicated.

F. Suitable means shall be provided by the Contractor for determining water lost by leakage under the test pressure.

G. Locate and repair the defective joints and retest until the leakage is within the specified allowance.

H. Repair any noticeable leakage even if total leakage is less than allowable.

I. Flushing:
   1. After pressure testing all pipelines shall be flushed.
   2. Flushing shall be accomplished through hydrants or, if a hydrant does not exist at the end of the line, the Contractor shall install a tap of sufficient size to provide the required flushing velocity in the line.
   3. Flush the line at a minimum velocity of 2.5 feet per second

3.3 OBSTRUCTION TEST

A. Visually examine pipe internally for obstructions.

B. When required by the Engineer, a round incompressible mandrel which is 1" less in diameter that the internal diameter of the pipeline and 2 times the diameter in length will be passed through the pipeline.

3.4 PIPE TESTING SCHEDULE

A. Potable Water System:
   1. Obstruction test.
   2. Pressure test.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Disinfection of potable water system.
B. Test and report results.

1.2 REFERENCES

A. AWWA A100: AWWA Standard for Water Wells.
B. AWWA B300: AWWA Standard for Hypochlorites.
C. AWWA B301: AWWA Standard for Liquid Chlorine.
D. AWWA C651: AWWA Standard for Disinfecting Water Mains.

1.3 DEFINITIONS

A. Disinfectant Residual: The quantity of disinfectant in treated water.
B. ppm: Parts per million.

1.4 SUBMITTALS

A. Contractors evidence of experience in disinfection.
B. Bacteriological laboratory’s evidence of certification.
C. Contractor’s disinfection plan
   1. Contractor’s disinfection plan shall be submitted for approval by the Engineer 30 days prior to the anticipated date of the beginning of disinfection activities.
D. Operation of valves
   1. Contractor shall only operate valves which were installed as a part of this work. Valves existing prior to this work shall be operated by the Owner’s representatives.
E. Disinfection Report: 3 copies including:
   1. Date issued.
   2. Project name and location.
   3. Treatment contractors name, address and phone number.
   4. Type and form of disinfectant used.
   5. Time and date of disinfectant injection started.
   6. Time and date of disinfectant injection completed.
   7. Test locations.
   8. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
   9. Time and date of flushing start.
  10. Time and date of flushing completion.
  11. Disinfectant residual after flushing in ppm for each outlet tested.

F. Bacteriological Report: 3 copies including:
   1. Date issued.
   2. Project name and location.
   3. Laboratory’s name, certification number, address, and phone number.
   4. Time and date of water sample collection.
   5. Name of person collecting samples.
   6. Test locations.
   7. Time and date of laboratory test start.
   8. Coliform bacteria test results for each outlet tested.
   9. Certification that water conforms or fails to conform to bacterial standards of State of Utah public drinking water regulations.
  10. Bacteriologist’s signature.
1.5 QUALITY ASSURANCE

A. Affidavit by manufacturer that disinfectant conforms to AWWA standards.
B. Bacteriological Laboratory: Certified by State of Utah.

1.6 PRODUCT HANDLING

A. Store and protect disinfectant in accordance with manufacturers recommendations to protect against damage or contamination. Do not use unsuitable disinfectant.
B. Follow all instruction labeling for safe handling and storage of disinfectant materials.

1.7 REGULATORY REQUIREMENTS

A. Conform to State of Utah public drinking water regulations.

PART 2 - PRODUCTS

2.1 DISINFECTANT

A. Liquid Chlorine: AWWA B301 with chlorine 99.5 percent pure by volume.
B. Sodium Hypochlorite: AWWA B300 with not less than 100 grams per liter available chlorine.
C. Calcium Hypochlorite: AWWA B300 with 65 to 70 percent available chlorine by weight in granular form.
D. Powder, tablet, or gas according to manufacturer’s specification.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to starting the disinfection procedure ensure the potable water system is completed, cleaned, tested in accordance with Section 33 11 25 and ready for disinfection.
B. Ensure that the pipeline to be disinfected is not connected to the existing system.

3.2 DISINFECTION OF WATER LINES

A. Use one of the approved methods in AWWA C651.
B. Disinfecting solutions containing chlorine should not exceed 12% active chlorine, because greater concentration can chemically attack and degrade polyethylene.
C. Chlorination shall provide a minimum of 25 ppm residual after 24-hours contact in the pipeline. In general, this residual may be expected with an application of 50 ppm although some conditions may require more.
D. Chlorine, in the form of a 1% slurry of high test calcium hypochlorite (HTH, Perchloron, Pittchlor, etc.) shall be fed into the pipeline in such a manner as to mix with the water flowing in the pipeline. (A 1% slurry results from mixing 1 pound of the calcium hypochlorite with 7.50 gallons of water.)

E. The following table provides information as to the required quantity of slurry to be used per 100 feet of pipe to provide a chlorine concentration of 50 ppm:

<table>
<thead>
<tr>
<th>Pipe Size (In.)</th>
<th>Vol. Of 100 Ft. Length (gal.)</th>
<th>Required Amount of Slurry (gal.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>65</td>
<td>0.33</td>
</tr>
<tr>
<td>6</td>
<td>147</td>
<td>0.74</td>
</tr>
<tr>
<td>8</td>
<td>261</td>
<td>1.3</td>
</tr>
<tr>
<td>10</td>
<td>408</td>
<td>2.0</td>
</tr>
<tr>
<td>12</td>
<td>588</td>
<td>3.0</td>
</tr>
<tr>
<td>16</td>
<td>1044</td>
<td>5.2</td>
</tr>
<tr>
<td>24</td>
<td>2350</td>
<td>11.5</td>
</tr>
</tbody>
</table>

F. During the process of chlorinating the pipeline all valves and other pipeline appurtenances shall be operated several times to provide sufficient contact with the chlorinating agent.

3.4 QUALITY CONTROL - BACTERIOLOGICAL TEST

A. No samples for testing shall be taken sooner than 24 hours after system flushing.

B. Sample water at each of the following locations, as applicable:
   1. Where water enters system.
   2. Ends of piping runs.

C. A minimum of two samples taken at least 24 hours apart shall be taken at each location.

D. Analyze water samples in accordance with State of Utah requirements.

E. If bacteriological tests proves water quality to be unacceptable, repeat system treatment.
F. Water systems shall not be accepted or placed into service until two negative bacteriological tests are made on water taken. Repeat dosing as necessary until negative tests are obtained. Provide a copy of the negative bacteriological tests to the Engineer.

G. It shall be the contractor’s responsibility to submit and pay for the bacteriological tests.

3.5 FLUSHING AND DISPOSAL OF DISINFECTANT

A. After the 24 hour retention period, flush the chlorinated water from the main until chlorine measurements show the concentration in the water leaving the main is no higher than that generally prevailing in the system or is acceptable for domestic use.

B. Legally dispose of disinfecting water and ensure no chlorine buildup or damage to the environment.

C. Failing to flush the line may require Contractor to replace all gaskets and valves within the system at Contractor’s expense.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe and fittings.
   2. Nonpressure and pressure couplings.
   3. Expansion joints.
   5. Encasement for piping.

B. Related Sections:
   1. 2012 APWA Standard Plans and Specifications

1.2 SUBMITTALS

A. Product Data: For expansion joints.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

D. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

E. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC Type PSM Sewer Piping:
   1. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
   2. Fittings: ASTM D 3034, PVC with bell ends.
   3. Pipes joined by elastomeric ring gaskets in accordance with ASTM D-1869
2.2 NONPRESSURE-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
   1. For Concrete Pipes: ASTM C 443, rubber.
   2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

C. Unshielded, Flexible Couplings:
   1. Description: Elastomeric sleeve with corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Ring-Type, Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.3 EXPANSION JOINTS

A. Ductile-Iron, Flexible Expansion Joints:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. EBAA Iron, Inc.
   b. Romac Industries, Inc.
   c. Star Pipe Products.
   3. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated.

2.4 CLEANOUTS

A. Cast-Iron Cleanouts, 6-inches and smaller: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
   1. Top-Loading Classification(s): Medium Duty and Heavy Duty.
   2. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
   3. Security: Cleanout lids located within the secure perimeter fence shall be installed with the Intimidator Manlock Security Lock by McGard or approved equal.
2.5 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478 precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum with less than 3 lines into and out of manhole. 60-inches minimum for manholes with 3 or more lines into and out of manhole.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, of length to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
12. Concrete Colar: Manhole frame anchored into collar.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser, with 4-inch- minimum-width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to “SANITARY SEWER.”
2. Material: ASTM A 536, Grade 80-55-06 ductile or ASTM A 48/A 48M, Class 35B gray iron unless otherwise indicated.
3. Security: Sewer manholes located within the secure perimeter fence shall be installed with the Intimidator Manlock Security Lock by McGard or approved equal.

2.6 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R and the following:

1. Cement: ASTM C 150, Type II.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cement materials ratio.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel, epoxy coated.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cement materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
   a. Invert Slope: 2 percent through manhole.

2. Benches: Concrete, sloped to drain into channel.
   a. Slope: 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cement materials ratio.

2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel, epoxy coated.

2.7 REINFORCING STEEL AND WELDED WIRE

A. All precast and cast in place concrete reinforcement bars and fabric shall be epoxy coated per Section 032000

PART 3 - EXECUTION.

3.1 EARTHWORK

A. Excavating, trenching, and backfilling shall follow 2012 APWA standard specifications.

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of micro-tunneling.

F. Install gravity-flow, non-pressure, drainage piping according to the following:
   1. Install piping pitched down in direction of flow, at slope indicated on drawings.
   2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
   3. Install piping with 48-inch minimum cover.
   4. Install PVC Type PSM SDR-35 sewer piping according to ASTM D 2321 and ASTM F 1668.

G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, non-pressure, drainage piping according to the following:
   1. Join PVC Type PSM SDR-35 sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
   2. Join dissimilar pipe materials with non-pressure-type, flexible couplings.

B. Pipe couplings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
   1. Use non-pressure flexible couplings where required to join gravity-flow, non-pressure sewer piping unless otherwise indicated.
      a. Unshielded flexible couplings for pipes of same or slightly different OD.
      b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
      c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.4 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Form continuous concrete channels and benches between inlets and outlet.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 2 inches above finished surface elsewhere unless otherwise indicated.

E. Install manhole-cover inserts in frame and immediately below cover.
3.5 CONCRETE PLACEMENT

A. CLEANSOUT INSTALLATION

1. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
2. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
3. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
4. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
5. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.6 CONNECTIONS

A. Connect non-pressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste and Vent Piping."

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
   a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
   b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
3.7 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Pipe Trenching." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
   1. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

B. As built information to be provided by contractor. If materials are not installed as indicated on plans, contractor to provide surveyed coordinates and elevations for any materials not constructed per plan

3.8 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
   1. Submit separate report for each system inspection.
   2. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visible between structures.
      b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
      c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
      d. Infiltration: Water leakage into piping.
      e. Exfiltration: Water leakage from or around piping.
   3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   1. Do not enclose, cover, or put into service before inspection and approval.
   2. Test completed piping systems according to requirements of authorities having jurisdiction.
   3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
   4. Submit separate report for each test.
   5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
      a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
      b. Close openings in system and fill with water.
      c. Purge air and refill with water.
      d. Disconnect water supply.
      e. Test and inspect joints for leaks.
   6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
b. Option: Test concrete gravity sewer piping according to ASTM C 924.

7. Manholes: Perform hydraulic test according to ASTM C 969.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.9 CLEANING

A. Clean dirt and superfluous material from interior of piping.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe and fittings.
   2. Channel drainage systems.
   5. Nonpressure transition couplings.
   7. Catch basins.
   8. Stormwater inlets.

B. Related Documents
   1. 2017 APWA Standard Plans and Specifications

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:
   1. Manholes: Include plans, elevations, sections, details, frames, and covers.
   2. Catch basins and stormwater inlets. Include plans, elevations, sections, details, frames, covers, and grates.

C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Corrugated Polyethylene Drainage Pipe
   1. Acceptable manufacturers include the following:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>MANUFACTURER</th>
<th>MANUFACTURER LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrugated Polyethylene Double-Wall Drainage Pipe</td>
<td>ADS</td>
<td>Columbus, OH</td>
</tr>
<tr>
<td></td>
<td>Hancor</td>
<td>Columbus, OH</td>
</tr>
<tr>
<td></td>
<td>Prinsco (Goldflo)</td>
<td>Prinsburg, MN</td>
</tr>
<tr>
<td></td>
<td>Approved Equal</td>
<td></td>
</tr>
</tbody>
</table>
B. The following product design criteria, options and accessories are required:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Criteria</td>
<td>Loading H-20</td>
</tr>
</tbody>
</table>

C. Stainless steel security bars shall be installed at each point where storm drainage passes under the perimeter security fence in all pipes 10 inches in diameter or larger to prevent passage of a human.

2.2 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground non-pressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
   1. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Ring-Type, Flexible Couplings:
   1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.3 MANHOLES

A. Standard Precast Concrete Manholes:
   1. Description: ASTM C 478 precast, epoxy coated reinforced concrete, of depth indicated, with provision for sealant joints.
   2. Diameter: 48 inches minimum unless otherwise indicated.
   3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
   4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
   5. Riser Sections: 4-inch minimum thickness and lengths to provide depth indicated.
   6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
   8. Resilient Pipe Connectors: ASTM C 923 cast or fitted into manhole walls, for each pipe connection.
   9. Steps: Deformed, 1/2-inch reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
   10. Retain one of two subparagraphs below if required to raise top of manhole to grade.
   11. Grade Rings: Epoxy coated reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.
B. Manhole Frames and Covers:
   1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch- minimum width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM DRAIN"
   2. Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.
   3. Security: Manholes located within the secure perimeter fence shall be installed with the Intimidator Manlock Security Lock by McGard or approved equal.

2.4 CONCRETE
A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:
   1. Cement: ASTM C 150, Type II.
B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
   1. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel, epoxy coated
C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
   1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
   2. Benches: Concrete, sloped to drain into channel.
D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
   1. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel, epoxy coated

2.5 CATCH BASINS
A. Standard Precast Concrete Catch Basins:
   1. Description: ASTM C 478 precast, epoxy coated reinforced concrete, of depth indicated, with provision for sealant joints.
   2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
   3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
   4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
   5. Joint Sealant: ASTM C 990 bitumen or butyl rubber.
6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.

7. Grade Rings: Include two or three epoxy coated reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.

8. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 24 by 36 inches minimum unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent unless otherwise indicated.
3. All shall be Bicycle Safe type grates.
4. Grates located within the secure perimeter fence shall be installed with the Intimidator Manlock Security Lock by McGard or approved equal, or be welded.

2.6 STORMWATER INLETS

A. Curb Inlets: Made with vertical curb opening.

B. Gutter Inlets: Made with horizontal gutter opening. Include heavy-duty frames and grates.

C. Combination Inlets: Made with vertical curb and horizontal gutter openings. Include heavy-duty frames and grates.

D. Frames and Grates: Heavy duty.

E. Grates located within the secure perimeter fence shall be installed with the Intimidator Manlock Security Lock by McGard or approved equal, or be welded to the frame.

2.7 PIPE OUTLETS

A. Head Walls: Cast-in-place epoxy coated reinforced concrete, with apron and tapered sides.

B. Riprap Basins: Broken, irregularly sized and shaped, graded stone according to NSSGA's "Quarried Stone for Erosion and Sediment Control."

4. Retain both paragraphs below to require specific stone sizes.


D. Stainless steel security bars shall be installed on all outlet pipes 10 inches in diameter or larger to prevent passage of a human.

E. Riprap: Per Section 31 37 00
2.8 REINFORCING STEEL

A. All precast and cast in place concrete reinforcement bars shall be epoxy coated per Section 032000.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling shall follow Section 31 20 00 and 31 20 01

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Install gravity-flow, non-pressure drainage piping according to the following:
   1. Install piping pitched down in direction of flow.
   2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
   3. Install piping with 24 inches minimum cover.

F. Install drainage pipe to tolerances recommended by manufacturer. Unless otherwise shown, install drainage pipe true and level using precision gauges and levels.

G. Refer variances between manufacturer's installation instructions and Contract Documents to Owner’s Representative.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, non-pressure drainage piping according to the following:
   1. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
   2. Join dissimilar pipe materials with non-pressure-type flexible couplings.
3.4 MANHOLE INSTALLATION
A. General: Install manholes, complete with appurtenances and accessories indicated.
B. Install precast concrete manhole sections with sealants according to ASTM C 891.
C. Where specific manhole construction is not indicated, follow manhole manufacturer’s written instructions.
D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.5 CATCH BASIN INSTALLATION
A. Set frames and grates to elevations indicated.

3.6 STORMWATER INLET AND OUTLET INSTALLATION
A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
B. Construct riprap of broken stone, as indicated.
C. Install outlets that spill onto grade, anchored with concrete, where indicated.
D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
E. Construct energy dissipaters at outlets, as indicated.

3.7 CONCRETE PLACEMENT
A. Place cast-in-place concrete according to ACI 318.

3.8 CONNECTIONS
A. Connect non-pressure, gravity-flow drainage piping in building's storm building drains as detailed in the building plumbing plans.
B. Make connections to existing piping and underground manholes.
   1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
   2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
   3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and
be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.9 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:
   a. Alignment: Less than full diameter of inside of pipe is visible between structures.
   b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
   c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
   d. Infiltration: Water leakage into piping.
   e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
   a. Exception: Piping with soil-tight joints unless required by authorities having jurisdiction.
   b. Option: Test plastic piping according to ASTM F 1417.
   c. Option: Test concrete piping according to ASTM C 924.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
### Item Test for Test Standard (ASTM or Other Test Standard) Frequency First Test Paid For By Retests Paid For By

<table>
<thead>
<tr>
<th>Item</th>
<th>Test for</th>
<th>Test Standard (ASTM or Other Test Standard)</th>
<th>Frequency</th>
<th>First Test Paid For By</th>
<th>Retests Paid For By</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrugated Polyethylene Double-Wall Drainage Pipe</td>
<td>Installation &amp; Leakage</td>
<td>Visual inspection of finished installation</td>
<td>1 inspection</td>
<td>Owner</td>
<td>Owner</td>
</tr>
<tr>
<td></td>
<td>Field Performance</td>
<td>ASTM F2487 Demonstrate compliance to Contract Documents and Manufacturers’ printed Literature</td>
<td>1 test</td>
<td>Contractor</td>
<td>Contractor</td>
</tr>
<tr>
<td></td>
<td>11 month Warranty Inspection</td>
<td>Demonstrate compliance to Contract Documents and Manufacturers printed Literature</td>
<td>1 test</td>
<td>Owner</td>
<td>Contractor</td>
</tr>
</tbody>
</table>

**END OF SECTION**
SECTION 33 51 13
NATURAL GAS PIPING AND FITTINGS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section includes materials and installation of High Density Polyethylene (HDPE) gas pressure pipe.

1.2 RELATED WORK DESCRIBED ELSEWHERE

A. Section 312000: Earthmoving
B. Section 335114: Bronze Process Valves 3-inches and Smaller

1.3 SYSTEM DESCRIPTION

A. Furnish and install complete HDPE pipe to the limits shown on the Plans including appurtenant connections in conformance with manufacturer’s installation requirements and compliance with applicable construction safety codes and standards.

1.4 QUALITY ASSURANCE

A. Manufacturer of pipe and fittings shall employ manufacturing methods and material formulations in use for a minimum of five years.

B. Factory testing shall include the following:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>TEST FOR</th>
<th>TEST STANDARD (ASTM OR OTHER TEST STANDARD)</th>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDPE Pipe</td>
<td>Additives and Fillers including, but not limited to, stabilizers, antioxidants, lubricants, colorants</td>
<td>Less than 5 parts by weight per 100 of PE resin in compound</td>
<td>One test each production lot</td>
</tr>
<tr>
<td>Hydrostatic Design Basis</td>
<td>1250 psi at 73°F per ASTM D2837</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C. Fusing of pipe and fittings shall be performed by personnel certified as fusion technicians by a manufacturer of HDPE pipe and/or fusing equipment.

D. At the time of manufacture, each lot of pipe and fittings shall be inspected for defects and tested for Elevated Temperature Sustain Pressure in accordance with ASTM F714.

E. The Owner or other designated representative shall be entitled to inspect pipes and witness the manufacturing process.

F. Packaging, handling, and shipping of pipe shall be performed in accordance with the Manufacturer’s instructions.


1.5 REFERENCES

A. ASTM D2513 Thermoplastic Gas Pressure Pipe and Fittings
B. ASTM D2683 Socket-Type PE Fittings for Outside Diameter Controlled PE Pipe and Tubing
C. ASTM D2774 Standard Recommended Practice for Underground Installation of Thermoplastic Pressure Piping
D. ASTM D2837 Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
E. ASTM D3261 Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
F. ASTM D3350 Polyethylene Plastics Pipe and Fittings Materials
G. Plastics Pipe Institute (PPI) Handbook of PE Pipe

1.6 SUBMITTALS

A. Furnish the following submittals:

<table>
<thead>
<tr>
<th>SUBMITTAL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catalog Data</td>
<td>Required per catalog data requirements. Required for pipe, couplings, fittings, and installation procedure.</td>
</tr>
<tr>
<td>Fusing Certification</td>
<td>Provide evidence of certification for operators of fusion joining equipment.</td>
</tr>
<tr>
<td>Certificate of Compliance</td>
<td>Deliver with the pipe an affidavit from the pipe manufacturer stating compliance with requirements of the Plans and Specifications.</td>
</tr>
</tbody>
</table>

1.7 DELIVERY, STORAGE, AND HANDLING

A. Packaging, shipping, handling, and storage of pipe shall be performed in accordance with the Manufacturer’s instructions.

B. Transportation shall be by competent haulers and accomplished in a manner that will avoid damage to the pipe and fittings.

C. Unload the pipe by mechanical means, such as a crane or backhoe, or by rope and skids, or by hand, as recommended by the manufacturer. In using skids, pipes must be prevented from striking other pipe. No dropping of pipe from trucks will be allowed.

D. Deliver pipe in coils for pipe 2 inches diameter and smaller. Deliver in straight lengths for pipe larger than 2 inches diameter.

E. Store pipe and fittings in accordance with manufacturer’s recommendations to prevent damage and contamination.
1.8 UNIT PRICES

A. Payment for the Work in this section shall be included as part of the lump-sum or unit-price bid amount for which such Work is appurtenant thereto, including all Work and materials specified herein and as may be required to install and complete this portion of the Work.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers include the following:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>MANUFACTURER</th>
<th>MANUFACTURER LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Density Polyethylene Gas Line Pipe, Fittings and Couplings</td>
<td>Performance Pipe</td>
<td>Plano, TX</td>
</tr>
<tr>
<td></td>
<td>Poly Pipe Inc.</td>
<td>Gainesville, TX</td>
</tr>
<tr>
<td></td>
<td>Approved equal</td>
<td></td>
</tr>
<tr>
<td>Identification Tape</td>
<td>Calpico, Inc.</td>
<td>South San Francisco, CA</td>
</tr>
<tr>
<td></td>
<td>Terra Tape Division Reef Industries</td>
<td>Houston, TX</td>
</tr>
<tr>
<td></td>
<td>Approved equal</td>
<td></td>
</tr>
</tbody>
</table>

2.2 MATERIALS

A. HDPE pipe and fittings shall homogeneous throughout, uniform in color and opacity and free of cracks, holes, blisters voids, foreign inclusions or deleterious faults. Pipe shall meet or exceed the following materials and manufacturing requirements:

<table>
<thead>
<tr>
<th>MATERIAL/COMPONENT</th>
<th>STANDARDS/CHARACTERISTICS</th>
<th>SPECIFICATION/REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>As shown on Plans.</td>
<td></td>
</tr>
<tr>
<td>Wall thickness</td>
<td>SDR-11</td>
<td></td>
</tr>
<tr>
<td>High Density Polyethylene</td>
<td>High density, high-molecular weight polyethylene compound, ASTM D-3350:335434C, PPI:PE 3408/3406, Type III, Grade P34</td>
<td></td>
</tr>
<tr>
<td>Markings</td>
<td>Show nominal pipe size, standard dimension ratio, ASTM material designation, PPI material designation, manufacturer’s production code, and seal of testing agency that verified the suitability of the material for gas service.</td>
<td></td>
</tr>
<tr>
<td>Joints</td>
<td>Style</td>
<td>Thermal butt fusion for joining pipe in accordance with manufacturer’s recommendations.</td>
</tr>
<tr>
<td>Wall thickness</td>
<td>Per manufacturer’s recommenda-</td>
<td></td>
</tr>
<tr>
<td>Fittings</td>
<td>Style</td>
<td>Thermal butt fusion for joining pipe in accordance with manufacturer’s recommendations.</td>
</tr>
<tr>
<td>Standards</td>
<td>ASTM D2683 or ASTM D3261</td>
<td></td>
</tr>
<tr>
<td>MATERIAL/COMPONENT</td>
<td>STANDARDS/CHARACTERISTICS</td>
<td>SPECIFICATION/REQUIREMENT</td>
</tr>
<tr>
<td>--------------------</td>
<td>---------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Material</td>
<td>High density, high molecular weight polyethylene conforming to pipe specifications.</td>
<td></td>
</tr>
<tr>
<td>Manufacturing Process</td>
<td>Injection molded or extruded and machined.</td>
<td></td>
</tr>
<tr>
<td>Wall thickness</td>
<td>Per manufacturer’s recommendations</td>
<td></td>
</tr>
<tr>
<td>Safety factor</td>
<td>2:1 minimum</td>
<td></td>
</tr>
<tr>
<td>Quick Burst Strength</td>
<td>Not less than the pipe connected to fitting.</td>
<td></td>
</tr>
<tr>
<td>Design Service Life</td>
<td>50 years minimum at 73.4°F</td>
<td></td>
</tr>
<tr>
<td>Transition Fittings</td>
<td>Style</td>
<td>Designed for use in connecting HDPE gas pressure pipe to brass bodies valves and steel gas lines.</td>
</tr>
<tr>
<td>Working pressure</td>
<td>Equal to pipe or 150 psi minimum</td>
<td></td>
</tr>
<tr>
<td>Service Saddles</td>
<td>Style</td>
<td>Sidewall fusion type.</td>
</tr>
<tr>
<td>Standards</td>
<td>ASTM D2513</td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td>High density, high molecular weight polyethylene conforming to pipe specifications.</td>
<td></td>
</tr>
<tr>
<td>Working pressure</td>
<td>Equal to pipe or 150 psi minimum</td>
<td></td>
</tr>
<tr>
<td>Quality</td>
<td>Saddle shall accurately fit contour of the pipe OD without causing distortion of the pipe when fused to the pipe.</td>
<td></td>
</tr>
</tbody>
</table>
B. Provide identification for buried HDPE pipe in the following manner:

<table>
<thead>
<tr>
<th>PIPE CONTENTS</th>
<th>IDENTIFICATION/ WARNING/ LOCATING</th>
<th>TYPE</th>
<th>MATERIALS/METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas</td>
<td>Pipe Contents Identification</td>
<td>Yellow stripe</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pipe Warning and Locating</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Warning and Locating Tape</td>
<td>See Section 31 20 01</td>
<td>Color = yellow with black letters</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Polyethylene</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 mils minimum thickness</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6-inch width</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2-inch high letters reading “CAUTION: GAS LINE BURIED BELOW”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Installed in pipe trench 24 inches above pipe</td>
</tr>
<tr>
<td>Metallic Markers</td>
<td>See Section 31 20 01</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.3 VALVES

A. Ball 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 or as approved by the engineer:

   a. Poly-valve gas valve or approved equal.

2.4 VALVE ACCESSORIES AND SPECIALTIES

A. Valve Boxes:

1. Provide valve box with plastic slip sleeve, concrete apron and cast iron cover. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering “GAS,” and bottom section with base that fits over valve and with a barrel approximately 5 inches (125 mm) in diameter.

2. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

PART 3 - EXECUTION

3.1 PREPARATION
A. Prior to installing the pipe, grade and prepare the bottom of the trench to provide uniform bearing throughout the entire length of each pipe. Form a flat or semi-circular trench bottom conforming to the grade to which the pipe is to be installed.

B. Place pipe in the trench accurately to the lines and grades shown on the Plans. Support fittings independently of the pipe.

### 3.2 PIPE INSTALLATION

A. Install HDPE solid wall pipe in accordance with the following requirements:

<table>
<thead>
<tr>
<th>CATEGORY OF WORK</th>
<th>ITEM OF WORK</th>
<th>REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthwork</td>
<td>Excavation and Backfill</td>
<td>Specifications Section 31 23 33</td>
</tr>
<tr>
<td></td>
<td>Pipe Bedding</td>
<td>Sand with SE = 30 or greater</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95% relative density compaction, unless otherwise specified</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thickness = 12 inches</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Placed over full width of trench</td>
</tr>
<tr>
<td></td>
<td>Backfill Within Pipe Zone</td>
<td>Sand with SE = 30 or greater</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95% relative density compaction, unless otherwise specified</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thickness = from bottom of pipe to 12 inches above pipe.</td>
</tr>
<tr>
<td>Cut HDPE Pipe and Fittings</td>
<td>Installation</td>
<td>In accordance with the 1998 CPC, ASTM D2774, and Title 49 CFR § 192.283 as it applies to heat fusion.</td>
</tr>
<tr>
<td></td>
<td>Handling</td>
<td>Prevent damage in handling, moving, unloading, and placing the pipe.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hand lay small diameter pipe. Carefully lower pipe into trench to avoid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>gouging, cutting, or puncturing pipe on edge of concrete, asphalt, rocks,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or other sharp objects. Remove any pipe that has been damaged.</td>
</tr>
<tr>
<td></td>
<td>Joining</td>
<td>Join pipe sections into continuous lengths on the jobsite above ground</td>
</tr>
<tr>
<td></td>
<td></td>
<td>using equipment and methods in strict conformance with the manufacturer's</td>
</tr>
<tr>
<td></td>
<td></td>
<td>recommendations. Maintain the surface temperature of the heater plate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>during fusion within the range recommended by the pipe manufacturer.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Perform sidewall fusion of service saddles using an application tool spe-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>cifically designed for such work. Clean and rough up the surface of the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pipe and the base of the saddle.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hot fusion joining of HDPE end sections, service, taps, and fittings may</td>
</tr>
<tr>
<td></td>
<td></td>
<td>be performed in the excavations.</td>
</tr>
</tbody>
</table>
### CATEGORY OF WORK

<table>
<thead>
<tr>
<th>ITEM OF WORK</th>
<th>REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut the ends of the pipe square with facing tool.</td>
<td></td>
</tr>
<tr>
<td>Make water tight, leak proof joints</td>
<td></td>
</tr>
<tr>
<td>Joints shall be equal in tensile strength to that of the pipe.</td>
<td></td>
</tr>
<tr>
<td>Threaded or solvent-cement joints and connections not allowed.</td>
<td></td>
</tr>
<tr>
<td>Connect in true alignment</td>
<td></td>
</tr>
</tbody>
</table>

C. Close the open end of the pipe with a tight-fitting cap or plug to prevent the entrance of foreign matter into the pipe at all times when pipe installation is not in progress. These provisions shall apply during the noon hour as well as overnight. Do not use the pipeline as a drain for removing water that has infiltrated into the trench. Maintain the inside of the pipe free from foreign materials and in a clean and sanitary condition until its acceptance by the Owner.

D. PE pipe exhibits relatively large expansion and contraction characteristics. Install pipe in such a manner as to avoid failure at tie-in points. Unrestrained PE pipe will expand or contract approximately 1.4” per 100 feet for each 10°F change in temperature. During installation protect PE pipe from lengthy exposure to the sun. Snake PE pipe in the trench to allow for thermal expansion and contraction. Complete connections at tie-in points and fittings only after the pipe has been tested and has been buried in the trench for 24 hours to stabilize the temperature with the surrounding soil.

### 3.3 VALVE INSTALLATION

A. Ball Valves: Installe each underground valve with stem pointing up and with valve box.

### 3.4 FIELD QUALITY CONTROL

A. Visually observe rollback beads at joints resulting from the use of proper temperature and pressure.

B. Allow adequate cooling time at the joint before removal of pressure.

C. All joints are subject to observation by the Engineer and District prior to backfill. All defective joints shall be cut out and replaced at no additional cost to the District.

D. Test all HDPE pipe in accordance with the following:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>TEST STANDARD/REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leakage</td>
<td>No perceptible drop in pressure allowed during leakage test.</td>
</tr>
<tr>
<td>Test Pressure</td>
<td>Unless otherwise modified in the Plans or in this Section, test pressure shall be 60 psig for welded pipe and for gas distribution systems with pressures in excess of 0.5 psig (14 inches of water column).</td>
</tr>
<tr>
<td>ITEM</td>
<td>TEST STANDARD/REQUIREMENT</td>
</tr>
<tr>
<td>---------------</td>
<td>----------------------------------------------------------------</td>
</tr>
<tr>
<td>Test Duration</td>
<td>As required by the Owner, but in no case less than 30 minutes.</td>
</tr>
</tbody>
</table>

3.5 CLEANING

A. Thoroughly clean pipe of all dirt, debris, and foreign matter after testing and prior to completing connections and placing pipe in service.

END OF SECTION 33 51 13
SECTION 33 51 14
BRONZE PROCESS VALVES 3-INCHES AND SMALLER

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section includes materials, testing, and installation of valves 3-inches and smaller on the customer side of meters and laterals including

1. Natural Gas piping.

B. Utility work on the Utility side of meters and laterals is typically covered by other sections which reflect the particular standards for the Servicing Utility.

1.2 RELATED WORK

A. Section 335113: Natural Gas Piping and Fittings

1.3 SYSTEM DESCRIPTION

A. Furnish and install complete operating valves as shown including appurtenant structural, mechanical and/or electrical mountings, connections required for compliance with manufacturer's installation requirements and compliance with applicable building codes and standards.

1.4 QUALITY ASSURANCE

A. Products coming into contact with potable water shall contain no more than 0.25% lead by average weight.

B. Stainless steel products may be substituted for bronze products provided dielectric protection is provided between stainless steel and bronze or copper alloys.

C. National Sanitation Foundation Marking is not required for piping in non-potable water or drainage service.

1.5 REFERENCES

A. ASME/ANSI B1.20.1 NPT National Pipe Thread Taper
B. ANSI/ASME B2.4
C. ANSI/ASME B16.3 Malleable Iron Threaded Fittings, Class 150 and 300
D. ASME/ANSI B16.5 Steel Pipe Flanges and Flanged Fittings (Including ratings for Class 150, 300, 400, 600, 900, 1500, and 2500)
E. ANSI/ASME B16.23 Cast Copper Alloy Solder Joint Drainage Fittings (DWV)
F. ANSI/ASME B16.29 Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings
G. ASTM A217 Steel Castings, Martensitic Stainless and Alloy, for Pressure- Containing Parts, Suitable for High-Temperature Service
H. ASTM B32 Solder Metal
I. ASTM B61 Steam or Valve Bronze Castings
J. ASTM B62 Composition Bronze or Ounce Metal Castings
K. ASTM B88 Copper-Silicon Alloy Rod, Bar and Shapes
L. ASTM B371 Copper-Zinc-Silicon Alloy Rod
M. ASTM B584 Copper Alloy Sand Castings for General Applications
1.6 SUBMITTALS

A. Furnish the following submittals.

<table>
<thead>
<tr>
<th>SUBMITTAL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shop Drawings</td>
<td>Required for each type of valve per shop drawing requirements.</td>
</tr>
<tr>
<td>Catalog Data</td>
<td>Required for each type of valve per catalog data requirements.</td>
</tr>
<tr>
<td>Installation Instructions</td>
<td>Required per installation instruction requirements.</td>
</tr>
<tr>
<td>O &amp; M Instructions</td>
<td>Required per operation and maintenance Instruction requirements.</td>
</tr>
<tr>
<td>Certificate of Compliance</td>
<td>Submit certified report of testing of factory-applied linings.</td>
</tr>
<tr>
<td>Warranty</td>
<td>Furnish 1-year warranty from date of final acceptance for plumbing fixtures.</td>
</tr>
</tbody>
</table>

1.7 DELIVERY, STORAGE AND HANDLING

A. Manufacturer’s instruction and warranty requirements for delivery, storage and handling of plumbing, fixtures, and appurtenant equipment shall be strictly followed.

1.8 UNIT PRICES

A. Payment for the Work in this section shall be included as part of the lump-sum or unit-price bid amount for which such Work is appurtenant thereto.

PART 2 - MATERIALS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers for bronze valves include the following:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>MANUFACTURER</th>
<th>MANUFACTURER LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approved equal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bronze Ball Cone Check Valves 3- inches and smaller</td>
<td>Apollo Valve Div Conbraco Industries 61 Series</td>
<td>Matthews, NC</td>
</tr>
<tr>
<td></td>
<td>Approved equal</td>
<td></td>
</tr>
<tr>
<td>Bronze Swing Check Valves 3- inches and smaller Class 200</td>
<td>A. Y. McDonald Co. Series 2050S</td>
<td>Dubuque, IA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITEM</td>
<td>MANUFACTURER</td>
<td>MANUFACTURER LOCATION</td>
</tr>
<tr>
<td>------</td>
<td>--------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>and smaller Class 150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 inches and smaller青铜阀</td>
<td>Crane Valves Fig 431-UB</td>
<td>Bolingbrook, IL</td>
</tr>
<tr>
<td>3 inches and smaller青铜阀</td>
<td>Fairbanks Valves Fig U-0226</td>
<td>Bakersfield, CA</td>
</tr>
<tr>
<td>3 inches and smaller青铜阀</td>
<td>Hammond Valve Fig IB629</td>
<td>Prairie du Sac WI</td>
</tr>
<tr>
<td>3 inches and smaller青铜阀</td>
<td>Jenkins Valves Inc. Fig 47U</td>
<td>Bolingbrook, IL</td>
</tr>
<tr>
<td>3 inches and smaller青铜阀</td>
<td>Lunkenheimer Co. Fig 3151</td>
<td>Cincinnati, OH</td>
</tr>
<tr>
<td>3 inches and smaller青铜阀</td>
<td>Nibco Inc. Fig T-134</td>
<td>Elkhart, IN</td>
</tr>
<tr>
<td>3 inches and smaller青铜阀</td>
<td>Red-White Valve Co.</td>
<td>Lake Forest, CA</td>
</tr>
<tr>
<td>3 inches and smaller青铜阀</td>
<td>Stockham Valves &amp; Fittings Fig B120</td>
<td>Birmingham, AL</td>
</tr>
<tr>
<td>3 inches and smaller青铜阀</td>
<td>Walworth Co. Fig 11</td>
<td>Houston, TX</td>
</tr>
<tr>
<td>3 inches and smaller青铜阀</td>
<td>William Powell Co. Fig 2714</td>
<td>Cincinnati, OH</td>
</tr>
<tr>
<td>Approved equal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 2.2 MATERIALS

A. Valve materials shall be chemically compatible with chemicals and solutions handled. If any portion of a specified valve is not chemically compatible with chemicals or solutions handled, substitute an appropriate valve during submittals, stating the reason for the exception.

B. Valves shall have name of manufacturer and size of valve cast or molded onto valve body or bonnet or shown on a permanently attached plate.

C. Bronze check valves 3 inches and smaller shall be constructed of the following materials:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>MATERIAL</th>
<th>SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body, and Cap</td>
<td>Bronze</td>
<td>ASTM B61 or B62</td>
</tr>
<tr>
<td>Disc</td>
<td>Bronze</td>
<td></td>
</tr>
</tbody>
</table>

D. Bronze gate valves 3 inches and smaller shall be constructed of the following materials:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>MATERIAL</th>
<th>SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body, bonnet</td>
<td>Bronze</td>
<td>ASTM B61 or B62</td>
</tr>
<tr>
<td>Disc</td>
<td>Bronze</td>
<td>ASTM B61, B62 or B584 Alloy C97600</td>
</tr>
<tr>
<td>Stem</td>
<td>Bronze or Copper Silicon</td>
<td>ASTM B98 (Alloy C65100) ASTM B584 (Alloy C87600) or ASTM B371 (Alloy C69400)</td>
</tr>
<tr>
<td>Handwheels</td>
<td>Bronze or malleable iron</td>
<td></td>
</tr>
<tr>
<td>Packing</td>
<td>Teflon or Kevlararamid fiber</td>
<td></td>
</tr>
</tbody>
</table>

E. Bronze or brass solenoid valves shall be constructed of the following materials:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>MATERIAL</th>
<th>SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body, bonnet</td>
<td>Bronze or Brass</td>
<td>ASTM B61 or B62</td>
</tr>
<tr>
<td>Trim (plunger, core tube plunger spring, and cage assembly)</td>
<td>Stainless Steel</td>
<td>Types 302, 304, or 305</td>
</tr>
<tr>
<td>Seat</td>
<td>Teflon</td>
<td>Renewable composition disc</td>
</tr>
<tr>
<td>Stem</td>
<td>Bronze or Copper Silicon</td>
<td>ASTM B98 (Alloy C65100) ASTM B584 (Alloy C87600) or ASTM B371 (Alloy C69400)</td>
</tr>
<tr>
<td>Handwheels</td>
<td>Bronze or malleable iron</td>
<td></td>
</tr>
</tbody>
</table>
F. The following product design criteria, options and accessories are required on bronze valves:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bronze Gate Valves 3-inches and smaller</td>
<td>End Female threaded ANSI B1.20.1</td>
</tr>
<tr>
<td>Actuator</td>
<td>Handwheel</td>
</tr>
<tr>
<td>Stem</td>
<td>Rising</td>
</tr>
<tr>
<td>Bonnet</td>
<td>Screwed Union</td>
</tr>
<tr>
<td>Disc</td>
<td>Solid wedge type</td>
</tr>
<tr>
<td>Fluid Conveyed</td>
<td>Natural Gas</td>
</tr>
<tr>
<td>Minimum Rated Working Pressure Class 150</td>
<td>(300 WOG psi at 150F)</td>
</tr>
<tr>
<td>Class 200 (400 WOG psi at 150F)</td>
<td></td>
</tr>
<tr>
<td>Class 300 (600 WOG psi at 150F)</td>
<td></td>
</tr>
<tr>
<td>Ends</td>
<td>Female threaded ANSI B1.20.1</td>
</tr>
<tr>
<td>Bronze Pressure Relief Valves Automatic,</td>
<td>Direct pressure actuated</td>
</tr>
<tr>
<td>Capacity labeled and ASME certified.</td>
<td></td>
</tr>
<tr>
<td>Minimum Rated Working Pressure Class 150</td>
<td>(300 WOG psi at 150F)</td>
</tr>
<tr>
<td>Class 200 (400 WOG psi at 150F)</td>
<td></td>
</tr>
<tr>
<td>Class 300 (600 WOG psi at 150F)</td>
<td></td>
</tr>
<tr>
<td>Ends</td>
<td>Female threaded ANSI B1.20.1</td>
</tr>
<tr>
<td>Bronze Solenoid Valves</td>
<td>Actuator Energized to Open / Energized to Close /</td>
</tr>
<tr>
<td></td>
<td>Energized to Open or Close as Shown</td>
</tr>
<tr>
<td>Fluid Conveyed</td>
<td>Natural Gas</td>
</tr>
<tr>
<td>Minimum Rated Working Pressure Class 150</td>
<td>(300 WOG psi at 150F)</td>
</tr>
<tr>
<td>Class 200 (400 WOG psi at 150F)</td>
<td></td>
</tr>
<tr>
<td>Class 300 (600 WOG psi at 150F)</td>
<td></td>
</tr>
<tr>
<td>Ends</td>
<td>Female threaded ANSI B1.20.1</td>
</tr>
<tr>
<td>Bronze Vacuum Breakers Required on</td>
<td>plumbing fixtures and equipment furnished with</td>
</tr>
<tr>
<td></td>
<td>hose connectors</td>
</tr>
<tr>
<td></td>
<td>Shall allow air to enter water line in event</td>
</tr>
<tr>
<td></td>
<td>vacuum occurs in line.</td>
</tr>
<tr>
<td></td>
<td>Air inlet shall close without spillage on initial</td>
</tr>
<tr>
<td></td>
<td>application of line pressure.</td>
</tr>
<tr>
<td>Minimum Rated Working Pressure Class 150</td>
<td>(300 WOG psi at 150F)</td>
</tr>
<tr>
<td>Class 200 (400 WOG psi at 150F)</td>
<td></td>
</tr>
<tr>
<td>Class 300 (600 WOG psi at 150F)</td>
<td></td>
</tr>
<tr>
<td>Ends</td>
<td>Female threaded ANSI B1.20.1</td>
</tr>
<tr>
<td>Power Requirement</td>
<td>120V single phase</td>
</tr>
<tr>
<td>Minimum Rated Working Pressure Class 150</td>
<td>(300 WOG psi at 150F)</td>
</tr>
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<td></td>
</tr>
<tr>
<td>Ends</td>
<td>Female threaded ANSI B1.20.1</td>
</tr>
</tbody>
</table>

PART 3 - EXECUTION

3.1 PREPARATION

A. Make field measurements needed to install valves before submitting shop drawings or ordering. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.

B. Remove scale and dirt on inside and outside of valves before assembly.
3.2 INSTALLATION

A. Install valves according to manufacturer's installation and warranty requirements. Manufacturer's requirements for installation, application, connection, erection, maintenance, operating, cleaning, conditioning and startup of products shall be strictly followed.

B. Use valve hangers and supports as detailed on the drawings, as specified, and as required by applicable plumbing codes.

C. Obtain and review dimensioned shop drawings from valve suppliers before roughing in for any equipment.

D. Provide clearance for installation of insulation and access to valves and fittings.

E. Refer variances between manufacturer's installation instructions and Contract Documents to Owner's Representative.

3.3 FIELD QUALITY CONTROL

A. Use adequate numbers of skilled plumbers who are thoroughly trained and experienced in the necessary trades and crafts and who are completely familiar with the specified requirements and methods needed for proper performance of the work of this section.

B. Field testing shall include the following:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>TEST FOR</th>
<th>TEST STANDARD (ASTM OR OTHER TEST STANDARD)</th>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Valves</td>
<td>Installation &amp; Leakage</td>
<td>Visual inspection for drip tight finished installation under pressure.</td>
<td>1 inspection</td>
</tr>
<tr>
<td>Field Performance</td>
<td>Demonstrate compliance of fixtures and equipment to Contract Documents and Manufacturers' printed Literature</td>
<td>1 test</td>
<td></td>
</tr>
</tbody>
</table>

END OF SECTION 33 51 14