SECTION 01 30 00
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Submittals for review, information, and project closeout.
B. Submittal procedures.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 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.

3.02 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.

3.03 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.

3.04 SUBMITTAL PROCEDURES
A. General Requirements:
   1. Use a single transmittal for related items.
   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.
   a. Submittals from sources other than the Contractor, or without Contractor's stamp will not be acknowledged, reviewed, or returned.

5. Schedule submittals to expedite the Project, and coordinate submission of related items.

6. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.

7. Provide space for Contractor and Architect review stamps.

8. When revised for resubmission, identify all changes made since previous submission.

9. Incomplete submittals will not be reviewed, unless they are partial submittals for distinct portion(s) of the work, and have received prior approval for their use.

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.

3.05 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 78 00
CLOSEOUT SUBMITTALS

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Warranties and bonds.

1.02 RELATED REQUIREMENTS
   A. Individual Product Sections: Warranties required for specific products or Work.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 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 10 00
CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

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

1.02 RELATED REQUIREMENTS
A. Section 03 20 00 - Concrete Reinforcing.
B. Section 03 30 00 - Cast-in-Place Concrete.
C. Section 03 38 00 - Post-Tensioned Concrete.
D. Section 04 20 00 - Unit Masonry: Reinforcement for masonry.
E. Section 31 23 16 - Excavation: Shoring and underpinning for excavation.

1.03 REFERENCE STANDARDS
A. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).
B. ACI 301 - Specifications for Structural Concrete; 2016.
C. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2014 (Errata 2018).
D. ACI 347R - Guide to Formwork for Concrete; 2014.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate pertinent dimensions, materials, bracing, and arrangement of joints and ties.

PART 2 PRODUCTS

2.01 FORMWORK - GENERAL
A. Provide concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work.
B. Design and construct concrete that complies with design with respect to shape, lines, and dimensions.
C. Chamfer outside corners of beams, joists, columns, and walls.
D. Comply with _________ with respect to design, fabrication, erection, and removal of formwork.

PART 3 EXECUTION

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

3.02 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.

3.03 APPLICATION - FORM RELEASE AGENT
A. Apply form release agent on formwork in accordance with manufacturer's recommendations.
3.04 INSERTS, EMBEDDED PARTS, AND OPENINGS
   A. Provide formed openings where required for items to be embedded in passing through concrete work.
   B. Locate and set in place items that will be cast directly into concrete.
   C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.

3.05 FORMWORK TOLERANCES
   A. Construct formwork to maintain tolerances required by ACI 117, unless otherwise indicated.

3.06 FIELD QUALITY CONTROL
   A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.

3.07 FORM REMOVAL
   A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.

END OF SECTION
SECTION 03 20 00
CONCRETE REINFORCING

PART 1 GENERAL

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

1.02 RELATED REQUIREMENTS
   A. Section 03 10 00 - Concrete Forming and Accessories.
   B. Section 03 30 00 - Cast-in-Place Concrete.
   C. Section 03 37 13 - Shotcrete: Reinforcement for shotcrete.
   D. Section 03 38 00 - Post-Tensioned Concrete.
   E. Section 04 20 00 - Unit Masonry: Reinforcement for masonry.
   F. Section 04 29 00 - Engineered Unit Masonry: Reinforcement for engineered masonry.

1.03 REFERENCE STANDARDS
   A. ACI 301 - Specifications for Structural Concrete; 2016.
   B. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2014 (Errata 2018).
   F. CRSI (DA4) - Manual of Standard Practice; 2009.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Shop Drawings: Comply with requirements of ACI SP-66. Include bar schedules, shapes of bent bars, spacing of bars, and location of splices.

1.05 QUALITY ASSURANCE
   A. Perform work of this section in accordance with ACI 301.

PART 2 PRODUCTS

2.01 REINFORCEMENT
   A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi).
   B. Steel Welded Wire Reinforcement (WWR): Galvanized, deformed type; ASTM A1064/A1064M.
   C. Reinforcement Accessories:

2.02 RE-BAR SPlicing:
   A. Coupler Systems: Mechanical devices for splicing reinforcing bars; capable of developing full steel reinforcing design strength in tension and compression.

2.03 FABRICATION
   A. Fabricate concrete reinforcing in accordance with CRSI (DA4) - Manual of Standard Practice.
   B. Welding of reinforcement is not permitted.
PART 3 EXECUTION

3.01 PLACEMENT
A. Place, support and secure reinforcement against displacement. Do not deviate from required position.
B. Accommodate placement of formed openings.

3.02 FIELD QUALITY CONTROL
A. An independent testing agency, as specified in Section 01 40 00 - Quality Requirements, will inspect installed reinforcement for conformance to contract documents before concrete placement.

END OF SECTION
SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Elevated concrete slabs.
B. Floors and slabs on grade.
C. Concrete shear walls, elevator shaft walls, and foundation walls.
D. Joint devices associated with concrete work.
E. Concrete curing.

1.02 RELATED REQUIREMENTS

A. Section 03 10 00 - Concrete Forming and Accessories: Forms and accessories for formwork.
B. Section 03 20 00 - Concrete Reinforcing.
C. Section 03 35 11 - Concrete Floor Finishes: Densifiers, hardeners, applied coatings, and polishing.
D. Section 07 92 00 - Joint Sealants: Products and installation for sealants and joint fillers for saw cut joints and isolation joints in slabs.

1.03 REFERENCE STANDARDS

A. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).
C. ACI 301 - Specifications for Structural Concrete; 2016.
D. ACI 302.1R - Guide to Concrete Floor and Slab Construction; 2015.
H. ACI 308R - Guide to External Curing of Concrete; 2016.
I. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2014 (Errata 2018).
J. ACI 347R - Guide to Formwork for Concrete; 2014.
R. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2015.
V. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2017.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit manufacturers’ data on manufactured products showing compliance with specified requirements and installation instructions.
   1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.
   2. For chemical-resistant waterstops, provide data on ASTM D471 test results.
C. Mix Design: Submit proposed concrete mix design.
D. Samples: Submit samples of underslab vapor retarder to be used.
E. Test Reports: Submit report for each test or series of tests specified.

1.05 QUALITY ASSURANCE
A. Perform work of this section in accordance with ACI 301 and ACI 318.
B. Follow recommendations of ACI 305R when concreting during hot weather.
C. Follow recommendations of ACI 306R when concreting during cold weather.

PART 2 PRODUCTS

2.01 FORMWORK
A. Comply with requirements of Section 03 10 00.
B. Formwork Design and Construction: Comply with guidelines of ACI 347R to provide formwork that will produce concrete complying with tolerances of ACI 117.
C. Form Materials: Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.
   1. Form Coating: Release agent that will not adversely affect concrete or interfere with application of coatings.

2.02 REINFORCEMENT MATERIALS
A. Comply with requirements of Section 03 20 00.
B. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi).
C. Steel Welded Wire Reinforcement (WWR): Galvanized, plain type, ASTM A1064/A1064M.
D. Reinforcement Accessories:
   1. Tie Wire: Annealed, minimum 16 gage, 0.0508 inch.
   2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.

2.03 CONCRETE MATERIALS
A. Cement: ASTM C150/C150M, Type I - Normal Portland type.
B. Fine and Coarse Aggregates: ASTM C33/C33M.
1. Acquire aggregates for entire project from same source.

C. Fly Ash: ASTM C618, Class C or F.

D. Calcined Pozzolan: ASTM C618, Class N.

E. Silica Fume: ASTM C1240, proportioned in accordance with ACI 211.1.

F. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.

2.04 ADMIXTURES

A. Chemical Admixture:

B. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.

C. Air Entrainment Admixture: ASTM C260/C260M.

D. High Range Water Reducing Admixture: ASTM C494/C494M Type F.

E. Water Reducing and Accelerating Admixture: ASTM C494/C494M Type E.

F. Water Reducing and Retarding Admixture: ASTM C494/C494M Type D.

G. Accelerating Admixture: ASTM C494/C494M Type C.

H. Retarding Admixture: ASTM C494/C494M Type B.

I. Water Reducing Admixture: ASTM C494/C494M Type A.

J. Corrosion Inhibiting Admixture:
   1. ASTM C494/C494M, Type C.

2.05 ACCESSORY MATERIALS

A. Underslab Vapor Retarder: Sheet material complying with ASTM E1745, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. The use of single ply polyethylene is prohibited.

   1. Installation: Comply with ASTM E1643.
   2. Accessory Products: Vapor retarder manufacturer’s recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations.

2.06 BONDING AND JOINTING PRODUCTS

A. Waterstops: Bentonite and butyl rubber, complying with NSF 61 and NSF 372.

B. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.

2.07 CURING MATERIALS

A. Evaporation Reducer: Liquid thin-film-forming compound that reduces rapid moisture loss caused by high temperature, low humidity, and high winds; intended for application immediately after concrete placement.


C. Curing Compound, Non-dissipating: Liquid, membrane-forming, clear, non-yellowing acrylic; complying with ASTM C309.

D. Curing and Sealing Compound, Low Gloss: Liquid, membrane-forming, clear, non-yellowing acrylic; complying with ASTM C1315 Type 1 Class A.

2.08 CONCRETE MIX DESIGN

A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.

B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.

   1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended or required by manufacturer.

D. Normal Weight Concrete:
   1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: As indicated on drawings.
   2. Fly Ash Content: Maximum 20 percent of cementitious materials by weight.
   3. Calcined Pozzolan Content: Maximum 10 percent of cementitious materials by weight.
   4. Silica Fume Content: Maximum 5 percent of cementitious materials by weight.

PART 3 EXECUTION

3.01 PREPARATION

A. Formwork: Comply with requirements of ACI 301. Design and fabricate forms to support all applied loads until concrete is cured, and for easy removal without damage to concrete.

B. Verify that forms are clean and free of rust before applying release agent.

C. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.

D. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning and applying bonding agent in accordance to bonding agent manufacturer's instructions.

E. Interior Slabs on Grade: Install vapor retarder under interior slabs on grade. Lap joints minimum 6 inches. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.

3.02 INSTALLING REINFORCEMENT AND OTHER EMBEDDED ITEMS

A. Comply with requirements of ACI 301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place to achieve not less than minimum concrete coverage required for protection.

B. Install welded wire reinforcement in maximum possible lengths, and offset end laps in both directions. Splice laps with tie wire.

C. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with concrete placement.

3.03 PLACING CONCRETE

A. Place concrete in accordance with ACI 304R.

B. Place concrete for floor slabs in accordance with ACI 302.1R.

C. Notify Architect not less than 24 hours prior to commencement of placement operations.

D. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

E. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.

F. Place concrete continuously without construction (cold) joints wherever possible; where construction joints are necessary, before next placement prepare joint surface by removing laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.

G. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

3.04 SLAB JOINTING

A. Locate joints as indicated on drawings.

B. Anchor joint fillers and devices to prevent movement during concrete placement.

C. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
3.05 CONCRETE FINISHING

A. Concrete Slabs: Finish to requirements of ACI 302.1R, and as follows:
   1. Other Surfaces to Be Left Exposed: Trowel as described in ACI 302.1R, minimizing burnish marks and other appearance defects.

3.06 CURING AND PROTECTION

A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

C. Formed Surfaces: Cure by moist curing with forms in place for full curing period.

D. Surfaces Not in Contact with Forms:
   1. Slabs and Floors To Receive Adhesive-Applied Flooring: Curing compounds and other surface coatings are usually considered unacceptable by flooring and adhesive manufacturers. If such materials must be used, either obtain the approval of the flooring and adhesive manufacturers prior to use or remove the surface coating after curing to flooring manufacturer's satisfaction.
   2. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
   3. Final Curing: Begin after initial curing but before surface is dry.

3.07 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.

B. Provide free access to concrete operations at project site and cooperate with appointed firm.

C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.

D. Compressive Strength Tests: ASTM C39/C39M, for each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cubic yards or less of each class of concrete placed.

E. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.

F. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C143/C143M.

3.08 DEFECTIVE CONCRETE

END OF SECTION
PART 1  GENERAL

1.01  RELATED REQUIREMENTS
A. Section 03 10 00 - Concrete Forming and Accessories: Prepared forms to achieve configuration, contours, and tolerances required.
B. Section 03 20 00 - Concrete Reinforcing.
C. Section 03 30 00 - Cast-in-Place Concrete: Reinforcement.
D. Section 31 23 16 - Excavation: Forming earth to achieve contours and surfaces required.

1.02  REFERENCE STANDARDS
A. ACI 506.2 - Specification for Shotcrete; 2013.

1.03  SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate formwork, and dimensions, reinforcement, accessories, and ________.
C. Mix design test reports.

1.04  QUALITY ASSURANCE
A. Perform Work in accordance with ACI 506.2.
B. Applicator Qualifications: Company specializing in performing shotcrete installations, with minimum 5 years of documented experience.

PART 2  PRODUCTS

2.01  MATERIALS
A. Cement: ASTM C150/C150M, Type I - Normal; white color.
C. Admixtures: Chemical type complying with ASTM C494/C494M (wet mix only).
E. Reinforcing Bars: Type and size as indicated on drawings.
F. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to shotcrete.
G. Curing Compound: Water-based, spray-on, penetrating curing compound and hardener; not detrimental to application of subsequent surface finish materials; containing no wax, resin, or solvents.

2.02  SHOTCRETE MIX
A. Provide wet or dry mix design that gives good compaction and low percentage of rebound, is stiff enough not to sag.
2.03 SOURCE QUALITY CONTROL
   A. An independent testing agency will provide inspection and testing services, as specified in Section 01 40 00 - Quality Requirements.
   B. Prior to start of work, testing agency will review mix proportions, gradation, and quality of aggregate.
   C. Provide inspection for compliance with design mix.
   D. Test samples in accordance with ACI 506.2.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify existing conditions before starting work.
   B. Verify that conditions are acceptable and are ready to receive work.
   C. Verify that field measurements are as indicated on drawings.
   D. Verify correct placement of reinforcement with sufficient clearances to permit complete encasement.
   E. Verify that embedded fittings, pipe, conduits, and other items are correctly and securely placed.

3.02 APPLICATION
   A. Place reinforcement in accordance with ACI 506.2.
   B. Use mixing and delivery equipment capable of thoroughly mixing aggregate, cement, and water in sufficient quantity to maintain continuous and uniform placement.
   C. Do not apply shotcrete more than 45 minutes after adding Portland cement to the mix.
   D. Do not place shotcrete on surfaces that are frozen, spongy, or where there is free water.
   E. Build-up to required thickness in multiple passes to achieve layering. Encase reinforcement with the first pass.
   F. Do not permit applied shotcrete to sag, slough, or displace.

END OF SECTION
SECTION 03 38 00
POST-TENSIONED CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Cast-in-place post-tensioned concrete framing members and slabs.
   B. Tensioning tendons and grout filled duct for bonded system.
   C. Sheathing-covered tensioning tendons for unbonded system.

1.02 RELATED REQUIREMENTS
   A. Section 03 10 00 - Concrete Forming and Accessories.
   B. Section 03 20 00 - Concrete Reinforcing: Reinforcement other than tensioning reinforcing.
   C. Section 03 30 00 - Cast-in-Place Concrete: Concrete product, mix, and testing requirements; floor slab tolerances; curing and repair.

1.03 REFERENCE STANDARDS
   A. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).
   B. ACI 301 - Specifications for Structural Concrete; 2016.
   C. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2014 (Errata 2018).
   D. ASTM A416/A416M - Standard Specification for Low-Relaxation, Seven-Wire Steel Strand for Prestressed Concrete; 2018.

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Preinstallation Meeting: Convene one week before starting work of this section.
      1. Discuss tendon locations, sleeve locations, and cautions regarding cutting or core drilling.

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Shop Drawings: Indicate layout, tendon sizes, grouping, spacing, placing sequence, duct sizes, supports and locations, tendon supports, accessories, clearances required for jack, and pressure plate stresses.
   C. Design Data: Indicate calculations for loadings and stresses of designed framing.

1.06 QUALITY ASSURANCE
   A. Designer Qualifications: Design post-tensioned concrete under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State in which the Project is located.
   B. Installer Qualifications: Company specializing in performing the type of work specified in this section with minimum 5 years of documented experience.

PART 2 PRODUCTS

2.01 FORMWORK
   A. Formwork: As specified in Section 03 10 00.

2.02 REINFORCEMENT
   A. Tendon Strand: ASTM A416/A416M, Grade 250 (1725) seven-wire stranded steel cable; low-relaxation type; full length without splices; uncoated.
   B. Tendon Strand: Factory assembled, ASTM A416/A416M, Grade 250 (1725) seven-wire stranded steel cable; low-relaxation type; full length without splices; weldless; covered with polyethylene sheathing providing free movement of tendon within sheathing; complete with end anchorages.
C. Tendon Anchor: Type compatible with tendon, of strength not less than tendon.
D. Tendon Coupling: Type compatible with tendon, of strength equal to or greater than tendon after attachment to tendons.

2.03 ACCESSORIES
A. Duct: Flex metal type, bright coated finish, sized to 200 percent of tendon cross sectional area, with a low point drain hole.
B. Chairs, Bolsters, Bar Supports, Spacers: Size and shape for strength and support of reinforcement during tendon location, installation, and placement of concrete.

2.04 CONCRETE MATERIALS AND MIX DESIGN
A. Concrete Materials: As specified in Section 03 30 00.
B. Mix Design: As specified in Section 03 30 00.

PART 3 EXECUTION
3.01 FORMWORK ERECTION
A. Construct and support formwork in accordance with Section 03 10 00.
B. Provide supports and working space for tensioning jacks.

3.02 TENDON PLACEMENT
A. Locate and position tendons. Protect from displacement. Protect from damage; replace if damaged.
B. Secure jack pressure plates in position perpendicular to line of stressing force.

3.03 PLACING CONCRETE
A. Place concrete in accordance with Section 03 30 00.
B. Verify tendons, anchors, seats, plates, and other items to be cast into concrete are placed and secure.

3.04 TENSIONING
A. Perform tensioning after concrete has reached 3000 psi compressive strength and ambient temperature is above specified requirements, in one steps.
B. Confirm concrete strength with test cylinders prior to tensioning.
C. Measure prestressing force. Maintain jacking and tensioning records as work progresses.
D. Jack against tendon pressure plate, not against concrete.

3.05 GROUTING BONDED SYSTEM
A. Execute grouting within 7 days of tensioning.
B. Flush ducts with water through grouting ports. Blow dry with oil free compressed air. Ensure complete removal of flushing water.
C. Pump grout through ports into ducts under pressure.
D. Cap venting end of grout port. Maintain grout pressure to 250 psi maximum and cap entry port.
E. Grout fill jacking access port.

3.06 GROUTING UNBONDED SYSTEM
A. Grout fill anchorage pockets.

3.07 FIELD QUALITY CONTROL
A. An independent testing agency will conduct field inspection and testing under provisions of Section 01 40 00 - Quality Requirements.
B. Take three concrete test cylinders for every 75 cu yd or less of concrete placed.
C. Take one additional test cylinder during cold weather concreting, cured on site under same conditions as concrete it represents.
D. Take one slump test for each set of test cylinders taken.

3.08 REMOVAL OF FORMS
A. See Section 03 10 00 for requirements for removal of forms.
B. Do not remove forms, shores, and bracing until concrete has been tensioned to strength sufficient to carry its own weight, construction loads, and design loads.

END OF SECTION
SECTION 03 35 11
CONCRETE FLOOR FINISHES

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Surface treatments for concrete floors and slabs.

1.02 ADMINISTRATIVE REQUIREMENTS
   A. Coordinate the work with concrete floor placement and concrete floor curing.

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

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

PART 2 PRODUCTS
2.01 CONCRETE FLOOR FINISH APPLICATIONS
   A. Dry Shake Hardener:
   B. High Gloss Clear Sealer:

2.02 DENSIFIERS AND HARDENERS
   A. Dry Shake Hardener: Premixed dry powder for spreading on and working into concrete surface prior to set.
      2. Color(s): As selected by Architect from manufacturer's standard range.

2.03 COATINGS
   A. Penetrating Sealer: Transparent, non-yellowing, water- or solvent-based coating.
      1. Composition: Siliconate.

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. Protect adjacent non-coated areas from drips, overflow, and overspray; immediately remove excess material.

END OF SECTION
SECTION 03 54 00
CAST UNDERLAYMENT

PART 1  GENERAL

1.01 SECTION INCLUDES
A. Liquid-applied self-leveling floor underlayment.
   1. Use gypsum-based type at gypcrete topping per rated floor assemblies.
   2. Use cementitious type at new floors to receive leveling.

1.02 RELATED REQUIREMENTS
A. Section 01 70 00 - Execution and Closeout Requirements: Alteration project procedures; selective demolition for remodeling.

1.03 REFERENCE STANDARDS
F. ICRI 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair; 2013.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Manufacturer's Instructions.

1.05 QUALITY ASSURANCE

1.06 DELIVERY, STORAGE, AND HANDLING
A. Store products in manufacturer's unopened packaging until ready for installation.
B. Keep dry and protect from direct sun exposure, freezing, and ambient temperature greater than 105 degrees F.

1.07 FIELD CONDITIONS
A. Do not install underlayment until floor penetrations and peripheral work are complete.
B. Maintain minimum ambient temperatures of 50 degrees F 24 hours before, during and 72 hours after installation of underlayment.
C. During the curing process, ventilate spaces to remove excess moisture.

PART 2  PRODUCTS

2.01 MANUFACTURERS
A. Gypsum Underlayment:
   1. ACG Materials; Accucrete: www.acgmaterials.com/#sle.
   2. ARDEX Engineered Cements; ARDEX K 22 F with ARDEX P51 Primer: www.ardexamericas.com/#sle.
B. Cementitious Underlayment:
   1. ARDEX Engineered Cements; ARDEX K 13 with ARDEX P51 Primer: www.ardexamericas.com/#sle.
2. Custom Building Products; CL-150 Self-Leveling Underlayment:
www.custombuildingproducts.com/#sle.
4. Dependable Chemical Co., Inc; ____: www.floorprep.com/#sle.
5. LATICRETE International, Inc; LATICRETE SUPERCAP SC500 with LATICRETE
6. LATICRETE International, Inc; LATICRETE DRYTEK Skimcoat with DRYTEK LEVELEX
Primer: www.laticrete.com/#sle.
7. LATICRETE International, Inc; LATICRETE NXT Level Plus with NXT Primer:
www.laticrete.com/#sle.

2.02 MATERIALS
A. Cast Underlayments, General:
1. Comply with applicable code for combustibility or flame spread requirements.
2. Provide certificate of compliance from authority having jurisdiction indicating approval of
underlayment materials in the required fire rated assembly.

B. Gypsum-Based Underlayment: Gypsum based mix, that when mixed with water in accordance
with manufacturer's directions will produce self-leveling underlayment with the following
properties:
1. Compressive Strength: Minimum 2500 pounds per square inch, tested per ASTM C472.
2. Density: Maximum 130 pounds per cubic foot.
3. Final Set Time: 1 to 2 hours, maximum.
4. Thickness: 3/4 inch to maximum 3-1/2 inch.
5. Surface Burning Characteristics: Flame spread/Smoke developed index of 0/0 in
accordance with ASTM E84.

C. Cementitious Underlayment: Blended cement mix, that when mixed with water in accordance
with manufacturer's directions will produce self-leveling underlayment with the following
properties:
1. Compressive Strength: Minimum 4000 pounds per square inch after 28 days, tested per
ASTM C109/C109M.
2. Flexural Strength: Minimum 1000 psi after 28 days, tested per ASTM C348.
3. Density: 125 pounds per cubic foot, nominal.
4. Final Set Time: 1-1/2 to 2 hours, maximum.
5. Thickness: Capable of thicknesses from feather edge to maximum 3-1/2 inch.
6. Surface Burning Characteristics: Flame spread/Smoke developed index of 0/0 in
accordance with ASTM E84.

D. Aggregate: Dry, well graded, washed silica aggregate, approximately 1/8 inch in size and
acceptable to underlayment manufacturer.
E. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to underlayment mix
materials.
F. Primer: Manufacturer's recommended type.
G. Joint and Crack Filler: Latex based filler, as recommended by manufacturer.

2.03 MIXING
A. Site mix materials in accordance with manufacturer's instructions.
B. Add aggregate for areas where thickness will exceed 1/2 inch. Mix underlayment and water for
at least two minutes before adding aggregate, and continue mixing to assure that aggregate has
been thoroughly coated.
C. Mix to self-leveling consistency without over-watering.
PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that substrate surfaces are clean, dry, unfrozen, do not contain petroleum byproducts, or other compounds detrimental to underlayment material bond to substrate.

3.02 PREPARATION
   A. Concrete: Mechanically prepare steel troweled concrete to create a textured surface necessary to achieve the best bond; acceptable methods include bead blasting and scarifying. Do not use acid etching.
   B. Concrete: Prepare surfaces according to ICRI 310.2R, ______.
   D. Vacuum clean surfaces.
   E. Prime substrate in accordance with manufacturer's instructions. Allow to dry.
   F. Close floor openings.
   G. Install sound control mat in accordance with manufacturer's instructions.

3.03 APPLICATION
   A. Install underlayment in accordance with manufacturer's instructions.
   B. Place to indicated thickness, with top surface level to 1/8 inch in 10 ft.
   C. Where additional aggregate has been used in the mix, add a top layer of neat mix (without aggregate), if needed to level and smooth the surface.

3.04 CURING
   A. Once underlayment starts to set, prohibit foot traffic until final set has been reached.
   B. Air cure in accordance with manufacturer's instructions.

3.05 PROTECTION
   A. Protect against direct sunlight, heat, and wind; prevent rapid drying to avoid shrinkage and cracking.
   B. Do not permit traffic over unprotected floor underlayment surfaces.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Mortar for masonry.
B. Grout for masonry.

1.02 RELATED REQUIREMENTS
A. Section 04 20 00 - Unit Masonry: Installation of mortar and grout.
B. Section 04 20 01 - Masonry Veneer: Installation of mortar.
C. Section 04 25 00 - Unit Masonry Panels: Installation of mortar and grout.
D. Section 04 26 00 - Single-Wythe Unit Masonry: Installation of mortar and grout.
E. Section 04 27 23 - Cavity Wall Unit Masonry: Installation of mortar and grout.
F. Section 04 29 00 - Engineered Unit Masonry: Installation of mortar and grout.
G. Section 08 11 13 - Hollow Metal Doors and Frames: Products and execution for grouting steel door frames installed in masonry.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Include design mix and indicate whether the Proportion or Property specification of ASTM C270 is to be used. Also include required environmental conditions and admixture limitations.
C. Samples: Submit two samples of mortar, illustrating mortar color and color range.
D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
E. Manufacturer's Installation Instructions: Submit packaged dry mortar manufacturer's installation instructions.

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

1.06 PRECONSTRUCTION TESTING
A. Mortar Mixes: Test mortars prebatched by weight in accordance with ASTM C780 recommendations for preconstruction testing.
B. Grout Mixes: Test grout batches in accordance with ASTM C1019 procedures.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

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

PART 2 PRODUCTS

2.01 MORTAR AND GROUT APPLICATIONS
A. At Contractor's option, mortar and grout may be field-mixed from packaged dry materials, made from factory premixed dry materials with addition of water only, or ready-mixed.
B. Mortar Color: Natural gray unless otherwise indicated.
   1. Masonry below grade and in contact with earth: Type S.
   2. Exterior Masonry Veneer: Type N.
   3. Exterior Cavity Walls: Type S mortar with Type N pointing mortar.
   4. Engineered Masonry: Type M.
   5. Exterior, Loadbearing Masonry: Type N.
   6. Exterior, Non-loadbearing Masonry: Type N.
   7. Interior, Loadbearing Masonry: Type N.
   8. Interior, Non-loadbearing Masonry: Type O.
   9. Pointing Mortar for Prefaced or Specially Faced Unit Masonry: One part Portland cement, 1/8 part hydrated lime, and two parts graded (80 mesh) aggregate, proportioned by volume. Add aluminum tristearate, calcium stearate, or ammonium stearate equal to 2 percent of Portland cement by weight.
   10. Mortar For Firebrick Masonry: N type.
D. Grout Mix Designs:
   1. Bond Beams andLintels: 3,000 psi strength at 28 days; 8-10 inches slump; provide premixed type in accordance with ASTM C 94/C 94M.
   2. Engineered Masonry: 3,000 psi strength at 28 days; 8-10 inches slump; provide premixed type in accordance with ASTM C 94/C 94M.

2.02 MATERIALS
A. Packaged Dry Material for Mortar for Unit Masonry: Premixed Portland cement, hydrated lime, and sand; complying with ASTM C387/C387M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
   1. Type: Type N.
B. Portland Cement: ASTM C150/C150M.
   1. Type: Type I - Normal; ASTM C150/C150M.

C. Masonry Cement: ASTM C91/C91M.
   1. Type: Type N; ASTM C91/C91M.

D. Hydrated Lime: ASTM C207, Type S.

E. Quicklime: ASTM C5, non-hydraulic type.

F. Mortar Aggregate: ASTM C144.


H. Water: Clean and potable.

I. Bonding Agent: Latex type.

2.03 MORTAR MIXING

A. Ready Mixed Mortar: ASTM C1142, Type equivalent to that specified according to ASTM C270.

B. Thoroughly mix mortar ingredients using mechanical batch mixer, in accordance with ASTM C270 and in quantities needed for immediate use.

C. Maintain sand uniformly damp immediately before the mixing process.

D. Do not use anti-freeze compounds to lower the freezing point of mortar.

E. If water is lost by evaporation, re-temper only within two hours of mixing.

2.04 GROUT MIXING

A. Mix grout in accordance with ASTM C94/C94M.

B. Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C476 for fine and coarse grout.

PART 3 EXECUTION

3.01 PREPARATION

A. Apply bonding agent to existing concrete surfaces.

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

3.02 GROUTING

A. Use either high-lift or low-lift grouting techniques, at Contractor's option, subject to other limitations of Contract Documents.

B. Low-Lift Grouting:
   1. Limit height of pours to 12 inches.
   2. Limit height of masonry to 16 inches above each pour.
   3. Pour grout only after vertical reinforcing is in place; place horizontal reinforcing as grout is poured. Prevent displacement of bars as grout is poured.
   4. Place grout for each pour continuously and consolidate immediately; do not interrupt pours for more than 1-1/2 hours.

C. High-Lift Grouting:
   1. Verify that horizontal and vertical reinforcement is in proper position and adequately secured before beginning pours.
   2. Place grout for spanning elements in single, continuous pour.

3.03 FIELD QUALITY CONTROL

A. An independent testing agency will perform field tests, in accordance with provisions of Section 01 40 00 - Quality Requirements.

B. Test and evaluate mortar in accordance with ASTM C780 procedures.

C. Test and evaluate grout in accordance with ASTM C1019 procedures.
D. Prism Tests: Test masonry and mortar panels for compressive strength in accordance with ASTM C1314, and for flexural bond strength in accordance with ASTM C1072 or ASTM E518/E518M; perform tests and evaluate results as specified in individual masonry sections.

3.04 SCHEDULES

A. Exterior Cavity Wall: Type S mortar with Type N pointing mortar.

END OF SECTION
SECTION 04 29 00
ENGINEERED UNIT MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Concrete block.
   B. Clay facing brick.
   C. Hollow brick.
   D. Reinforcement and anchorage.
   E. Flashings.
   F. Lintels.
   G. Accessories.

1.02 RELATED REQUIREMENTS
   A. Section 03 20 00 - Concrete Reinforcing: Reinforcing steel for grouted masonry.
   B. Section 04 05 11 - Mortar and Masonry Grout.
   C. Section 05 50 00 - Metal Fabrications: Loose steel lintels.
   D. Section 06 10 00 - Rough Carpentry: Nailing strips built into masonry.
   E. Section 07 11 13 - Bituminous Damp proofing: Damp proofing parged masonry surfaces.
   F. Section 07 62 00 - Sheet Metal Flashing and Trim: Through-wall masonry flashings.
   G. Section 07 92 00 - Joint Sealants: Sealing control and expansion joints.

1.03 REFERENCE STANDARDS
   F. ASTM C140/C140M - Standard Test Methods of Sampling and Testing Concrete Masonry Units and Related Units; 2017a.
   G. ASTM C216 - Standard Specification for Facing Brick (Solid Masonry Units Made From Clay or Shale); 2017a.
   K. ASTM C652 - Standard Specification for Hollow Brick (Hollow Masonry Units Made From Clay or Shale); 2017a.
   O. BIA Technical Notes No. 28B - Brick Veneer/Steel Stud Walls; 2005.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Preinstallation Meeting: Convene one week before starting work of this section.

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

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

1.07 DELIVERY, STORAGE, AND HANDLING
A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

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

PART 2 PRODUCTS

2.01 UNIT MASONRY - GENERAL
A. Comply with applicable code for UL (FRD) Assembly No. (RE: Assemblies).

2.02 CONCRETE MASONRY UNITS
A. Concrete Block: Comply with referenced standards and as follows:
   1. Size: Standard units with nominal face dimensions of 16 by 8 inches and nominal depth of 8 inches.
   2. Special Shapes: Provide non-standard blocks configured for corners.
   3. Load-Bearing Units: ASTM C90, normal weight.
      a. Hollow block, as indicated.

2.03 BRICK UNITS
A. Facing Brick: ASTM C216, Type FBS, Grade SW.
   1. Color and Texture: to be as shown in documents.
   2. Actual Size: As indicated on drawings.
   3. Special Shapes: Molded units as required by conditions indicated, unless standard units can be sawn to produce equivalent effect.
   4. Compressive Strength: As indicated on drawings, measured in accordance with ASTM C67/C67M.
B. Hollow Facing and Building Brick: ASTM C652, Grade SW; Type HBS; Class H40V.
   1. Color and Texture: to be as shown in documents.
   2. Actual Size: As indicated on drawings.
   3. Compressive Strength: As indicated on drawings, measured in accordance with ASTM C67/C67M.

2.04 REINFORCEMENT AND ANCHORAGE
A. Reinforcing Steel: Type specified in Section 03 20 00; size as indicated on drawings; galvanized finish.
B. Strap Anchors: Bent steel shapes configured as required for specific situations, 1-1/4 in width, 0.105 in thick, lengths as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face, corrugated for embedment in masonry joint, hot dip galvanized to ASTM A153/A153M, Class B.

2.05 FLASHINGS
A. Metal Flashing Materials: Galvanized Steel, as specified in Section 07 62 00.
B. Metal Flashing Materials:
   1. Prefabricated Metal Flashing: Smooth fabricated 12 oz/sq ft flashing for surface mounted conditions.

C. Combination Non-Asphaltic Flashing Materials - Stainless Steel:
   2. Stainless Steel/Polymer Fabric Flashing - Self-adhering: ASTM A240/A240M; 2 mil type 304 stainless steel sheet bonded on inward facing side to a sheet of polymer fabric that has a clear adhesive with a removable release liner.

D. Membrane Non-Asphaltic Flashing Materials
   1. Composite Polymer Flashings - Self-Adhering: Composite polyethylene; 40 mil thick with pressure-sensitive adhesive and release paper.
   2. EPDM Flashing: ASTM D4637/D4637M, Type I, 0.040 inch thick.

E. Factory-Fabricated Flashing Corners and Ends: Stainless steel.

F. Flashing Sealant/Adhesives: Silicone, polyurethane, or silyl-terminated polyether/polyurethane, or other type required or recommended by flashing manufacturer; type capable of adhering to type of flashing used.

G. Termination Bars: Stainless steel; compatible with membrane and adhesives.

H. Drip Edge: Stainless steel; angled drip with hemmed edge; compatible with membrane and adhesives.

I. Lap Sealants and Tapes: As recommended by flashing manufacturer; compatible with membrane and adhesives.

2.06 ACCESSORIES
   A. Joint Filler: Closed cell polyvinyl chloride; oversized 50 percent to joint width; self expanding; in maximum lengths available.
   C. Nailing Strips: Softwood lumber, preservative treated; as specified in Section 06 10 00.
   D. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.07 MORTAR MIXES
   A. Mortar: As specified in Section 04 05 11.
   B. Ready Mixed Mortar: ASTM C1142, Type RM.

2.08 MORTAR MIXING
   A. Thoroughly mix mortar ingredients using mechanical batch mixer, in accordance with ASTM C270 and in quantities needed for immediate use.
   B. Maintain sand uniformly damp immediately before the mixing process.
   C. Do not use anti-freeze compounds to lower the freezing point of mortar.
   D. If water is lost by evaporation, re-temper only within two hours of mixing.

2.09 GROUT MIXES
   A. Bond Beams and Lintels: 3,000 psi strength at 28 days; 8-10 inches slump; provide premixed type in accordance with ASTM C94/C94M.
   B. Engineered Masonry: 3,000 psi strength at 28 days; 8-10 inches slump; provide premixed type in accordance with ASTM C94/C94M.

2.10 GROUT MIXING
   A. Mix grout in accordance with ASTM C94/C94M.
   B. Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C476 for fine and coarse grout.
C. Add admixtures in accordance with manufacturer’s instructions; mix uniformly.
D. Do not use anti-freeze compounds to lower the freezing point of grout.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that field conditions are acceptable and are ready to receive masonry.
B. Verify that related items provided under other sections are properly sized and located.
C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 PREPARATION
A. Direct and coordinate placement of metal anchors supplied for installation under other sections.
B. Clean reinforcement of loose rust.
C. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.03 COURSING
A. Establish lines, levels, and coursing indicated. Protect from displacement.
B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
C. Concrete Masonry Units:
D. Brick Units:

3.04 PLACING AND BONDING
A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
B. Lay hollow masonry units with face shell bedding on head and bed joints.

3.05 REINFORCEMENT AND ANCHORAGE
A. Reinforcement Bars: Secure at locations indicated and to avoid displacement during grouting. Minimum spacing between bars or to masonry surfaces shall be one bar diameter.
B. Anchors: Reinforce stack bonded unit joint corners and intersections with strap anchors 16 inches on center.
C. Anchors: Fasten anchors to structural framing and embed in masonry joints as masonry is laid. Unless otherwise indicated on drawings or closer spacing is indicated under specific wall type, space anchors at maximum of 36 inches horizontally and 24 inches vertically.

3.06 MASONRY FLASHINGS
A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.
   1. Extend flashings full width at such interruptions and at least 6 inches, minimum, into adjacent masonry or turn up at least 1 inch, minimum, to form watertight pan at non-masonry construction.
   2. Remove or cover protrusions or sharp edges that could puncture flashings.
   3. Seal lapped ends and penetrations of flashing before covering with mortar.
B. Terminate flashing up 8 inches minimum on vertical surface of backing:
   1. Install vertical leg of flashing behind water-resistive barrier sheet over backing.
   2. Install vertical leg of flashing over fluid-applied or self-adhered air/vapor barriers over backing or per manufacturer’s directions.
C. Install flashing in accordance with manufacturer’s instructions and BIA Technical Notes No. 7.
D. Extend metal flashings through exterior face of masonry and terminate in an angled drip with hemmed edge. Install joint sealer below drip edge to prevent moisture migration under flashing.
E. Lap end joints of flashings at least 6 inches, minimum, and seal watertight with flashing sealant/adhesive.

3.07 GROUTING
A. Use either high-lift or low-lift grouting techniques, at Contractor's option, subject to other limitations of Contract Documents.

3.08 CONTROL AND EXPANSION JOINTS
A. Do not continue horizontal joint reinforcement through control or expansion joints.
B. Form expansion joint as detailed on drawings.

3.09 BUILT-IN WORK
A. As work progresses, install built-in metal door frames and other items to be built into the work and furnished under other sections.
B. Install built-in items plumb, level, and true to line.
C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
   1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.
D. Do not build into masonry construction organic materials that are subject to deterioration.

3.10 TOLERANCES
A. Install masonry within the site tolerances found in TMS 402/602.

3.11 CUTTING AND FITTING
A. Cut and fit for chases. Coordinate with other sections of work to provide correct size, shape, and location.
B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.12 PARGING

3.13 FIELD QUALITY CONTROL
A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.
B. Concrete Masonry Unit Tests: Test each variety of concrete unit masonry in accordance with ASTM C140/C140M for compliance with requirements of this specification.
C. Test and evaluate grout in accordance with ASTM C1019 procedures.

3.14 CLEANING
A. Remove excess mortar and mortar smears as work progresses.
B. Replace defective mortar. Match adjacent work.
C. Clean soiled surfaces with cleaning solution.
D. Use non-metallic tools in cleaning operations.

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

END OF SECTION
SECTION 04 72 00
CAST STONE MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Architectural cast stone.
B. Architectural synthetic stone units.
C. Units required are:
   1. Exterior wall units, including wall caps, coping, and sills.
   2. Manufactured stone lintels.
   3. Other items indicated on drawings.

1.02 RELATED REQUIREMENTS
A. Section 04 05 11 - Mortar and Masonry Grout: Mortar for setting cast stone.
B. Section 04 20 00 - Unit Masonry: Installation of cast stone in conjunction with masonry.
C. Section 04 29 00 - Engineered Unit Masonry: Installation of cast stone in conjunction with masonry.
D. Section 07 92 00 - Joint Sealants: Sealing joints indicated to be left open for sealant.
E. Section 32 33 00 - Site Furnishings: Precast concrete, wood or metal benches; precast concrete or metal bollards.

1.03 REFERENCE STANDARDS
A. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2014 (Errata 2018).

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

1.05 DELIVERY, STORAGE, AND HANDLING
A. Deliver cast stone components secured to shipping pallets and protected from damage and discoloration. Protect corners from damage.
B. Number each piece individually to match shop drawings and schedule.
C. Store cast stone components and installation materials in accordance with manufacturer's instructions.
D. Store cast stone components on pallets with nonstaining, waterproof covers. Ventilate under covers to prevent condensation. Prevent contact with dirt.

E. Protect cast stone components during handling and installation to prevent chipping, cracking, or other damage.

F. Store mortar materials where contamination can be avoided.

G. Schedule and coordinate production and delivery of cast stone components with unit masonry work to optimize on-site inventory and to avoid delaying the work.

PART 2 PRODUCTS

2.01 ARCHITECTURAL CAST STONE

   1. Compressive Strength: As specified in ASTM C1364; calculate strength of pieces to be field cut at 80 percent of uncut piece.
   2. Freeze-Thaw Resistance: Demonstrated by laboratory testing in accordance with ASTM C1364.
   3. Surface Texture: Fine grained texture, with no bugholes, air voids, or other surface blemishes visible from distance of 20 feet.
   5. Remove cement film from exposed surfaces before packaging for shipment.

B. Shapes: Provide shapes indicated on drawings.
   1. Variation from Any Dimension, Including Bow, Camber, and Twist: Maximum of plus/minus 1/8 inch or length divided by 360, whichever is greater, but not more than 1/4 inch.
   2. Unless otherwise indicated on drawings, provide:
      a. Wash or slope of 1:12 on exterior horizontal surfaces.
      b. Drips on projecting components, wherever possible.
      c. Raised fillets at back of sills and at ends to be built in.

C. Reinforcement: Provide reinforcement as required to withstand handling and structural stresses; comply with ACI 318.
   1. Pieces More than 24 inches in Any Dimension: Provide full length two-way reinforcement of cross-sectional area not less than 0.25 percent of unit cross-sectional area.

2.02 ARCHITECTURAL SYNTHETIC STONE UNITS

A. Architectural Synthetic Stone Units: Factory-fabricated, high-density cementitious units made from cement, crushed stone, sand, and polymer reinforced with fiberglass strands; designed to simulate appearance of natural stone.
   1. Freeze-Thaw Resistance: Demonstrated by laboratory testing in accordance with ICC-ES AC219.
   2. Surface Texture: Fine grained texture, with no bugholes, air voids, or other surface blemishes visible from distance of 20 feet.
   3. Remove cement film from exposed surfaces before packaging for shipment.

B. Shapes: Provide shapes indicated on drawings.
   1. Variation from Any Dimension, Including Bow, Camber, and Twist: Maximum of plus/minus 1/8 inch or length divided by 360, whichever is greater, but not more than 1/4 inch.
   2. Unless otherwise indicated on drawings, provide:
      a. Wash or slope of 1:12 on exterior horizontal surfaces.
      b. Drips on projecting components, wherever possible.
      c. Raised fillets at back of sills and at ends to be built in.

C. Reinforcement: Provide reinforcement as required to withstand handling and structural stresses; comply with ACI 318.
2.03 MATERIALS

A. Portland Cement: ASTM C150/C150M.
   1. For Units: Type I, white or gray as required to match Architect’s sample.
   2. For Mortar: Type I or II, except Type III may be used in cold weather.
B. Coarse Aggregate: ASTM C33/C33M, except for gradation; granite, quartz, or limestone.
C. Fine Aggregate: ASTM C33/C33M, except for gradation; natural or manufactured sands.
D. Admixtures: ASTM C494/C494M.
E. Water: Potable.
F. Reinforcing Bars: ASTM A615/A615M deformed bars, galvanized.
   1. Galvanized in accordance with ASTM A767/A767M, Class I.
H. Embedded Anchors, Dowels, and Inserts: Type 304 stainless steel, of type and size as required for conditions.
I. Mortar: Portland cement-lime, as specified in Section 04 05 11; do not use masonry cement.
J. Cleaner: General-purpose cleaner designed for removing mortar and grout stains, efflorescence, and other construction stains from new masonry surfaces without discoloring or damaging masonry surfaces; approved for intended use by cast stone manufacturer and by cleaner manufacturer for use on cast stone and adjacent masonry materials.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine construction to receive cast stone components. Notify Architect if construction is not acceptable.
B. Do not begin installation until unacceptable conditions have been corrected.

3.02 INSTALLATION

A. Install in accordance with manufacturer’s instructions.
B. Install cast stone components in conjunction with masonry, complying with requirements of Section 04 20 00.
C. Mechanically anchor cast stone units indicated; set remainder in mortar.
D. Setting:
   1. Drench cast stone components with clear, running water immediately before installation.
   2. Set units in a full bed of mortar unless otherwise indicated.
   3. Fill vertical joints with mortar.
   4. Fill dowel holes and anchor slots completely with mortar or non-shrink grout.

3.03 TOLERANCES

A. Joints: Make all joints 3/8 inch, except as otherwise detailed.
   1. Rake mortar joints 3/4 inch for pointing.
   2. Remove excess mortar from face of stone before pointing joints.
   3. Point joints with mortar in layers 3/8 inch thick and tool to a slight concave profile.
   4. Leave the following joints open for sealant:
      a. Head joints in top courses, including copings, parapets, cornices, sills, and steps.
      b. Joints in projecting units.
      c. Joints between rigidly anchored units, including soffits, panels, and column covers.
      d. Joints below lugged sills and stair treads.
      e. Joints below ledge and relieving angles.
      f. Joints labeled "expansion joint".
B. Installation Tolerances:
1. Variation from Plumb: Not more than 1/8 inch in 10 feet or 1/4 inch in 20 feet or more.
2. Variation from Level: Not more than 1/8 inch in 10 feet or 1/4 inch in 20 feet, or 3/8 inch maximum.
3. Variation in Joint Width: Not more than 1/8 inch in 36 inches or 1/4 of nominal joint width, whichever is less.
4. Variation in Plane Between Adjacent Surfaces (Lipping): Not more than 1/16 inch difference between planes of adjacent units or adjacent surfaces indicated to be flush with units.

3.04 CLEANING
A. Keep cast stone components clean as work progresses.
B. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.

3.05 PROTECTION
A. Protect completed work from damage.
B. Clean, repair, or restore damaged or mortar-splashed work to condition of new work.

END OF SECTION
PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Shop fabricated steel and aluminum items.
   B. Prefabricated ladders and ship ladders.
1.02 REFERENCE STANDARDS
   H. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions; 2015a.
   J. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 1999 (Ed. 2004).
1.03 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. Include erection drawings, elevations, and details where applicable.

PART 2 PRODUCTS
2.01 MATERIALS - STEEL
   A. Steel Sections: ASTM A36/A36M.
   B. Steel Tubing: ASTM A501/A501M hot-formed structural tubing.
   C. Plates: ASTM A283/A283M.
   F. Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, plain.
   G. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
   H. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
2.02 FABRICATION
   A. Fit and shop assemble items in largest practical sections, for delivery to site.
   B. Fabricate items with joints tightly fitted and secured.
C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

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

2.03 FABRICATED ITEMS

A. Ladders: Steel; in compliance with ANSI A14.3; with mounting brackets and attachments; prime paint finish.
   1. Side Rails: 3/8 x 2 inches members spaced at 20 inches.
   2. Rungs: one inch diameter solid round bar spaced 12 inches on center.
   3. Space rungs 7 inches from wall surface.

B. Bollards: Steel pipe, concrete filled, crowned cap, as detailed; prime paint finish.

2.04 FINISHES - STEEL

A. Prime paint steel items.
B. Prepare surfaces to be primed in accordance with SSPC-SP2.
C. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
D. Prime Painting: One coat.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install items plumb and level, accurately fitted, free from distortion or defects.
B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
C. Obtain approval prior to site cutting or making adjustments not scheduled.

END OF SECTION
SECTION 05 51 00
METAL STAIRS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Stairs with concrete treads.
B. Structural steel stair framing and supports.
C. Handrails and guards.

1.02 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Placement of metal anchors in concrete.
B. Section 04 20 00 - Unit Masonry: Placement of metal fabrications in masonry.
C. Section 05 52 13 - Pipe and Tube Railings: Metal handrails for the stairs specified in this section.
D. Section 09 91 23 - Interior Painting: Paint finish.
E. Section 10 14 00 - Signage: Photoluminescent markings.

1.03 REFERENCE STANDARDS

G. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2013.
K. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions; 2015a.
L. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2012.
N. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
O. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 1999 (Ed. 2004).
1.04 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.

1.05 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. Photoluminescent Stair Accessories: Comply with applicable building code.
   5. Dimensions: As indicated on drawings.
   6. Shop assemble components; disassemble into largest practical sections suitable for transport and access to site.
   7. No sharp or rough areas on exposed travel surfaces and surfaces accessible to touch.
   8. 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. Commercial: Exposed joints as inconspicuous as possible, whether welded or mechanical; underside of stair not covered by soffit IS considered exposed to view.
      a. Welded Joints: Intermittently welded on back side, filled with body putty, and sanded smooth and flush.
      b. Welds Exposed to View: Ground smooth and flush.
      c. Mechanical Joints: Butted tight, flush, and hairline.
      d. Bolts Exposed to View: Countersunk flat or oval head bolts; no exposed nuts.
      e. Exposed Edges and Corners: Eased to small uniform radius.
      f. Metal Surfaces to be Painted: Sanded or ground smooth, suitable for satin or matte finish.
   3. Service: Exposed joints tight with face surfaces aligned; underside of stair not covered by soffit is not considered exposed to view.
      a. Welded Joints: Welded on back side wherever possible.
      b. Welds Exposed to View: Ground smooth; not required to be flush.
      c. Bolts Exposed to View: Countersunk flat or oval head bolts; no exposed nuts or screw threads.
d. Metal Surfaces to be Painted: Sanded smooth, suitable for satin or matte finish.

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

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

B. Risers: Open.

C. Treads: Metal pan with field-installed concrete fill.
   1. Concrete Depth: 1-1/2 inches, minimum.
   2. Tread Pan Material: Steel sheet.
   3. Tread Pan Thickness: As required by design; 14 gage, 0.075 inch minimum.
   4. Concrete Reinforcement: None.
   5. Concrete Finish: For resilient floor covering.

D. Stringers: Rolled steel channels.
   1. Stringer Depth: As indicated on drawings.
   2. End Closure: Sheet steel of same thickness as risers welded across ends.

E. Railings: Steel pipe railings.

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

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

2.03 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: Pipe railings as specified in Section 05 52 13.

2.04 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. Steel Plates: ASTM A6/A6M or ASTM A283/A283M.


E. Ungalvanized Steel Sheet: Hot- or cold-rolled, except use cold-rolled where finished work will be exposed to view.
   1. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Designation CS (commercial steel).
   2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Designation CS (commercial steel).

2.05 ACCESSORIES

   1. Finish: Manufacturer's standard clear anodized.
   2. Color: To be selected by Architect from manufacturer's standard range.

B. Photoluminescent Handrail Strips: Manufacturer's standard clear anodized aluminum extrusion with embedded photoluminescent strip, complies with UL 1994.

C. Steel Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, and galvanized to ASTM A153/A153M where connecting galvanized components.

D. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

E. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
2.06 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.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION
   A. When field welding is required, clean and strip primed steel items to bare metal.
   B. Supply items required to be cast into concrete and embedded in masonry with setting templates.

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

3.04 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 07 11 13
BITUMINOUS DAMPPROOFING

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Bituminous dampproofing.
B. Protection boards.
C. Drainage panels.

1.02 REFERENCE STANDARDS

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

1.04 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.
B. Primers, Mastics, and Related Materials: Type as recommended by dampproofing manufacturer.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify existing conditions are acceptable prior to starting this work.
B. Verify substrate surfaces are durable, free of matter detrimental to adhesion or application of 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. Foundation Walls: Patch disturbed areas of existing dampproofing with two additional coats of dampproofing of the same generic type.
C. Perform this work in accordance with manufacturer’s instructions and NRCA (WM) applicable requirements.

D. Prime surfaces in accordance with manufacturer’s instructions and NRCA (WM) applicable requirements.

E. Apply bitumen with mop.

F. Seal items watertight with mastic, that project through dampproofing surface.

END OF SECTION
SECTION 07 12 00
BUILT-UP BITUMINOUS WATERPROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Hot applied asphaltic waterproofing.
   B. Drainage panels.
   C. Protective cover.

1.02 RELATED REQUIREMENTS
   A. Section 07 21 00 - Thermal Insulation: Protection board.

1.03 REFERENCE STANDARDS

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

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

PART 2 PRODUCTS

2.01 WATERPROOFING APPLICATIONS

2.02 HOT ASPHALTIC MATERIALS
   A. Asphalt: ASTM D449/D449M, Type I.

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

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify substrate surfaces are durable and free of matter detrimental to adhesion or application of waterproofing system.

3.02 PREPARATION
   A. Protect adjacent surfaces not designated to receive waterproofing.
   B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer’s instructions.

3.03 WATERPROOFING INSTALLATION
   A. Install waterproofing in compliance with NRCA (WM) and applicable requirements.
   B. Prime surfaces in accordance with manufacturer's instructions and NRCA (WM).
C. Apply moppings of bitumen and embed reinforcement in accordance with manufacturer's instructions.
D. Apply hot bitumen at a temperature limited by equiviscous temperature (EVT) plus or minus 25 degrees F; do not exceed finish blowing temperature for four hours.

3.04 PROTECTION BOARD AND DRAINAGE PANEL INSTALLATION
A. Place drainage panel directly against membrane; butt joints; position to direct drainage downward.
B. Place protection board directly against drainage panel; butt joints.
C. Adhere protection board and drainage panel to substrate with mastic, and scribe and cut boards around projections, penetrations, and interruptions.

3.05 PROTECTION
A. Do not permit traffic over unprotected or uncovered membrane.
B. Protect membrane and board from damage.

END OF SECTION
SECTION 07 13 00
SHEET WATERPROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Sheet Waterproofing:

1.02 RELATED REQUIREMENTS
A. Section 03 30 00 - Cast-in-Place Concrete: Concrete substrate.

1.03 ABBREVIATIONS
A. EPDM - Ethylene Propylene Diene Monomer.

1.04 REFERENCE STANDARDS

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

1.06 FIELD CONDITIONS
A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application and until liquid or mastic accessories have cured.

PART 2 PRODUCTS

2.01 MEMBRANE MATERIALS
A. Self-Adhered Modified Bituminous Sheet Membrane:
   1. Thickness: 60 mil, 0.060 inch, minimum.
   2. Adhesives, Sealants, Tapes, and Accessories: As recommended by membrane manufacturer.

B. Mechanically Attached Elastomeric Sheet Membrane: Composite membrane formed of elastomeric materials bonded to an inner core and covered by a non-woven geotextile fabric, recommended by the manufacturer for direct concrete contact in negative-side waterproofing applications.
   1. Membrane Thickness: 73 mil, minimum
   2. Adhesives, Sealants, Tapes and Accessories: As recommended by membrane manufacturer

C. Butyl Rubber Sheet Membrane: Unreinforced IIR sheet complying with ASTM D6134, Type II.
   1. Thickness: 0.060 inch, minimum.
   2. Sheet Width: As large as is practical, with factory vulcanized splices.
   3. Field Seaming: Contact cement and lap edge sealant.
   4. Adhesives, Sealants, Tapes, and Accessories: As recommended by membrane manufacturer.
   5. Flashing: Cured EPDM rubber sheet.

D. Modified Bituminous Sheet Membrane: Asphalt and polymer modifiers of SBS type, reinforced with non-woven polyester; smooth surfaced.
2.02 ACCESSORIES
   A. Sealant for Cracks and Joints In Substrates: Resilient elastomeric joint sealant compatible with substrates and waterproofing materials.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify existing conditions are acceptable prior to starting this work.
   B. Verify substrate surfaces are durable; free of matter detrimental to adhesion or application of waterproofing system.
   C. Verify items that penetrate surfaces to receive waterproofing are securely installed.

3.02 PREPARATION
   A. Protect adjacent surfaces from damage not designated to receive waterproofing.
   B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions; vacuum substrate clean.
   C. Do not apply waterproofing to surfaces unacceptable to membrane manufacturer.
   D. Fill non-moving joints and cracks with a filler compatible with waterproofing materials.
   E. Seal moving cracks with sealant and non-rigid filler, using procedures recommended by sealant and waterproofing manufacturers.
   F. Prepare building expansion joints at locations as indicated on drawings.
   G. Surfaces for Adhesive Bonding: Apply surface conditioner at a rate recommended by manufacturer, and protect conditioner from rain or frost until dry.
   H. Concrete Surfaces for Adhesive Bonding: Prepare concrete substrate according to ASTM D5295/D5295M.
      1. Remove substances that inhibit adhesion including form release agents, curing compounds admixtures, laitance, moisture, dust, dirt, grease and oil.
      2. Repair surface defects including honeycombs, fins, tie holes, bug holes, sharp offsets, rutted cracks, ragged corners, deviations in surface plane, spalling and delaminations, as described in the reference standard.
      3. Remove and replace areas of defective concrete as specified in Section 03 30 00.
      4. Prepare concrete for adhesive bonded waterproofing using mechanical or chemical methods described in the referenced standard.
      5. Test concrete surfaces as described in the referenced standards. Verify surfaces are ready to receive adhesive bonded waterproofing membrane system.

3.03 INSTALLATION - MEMBRANE
   A. Install membrane waterproofing in accordance with manufacturer's instructions and NRCA (WM) applicable requirements.
   B. Roll out membrane, and minimize wrinkles and bubbles.
   C. Overlap edges and ends, minimum 3 inches, seal permanently waterproof by method recommended by manufacturer, and apply uniform bead of sealant to joint edge.
   D. Reinforce membrane with multiple thickness of membrane material over joints, whether joints are static or dynamic.
   E. Weather lap joints on sloped substrate in direction of drainage, and seal joints and seams.
   F. Flexible Flashings: Seal items watertight that penetrate through waterproofing membrane with flexible flashings.
   G. Seal membrane and flashings to adjoining surfaces.

3.04 INSTALLATION - DRAINAGE PANEL AND PROTECTION BOARD
   A. Place drainage panel directly against membrane, butt joints, place to encourage drainage downward. Scribe and cut boards around projections, penetrations, and interruptions.
B. Place protection board directly against drainage panel; butt joints. Scribe and cut boards around projections, penetrations, and interruptions.

C. Adhere protection board to substrate with compatible adhesive.

3.05 PROTECTION

A. Do not permit traffic over unprotected or uncovered membrane.

END OF SECTION
PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Fluid-Applied Waterproofing:
      1. Hot-applied rubberized asphalt waterproofing.
      2. Cold-applied rubberized asphalt waterproofing.

1.02 ABBREVIATIONS
   A. CSPE - Chlorosulfonated Polyethylene.
   B. HDPE - High-Density Polyethylene.
   D. SBS - Styrene-Butadiene-Styrene.

1.03 REFERENCE STANDARDS
   F. ASTM E154/E154M - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover; 2008a, with Editorial Revision (2013).
   H. NRCA (WM) - The NRCA Waterproofing Manual; 2005.

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

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

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

PART 2 PRODUCTS
2.01 WATERPROOFING APPLICATIONS
   A. Hot-Applied Rubberized Asphalt Waterproofing:
   B. Cold-Applied Rubberized Asphalt Waterproofing:

2.02 FLUID APPLIED WATERPROOFING MATERIALS
      1. Suitable for installation over concrete, gypsum board, and plywood substrates.
      2. Ultimate Elongation: 500 percent, minimum, measured in accordance with ASTM D412.
3. Water Vapor Permeance: 0.016 perms, maximum, measured in accordance with ASTM E96/E96M.
4. Reinforcing: Continuous; manufacturer's standard reinforcing fabric, approved for use with specified product.
5. Finished Coating Thickness: 215 mils, 0.215 inch, minimum.

B. Cold-Applied Rubberized Asphalt Waterproofing: Rubberized asphaltic compound, suitable for installation on concrete and concrete masonry.
   1. Cured Thickness: 60 mils, 0.060 inch, minimum.
   3. Hydrostatic Pressure Resistance: When tested in accordance with ASTM C1306/C1306M, at least 50 pounds per square inch by the rapid test and at least 35 pounds per square inch by the long term test.
   4. Low Temperature Resistance: No cracking, loss of adhesion, splitting or pinholes when tested at minus 15 degrees F in accordance with ASTM C836/C836M.
   5. Adhesion: No separation when tested in accordance with ASTM C836/C836M.
   6. Decay Resistance: No decay when tested in accordance with ASTM E154/E154M.
   7. Wet Film Sag Resistance: No sag or sag within plus/minus 5 mils when tested in accordance with ASTM C836/C836M.
   8. Water Vapor Permeance: Less than one perm, when tested in accordance with ASTM E96/E96M.
   9. Heat Aging Resistance: No cracking, splitting, or pinholes when tested in accordance with ASTM C836/C836M.
  10. Elongation at Break: 1000 percent, minimum, when tested in accordance with ASTM D412.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.
B. Verify substrate surfaces are free of frozen matter, dampness, loose particles, cracks, pits, projections, penetrations, or foreign matter detrimental to adhesion or application of waterproofing system.
C. Verify that substrate surfaces are smooth, free of honeycomb or pitting, and not detrimental to full contact bond of waterproofing materials.
D. Verify items that penetrate surfaces to receive waterproofing are securely installed.

3.02 PREPARATION

A. Protect adjacent surfaces from damage not designated to receive waterproofing.
B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions; vacuum substrate clean.
C. Do not apply waterproofing to surfaces unacceptable to waterproofing manufacturer.
D. Fill non-moving joints and cracks with a filler compatible with waterproofing materials.
E. Seal moving cracks with sealant and non-rigid filler, using procedures recommended by sealant and waterproofing manufacturers.
F. Prepare building expansion joints at locations as indicated on drawings.
G. Install cant strips at inside corners.

3.03 INSTALLATION

A. Install waterproofing to specified minimum thickness in accordance with manufacturers instructions and NRCA (WM) applicable requirements.
B. Seal membrane and flashings to adjoining surfaces.
   1. Install termination bar along edges.
2. Install counterflashing over exposed edges.

3.04 INSTALLATION - DRAINAGE PANEL AND PROTECTION BOARD

3.05 PROTECTION

A. Do not permit traffic over unprotected or uncovered membrane.

END OF SECTION
SECTION 07 19 00
WATER REPELLENTS

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Water repellents applied to exterior and interior, masonry, stone, and concrete surfaces.

1.02 ADMINISTRATIVE REQUIREMENTS
   A. Preinstallation Meeting: Convene a meeting at least one week prior to starting work; require attendance of affected installers; invite Architect and Owner.

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

1.04 QUALITY ASSURANCE
   A. Owner reserves the right to provide continuous independent inspection of surface preparation and application of water repellent.

1.05 MOCK-UP
   A. Prepare a representative surface 36 inch by 36 inch in size using specified materials and preparation and application methods on surfaces identical to those to be coated; approved mock-up constitutes standard for workmanship.

1.06 FIELD CONDITIONS
   A. Protect liquid materials from freezing.
   B. Do not apply water repellent when ambient temperature is lower than 50 degrees F or higher than 100 degrees F.

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

PART 2 PRODUCTS
2.01 MATERIALS
   A. Water Repellent: Non-glossy, colorless, penetrating, water-vapor-permeable, non-yellowing sealer, that dries invisibly leaving appearance of substrate unchanged.
      1. Applications: Vertical surfaces and non-traffic horizontal surfaces.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify existing conditions before starting work.
   B. Verify joint sealants are installed and cured.
   C. Verify surfaces to be coated are dry, clean, and free of efflorescence, oil, or other matter detrimental to application of water repellent.

3.02 PREPARATION
   A. Protection of Adjacent Work:
      1. Protect adjacent landscaping, property, and vehicles from drips and overspray.
      2. Protect adjacent surfaces not intended to receive water repellent.
   B. Prepare surfaces to be coated as recommended by water repellent manufacturer for best results.

3.03 APPLICATION
   A. Apply water repellent in accordance with manufacturer's instructions, using procedures and application methods recommended as producing the best results.
B. Remove water repellent from unintended surfaces immediately by a method instructed by water repellent manufacturer.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Board insulation at cavity wall construction, cavity wall construction, perimeter foundation wall, perimeter foundation wall, underside of floor slabs, underside of floor slabs, over roof deck, over roof deck, over roof sheathing, over roof sheathing, exterior wall behind final wall finish, interior wall with facer providing exposed finish, and interior wall with facer providing exposed finish.

B. Batt insulation and vapor retarder in exterior wall, ceiling, and roof 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.

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 Under Concrete Slabs: Extruded polystyrene (XPS) board.

B. Insulation at Perimeter of Foundation: Extruded polystyrene (XPS) board.

C. Insulation Inside Masonry Cavity Walls: Extruded polystyrene (XPS) carbon black board.

D. Insulation in Metal Framed Walls: Batt insulation with separate vapor retarder.

E. Insulation in Wood Framed Walls: Batt insulation with separate vapor retarder.

F. Insulation in Wood Framed Ceiling Structure: Batt insulation with separate vapor retarder.

G. Insulation Above Lay-In Acoustical Ceilings: Batt insulation with no vapor retarder.

H. Insulation Over Roof Deck: Extruded polystyrene (XPS) board.

2.02 FOAM BOARD INSULATION MATERIALS

A. Extruded Polystyrene (XPS) Board Insulation: Complies with ASTM C578 with either natural skin or cut cell surfaces.
   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. Type and Thermal Resistance, R-value: Type IV, 5.0 (0.88) per 1 inch thickness at 75 degrees F mean temperature.

B. Extruded Polystyrene (XPS) Cavity Wall Insulation Board: Complies with ASTM C578, and manufactured using carbon black technology.
   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. Type and Thermal Resistance, R-value: Type IV, 5.0 (0.88), minimum, 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. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
   2. Formaldehyde Content: Zero.
C. Mineral Fiber Batt Insulation: Flexible or semi-rigid preformed batt or blanket, complying with ASTM C665; friction fit; unfaced flame spread index of 0 (zero) when tested in accordance with ASTM E84.
   1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
   2. Smoke Developed Index: 0 (zero), when tested in accordance with ASTM E84.

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 horizontally on foundation perimeter.
B. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.03 BOARD INSTALLATION AT EXTERIOR WALLS
A. Install boards horizontally on walls.
B. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.04 BOARD INSTALLATION AT CAVITY WALLS
A. Install boards to fit snugly between wall ties.
B. Install boards horizontally on walls.
C. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.05 BOARD INSTALLATION UNDER CONCRETE SLABS
A. Place insulation under slabs on grade after base for slab has been compacted.
B. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.
C. Prevent insulation from being displaced or damaged while placing vapor retarder and placing slab.

3.06 BOARD INSTALLATION OVER LOW SLOPE ROOF DECK
A. Board Installation Over Roof Deck, General:
   1. See applicable roofing specification section for specific board installation requirements.
   2. Ensure vapor retarder is clean and dry, continuous, and ready for application of roofing system.
   3. Fasten insulation to deck in accordance with roofing manufacturer's written instructions and applicable Factory Mutual requirements.
4. Do not apply more insulation than can be covered with roofing in same day.

3.07 BATT INSTALLATION
   A. Install insulation and vapor retarder in accordance with manufacturer’s instructions.
   B. Install in exterior wall and roof 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.

3.08 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.

3.09 PROTECTION
   A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION
SECTION 07 21 29
SPRAYED INSULATION

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Fiberglass insulation applied to underside of structure and placed in walls.

1.02 REFERENCE STANDARDS
   A. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

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

1.04 FIELD CONDITIONS
   A. Maintain acceptable ambient and substrate surface temperatures prior to, during, and after installation of primer and insulation materials and overcoat.

PART 2 PRODUCTS
2.01 MATERIALS
   A. Fiberglass/Mineral Fiber Sprayed Insulation: ASTM C1014.
   B. Thermal Resistance [R-value]: Provided minimum values in accordance with applicable edition of ASHRAE Std 90.1 I-P for envelope requirements of building location and climate zone.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that surfaces are clean, dry, and free of matter that may inhibit adhesion.
   B. Verify that ceiling hangers and supporting clips have been are installed correctly.
   C. Verify other work on and within spaces to be insulated is complete prior to application.

3.02 PREPARATION
   A. Mask and protect adjacent surfaces from overspray or damage.
   B. Apply primer in accordance with manufacturer's instructions.
   C. Install insulation stops between rafters at wall/sloped roof construction to prevent insulation from covering soffit vents or from limiting air circulation from soffit to attic space.

3.03 INSTALLATION
   A. Install sprayed insulation in accordance with manufacturer's instructions.

3.04 PROTECTION
   A. Do not permit subsequent construction work to disturb applied sprayed insulation.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Water-Resistive Barrier: Under exterior wall cladding, over sheathing or other substrate; not air tight or vapor retardant.
B. Vapor Retarders: Materials to make exterior walls, joints between exterior walls and roof, and joints around frames of openings in exterior walls water vapor resistant and air tight.
C. Air Barriers: Materials that form a system to stop passage of air through exterior walls, joints between exterior walls and roof, and joints around frames of openings in exterior walls.

1.02 RELATED REQUIREMENTS
A. Section 03 30 00 - Cast-in-Place Concrete: Vapor retarder under concrete slabs on grade.
B. Section 07 51 00 - Built-Up Bituminous Roofing: Vapor retarder installed as part of roofing system.
C. Section 07 52 00 - Modified Bituminous Membrane Roofing: Vapor retarder installed as part of roofing system.
D. Section 07 53 00 - Elastomeric Membrane Roofing: Vapor retarder installed as part of roofing system.
E. Section 07 54 00 - Thermoplastic Membrane Roofing: Vapor retarder installed as part of roofing system.

1.03 DEFINITIONS
A. Weather Barrier: Assemblies that form either water-resistive barriers, air barriers, or vapor retarders.
B. Air Barrier: Air tight barrier made of material that is relatively air impermeable but water vapor permeable, both to the degree specified, with sealed seams and with sealed joints to adjacent surfaces. Note: For the purposes of this specification, vapor impermeable air barriers are classified as vapor retarders.
C. Water-Resistive Barrier: Water-shedding barrier made of material that is moisture resistant, to the degree specified, intended to be installed to shed water without sealed seams.

1.04 REFERENCE STANDARDS

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

1.06 FIELD CONDITIONS
A. Maintain temperature and humidity recommended by the materials manufacturers before, during and after installation.

PART 2 PRODUCTS

2.01 WEATHER BARRIER ASSEMBLIES
A. Water-Resistive Barrier: Provide on exterior walls under exterior cladding.
    1. Use building wrap unless otherwise indicated.
B. Air Barrier:
   1. On outside surface of sheathing of exterior walls use air barrier coating.

2.02 WATER-RESISTIVE BARRIER MATERIALS (NEITHER AIR BARRIER OR VAPOR RETARDER)

A. Weather-Resistive Barrier, Composite: Tear-resistant polyester sheet with UV-resistant acrylic coating.
   1. Air Permeance: 0.178 cubic feet per minute per square foot, maximum, when tested in accordance with ASTM E2178.
   2. Water Vapor Permeance: 200 perms, minimum, when tested in accordance with ASTM E96/E96M Procedure A (desiccant procedure).
   3. Ultraviolet and Weathering Resistance: Approved in writing by manufacturer for up to 210 days of weather exposure.
   4. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less (Class A), when tested in accordance with ASTM E84.
   6. Seam and Perimeter Tape: As recommended by sheet manufacturer.

2.03 AIR BARRIER MATERIALS (WATER VAPOR PERMEABLE AND WATER-RESISTIVE)

A. Air Barrier, Fluid Applied: Vapor permeable, elastomeric waterproofing.

2.04 ACCESSORIES

A. Sealants, Tapes, and Accessories for Sealing Weather Barrier and Sealing Weather Barrier to Adjacent Substrates: As specified or as recommended by weather barrier manufacturer.


PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces and conditions are ready to accept the work of this section.

3.02 PREPARATION

A. Remove projections, protruding fasteners, and loose or foreign matter that might interfere with proper installation.

B. Clean and prime substrate surfaces to receive adhesives in accordance with manufacturer’s instructions.

3.03 INSTALLATION

A. Install materials in accordance with manufacturer’s instructions.

B. Water-Resistive Barriers: Install continuous barrier over surfaces indicated, with sheets lapped to shed water but with seams not sealed.

C. Air Barriers: Install continuous air tight barrier over surfaces indicated, with sealed seams and with sealed joints to adjacent surfaces.

D. Mechanically Fastened Sheets - On Exterior:
   1. Install sheets shingle-fashion to shed water, with seams generally horizontal.
   2. Overlap seams as recommended by manufacturer but at least 6 inches.
   3. Overlap at outside and inside corners as recommended by manufacturer but at least 12 inches.
   4. Install water-resistant barrier over jamb flashings.
   5. Install air barrier and vapor retarder UNDER jamb flashings.
   6. Install head flashings under weather barrier.
   7. At openings to be filled with frames having nailing flanges, wrap excess sheet into opening; at head, seal sheet over flange and flashing.

E. Openings and Penetrations in Exterior Weather Barriers:
1. Install flashing over sills, covering entire sill frame member, extending at least 5 inches onto weather barrier and at least 6 inches up jambs; mechanically fasten stretched edges.
2. At openings to be filled with frames having nailing flanges, seal head and jamb flanges using a continuous bead of sealant compressed by flange and cover flanges with sealing tape at least 4 inches wide; do not seal sill flange.
3. At openings to be filled with non-flanged frames, seal weather barrier to each side of opening framing, using flashing at least 9 inches wide, covering entire depth of framing.
4. At head of openings, install flashing under weather barrier extending at least 2 inches beyond face of jambs; seal weather barrier to flashing.
5. At interior face of openings, seal gap between window/door frame and rough framing, using joint sealant over backer rod.
6. Service and Other Penetrations: Form flashing around penetrating item and seal to weather barrier surface.

3.04 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.
   B. Coordination of ABAA Tests and Inspections:
      1. Provide testing and inspection required by ABAA QAP.
      2. Notify ABAA in writing of schedule for air barrier work, and allow adequate time for testing and inspection.
      3. Cooperate with ABAA testing agency.
      4. Allow access to air barrier work areas and staging.
      5. Do not cover air barrier work until tested, inspected, and accepted.

3.05 PROTECTION
   A. Do not leave materials exposed to weather longer than recommended by manufacturer.
   B. Do not leave paper- or felt-based barriers exposed to weather for longer than one week.

END OF SECTION
SECTION 07 46 46
FIBER-CEMENT SIDING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Fiber-cement siding.

1.02 RELATED REQUIREMENTS
A. Section 05 40 00 - Cold-Formed Metal Framing: Water-resistive barrier under siding.
B. Section 06 10 00 - Rough Carpentry: Siding substrate.
C. Section 07 25 00 - Weather Barriers: Weather barrier under siding.
D. Section 09 21 16 - Gypsum Board Assemblies: Water-resistive barrier under siding.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit manufacturer's data sheets on each product to be used, including:
   1. Manufacturer's requirements for related materials to be installed by others.
   2. Preparation instructions and recommendations.
   3. Storage and handling requirements and recommendations.
   4. Installation methods, including nail patterns.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Store products under waterproof cover and elevated above grade, on a flat surface.

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

PART 2 PRODUCTS

2.01 FIBER-CEMENT SIDING
A. Panel Siding: Vertically oriented panels made of cement and cellulose fiber formed under high pressure with integral surface texture, complying to ASTM C1186, Type A, Grade II; with machined edges, for nail attachment.
   1. Length (Height): 96 inches, nominal.
   2. Width: 48 inches.
   3. Thickness: varies between 7/16 inch sheets and battens at 3/4 inch, nominal.
   5. Warranty: 50 year limited; transferable.
B. Soffit Panels: Smooth panels of same material and finish.

2.02 ACCESSORIES
A. Trim: Same material and texture as siding.
B. Fasteners: Galvanized or corrosion resistant; length as required to penetrate minimum 1-1/4 inch.

PART 3 EXECUTION

3.01 EXAMINATION
A. Examine substrate, clean and repair as required to eliminate conditions that would be detrimental to proper installation.
B. Verify that water-resistive barrier has been installed over substrate completely and correctly.
C. Do not begin until unacceptable conditions have been corrected.
D. If substrate preparation is responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

### 3.02 PREPARATION

A. Install Sheet Metal Flashing:
1. Above door and window trim and casings.
2. Above horizontal trim in field of siding.

### 3.03 INSTALLATION

A. Install in accordance with manufacturer’s instructions and recommendations.
1. Read warranty and comply with terms necessary to maintain warranty coverage.
2. Use trim details indicated on drawings.
3. Touch up field cut edges before installing.
4. Pre-drill nail holes if necessary to prevent breakage.

B. Joints in Horizontal Siding: Avoid joints in lap siding except at corners; where joints are inevitable stagger joints between successive courses.

C. Joints in Vertical Siding: Install Z-flashing in horizontal joints between successive courses of vertical siding.

D. Do not install siding less than 6 inches from surface of ground nor closer than 1 inch to roofs, patios, porches, and other surfaces where water may collect.

E. After installation, seal joints except lap joints of lap siding; seal around penetrations, and paint exposed cut edges.

### 3.04 PROTECTION

A. Protect installed products until Date of Substantial Completion.

B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION
SECTION 07 54 00
THERMOPLASTIC MEMBRANE ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Mechanically attached system with thermoplastic roofing membrane.
B. Adhered system with thermoplastic roofing membrane.
C. Vapor retarder.
D. Flashings.
E. Roofing cant strips, stack boots, roofing expansion joints, and walkway pads.

1.02 REFERENCE STANDARDS


1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week before starting work of this section.
   1. Review preparation and installation procedures and coordinating and scheduling required with related work.

1.04 SUBMITTALS

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

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original containers, dry and undamaged, with seals and labels intact.
B. Store materials in weather protected environment, clear of ground and moisture.
C. Ensure storage and staging of materials does not exceed static and dynamic load-bearing capacities of roof decking.
D. Protect foam insulation from direct exposure to sunlight.

1.06 FIELD CONDITIONS

A. Do not apply roofing membrane during unsuitable weather.
B. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
C. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.
D. Schedule applications so that no partially completed sections of roof are left exposed at end of workday.

1.07 WARRANTY

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Thermoplastic Polyolefin (TPO) Membrane Roofing Materials:
   2. Firestone Building Products, LLC; _____: www.firestonebpco.com/#sle.

2.02 ROOFING - UNBALLASTED APPLICATIONS

A. Thermoplastic Membrane Roofing: One ply membrane, fully adhered, over vapor retarder and insulation.

B. Acceptable Insulation Types - Constant Thickness Application: Any of the types specified.
   1. Minimum 2 layers of cellulose, perlite, molded polystyrene, polyisocyanurate, glass fiber, extruded polystyrene, or composite board.
   2. Bottom layer of cellulose, perlite, molded polystyrene, polyisocyanurate, glass fiber, extruded polystyrene, composite, or cellular glass board covered with single layer of cellulose, perlite, molded polystyrene, polyisocyanurate, glass fiber, extruded polystyrene, or composite board.

C. Acceptable Insulation Types - Tapered Application:
   1. Tapered polyisocyanurate, perlite, or extruded polystyrene board.

2.03 MEMBRANE ROOFING AND ASSOCIATED MATERIALS

A. Membrane Roofing Materials:
   1. TPO: Thermoplastic polyolefin (TPO) complying with ASTM D6878/D6878M, sheet contains reinforcing fabrics or scrims.
      a. Thickness: 60 mil, 0.060 inch, minimum.
   2. Sheet Width: Factory fabricated into largest sheets possible.

B. Seaming Materials: As recommended by membrane manufacturer.

C. Flexible Flashing Material: Same material as membrane.

2.04 INSULATION

A. Cellulose Fiber Board Insulation: ASTM C208, Type II; natural finish.

B. Perlite Board Insulation: Expanded perlite mineral aggregate, complying with ASTM C728.
   2. Board Thickness: 1/2 inch.
   3. Tapered Board: Slope as indicated; minimum thickness _____ inch; fabricate of fewest layers possible.

C. Expanded Polystyrene (EPS) Board Insulation: Complies with ASTM C578, with drainage channels on one face.
   1. Board Size: 48 by 96 inch.

D. Polyisocyanurate (ISO) Board Insulation: Rigid cellular foam, complying with ASTM C1289.
   1. Classifications:
   2. Board Size: 48 by 96 inch.
   3. Board Thickness: 1.5 inch.
   4. Tapered Board: Slope as indicated; minimum thickness 4 inches; fabricate of fewest layers possible.
E. Glass Fiber Board Insulation: Rigid glass fiber, ASTM C726; top surface coated with asphalt and Kraft paper.
   2. Board Thickness: 1 inches.
F. Extruded Polystyrene (XPS) Board Insulation: Complies with ASTM C578 with natural skin surface, drainage channels on one face.
   1. Board Size: 48 by 96 inch.
   2. Board Thickness: 1-1/2 inches.
   3. Tapered Board: Slope as indicated; minimum thickness 1/2 in; fabricate of fewest layers possible.
G. Composite Board Insulation: Top layer high-density wood fiberboard (HDF), bottom layer polyisocyanurate, complying with ASTM C1289.
   1. Polyisocyanurate surfaces faced with aluminum foil.
   1. Integral Protection Boards: Manufacturer's standard.
I. Cellular Glass Board Insulation: Complying with ASTM C552, Type IV.
   2. Board Thickness: 2 inch.

2.05 ACCESSORIES
   A. Insulation Fasteners: Appropriate for purpose intended and approved by roofing manufacturer.
   B. Membrane Adhesive: As recommended by membrane manufacturer.
   C. Walkway Pads: Suitable for maintenance traffic, contrasting color or otherwise visually distinctive from roof membrane.
      1. Composition: Asphaltic with mineral granule surface.
      2. Surface Color: White or yellow.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that surfaces and site conditions are ready to receive work.
   B. Verify deck is supported and secure.
   C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.
   D. Verify deck surfaces are dry and free of snow or ice.
   E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.
3.02 WOOD DECK PREPARATION
   A. Verify flatness and tightness of joints of wood decking. Fill knot holes with latex filler.
3.03 CONCRETE DECK PREPARATION
   A. Fill surface honeycomb and variations with latex filler.
   B. Confirm dry deck by moisture meter with 12 percent moisture maximum.
3.04 METAL DECK PREPARATION
3.05 INSTALLATION - GENERAL
   A. Perform work in accordance with manufacturer's instructions, NRCA (RM), and NRCA (WM) applicable requirements.
   B. Do not apply roofing membrane during unsuitable weather.
   C. Do not apply roofing membrane when ambient temperature is outside the temperature range recommended by manufacturer.
D. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

3.06 VAPOR RETARDER AND INSULATION - UNDER MEMBRANE
A. Apply vapor retarder to deck surface with adhesive in accordance with manufacturer's instructions.
   1. Extend vapor retarder under cant strips and blocking to deck edge.
   2. Install flexible flashing from vapor retarder to air seal material of wall construction, lap and seal to provide continuity of the air barrier plane.
B. Attachment of Insulation:
   1. Mechanically fasten insulation to deck in accordance with roofing manufacturer's instructions and FM (AG) Factory Mutual requirements.
C. Lay subsequent layers of insulation with joints staggered minimum 6 inch from joints of preceding layer.
D. Place tapered insulation to the required slope pattern in accordance with manufacturer's instructions.
E. On metal deck, place boards parallel to flutes with insulation board edges bearing on deck flutes.
F. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
G. At roof drains, use factory-tapered boards to slope down to roof drains over a distance of 18 inches.
H. Do not apply more insulation than can be covered with membrane in same day.

3.07 MEMBRANE APPLICATION
A. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.
B. Shingle joints on sloped substrate in direction of drainage.
C. Overlap edges and ends and seal seams by contact adhesive, minimum 3 inches. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.
D. At intersections with vertical surfaces:
   1. Extend membrane over cant strips and up a minimum of 4 inches onto vertical surfaces.
   2. Fully adhere flexible flashing over membrane and up to nailing strips.
E. Around roof penetrations, seal flanges and flashings with flexible flashing.
F. Coordinate installation of roof drains and sumps and related flashings.

3.08 CLEANING
A. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.
B. Remove bituminous markings from finished surfaces.
C. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and comply with their documented instructions.
D. Repair or replace defaced or damaged finishes caused by work of this section.

3.09 PROTECTION
A. Protect installed roofing and flashings from construction operations.
B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION
PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Fluid-applied roofing materials.
   B. Accessories.

1.02 REFERENCE STANDARDS
   A. CRRC-1 - Standard; Cool Roofs Rating Council; 2017.

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner’s name and registered with manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING
   A. Deliver materials in manufacturer’s original containers, dry and undamaged, with seals and labels intact.
   B. Store materials in weather protected environment, clear of ground and moisture.
   C. Ensure storage and staging of materials does not exceed static and dynamic load-bearing capacities of roof decking.

1.05 FIELD CONDITIONS
   A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application and until cured.
   B. Schedule applications so that no partially completed sections of roof are left exposed at end of workday.

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

PART 2 PRODUCTS
2.01 MANUFACTURERS
   A. Fluid-Applied Roofing:

2.02 MATERIALS
   A. Fluid-Applied Roofing: Gray, cold-applied; single-component or two component; polyurethane, silicone elastomer, or water-based acrylic elastomeric, approved by manufacturer for permanent exposure to weather and sunlight.
      1. Solar Reflectance Index (SRI) - Initial: 110, minimum, determined in accordance with CRRC-1.

2.03 ACCESSORIES
   A. Flexible Flashing Sheet: Neoprene or other elastic type sheets approved by roofing membrane manufacturer.
   B. Cant Strips: Premolded composition material, compatible with roofing membrane.
   C. Counterflashings: As recommended by roofing manufacturer.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify existing conditions prior to starting this work.
B. Verify substrate surfaces are free of frozen matter, dampness, loose particles, cracks, pits, projections, penetrations, or foreign matter detrimental to adhesion or application of roofing system.

C. Verify that roof openings, curbs, and items that penetrate surfaces to receive roofing materials are securely and properly installed.

3.02 PREPARATION

A. Clean and prepare surfaces to receive roofing in accordance with manufacturer's instructions and recommendations.

B. Seal cracks and non-moving open joints less than 1/2 inch wide with sealant using methods recommended by roofing and sealant manufacturers; do not seal expansion joints or moving joints of any width.

C. Install cant strips at inside corners, where indicated and where required by roofing manufacturer.

D. Protect adjacent surfaces not designated to receive roofing.

3.03 INSTALLATION

A. Install fluid-applied roofing in accordance with manufacturer's instructions and recommendations, to specified minimum thickness.

B. Apply roofing materials to surfaces that are acceptable to manufacturer.

C. Installations Over Sealant-Filled Joints: Install an extra coating of roofing material over joints at least 6 inches on each side of joint.

D. Penetrations: Unless otherwise indicated on drawings, or recommended by roofing manufacturer, seal flexible flashing sheet around penetrations and to roofing substrate prior to installation of roofing material, embedding flashing sheet in one coat of roofing material.

E. Embedded Flexible Flashing Sheet: Apply full thickness of roofing material over exposed flashing sheet.

3.04 PROTECTION

A. Protect installed roofing and flashings from construction operations.

B. Where traffic must proceed over installed roofing materials, protect surfaces using durable materials acceptable to roofing material manufacturer.

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, counterflashings, gutters, and downspouts.
B. Sealants for joints within sheet metal fabrications.

1.02 RELATED REQUIREMENTS
A. Section 07 61 00 - Sheet Metal Roofing.

1.03 REFERENCE STANDARDS
C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Preinstallation Meeting: Convene one week before starting work of this section.

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

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

1.07 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. Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24 gage, (0.0239 inch) thick base metal.
B. Pre-Finished Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24 gage, (0.0239) inch thick base metal, shop pre-coated with PVDF coating.
   1. PVDF (Polyvinylidene Fluoride) Coating: Superior Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system.
C. Stainless Steel: ASTM A666, Type 304 alloy, soft temper, 28 gage, (0.0156 inch) thick; smooth No. 4 - Brushed finish.
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 flashings to allow toe to extend 2 inches over roofing gravel. Return and brake edges.

2.03 GUTTER AND DOWNSPOUT FABRICATION
A. Seal metal joints.

2.04 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 PREPARATION
A. Install starter and edge strips, and cleats before starting installation.
B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil.

3.03 INSTALLATION
A. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted.
B. Apply plastic cement compound between metal flashings and felt flashings.
C. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.
D. Seal metal joints watertight.
E. Secure gutters and downspouts in place with concealed fasteners.

END OF SECTION
SECTION 07 71 00
ROOF SPECIALTIES

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Manufactured roof specialties, including copings, fascias, and gravel stops.
B. Roof membrane vents.

1.02 RELATED REQUIREMENTS
A. Section 07 72 00 - Roof Accessories: Manufactured curbs, roof hatches, and snow guards.

1.03 REFERENCE STANDARDS
B. NRCA (RM) - The NRCA Roofing Manual; 2018.

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

PART 2 PRODUCTS
2.01 COMPONENTS
A. Roof Edge Flashings: Factory fabricated to sizes required; mitered, welded corners; concealed fasteners.
   2. Pull-Off Resistance: Tested in accordance with ANSI/SPRI/FM 4435/ES-1 using test methods RE-1 and RE-2 to positive and negative design wind pressure as defined by applicable local building code.
B. Copings: Factory fabricated to sizes required; mitered, welded corners; concealed fasteners.
   1. Configuration: Concealed continuous hold down cleat at both legs; internal splice piece at joints of same material, thickness and finish as cap; concealed stainless steel fasteners.
   2. Pull-Off Resistance: Tested in accordance with ANSI/SPRI/FM 4435/ES-1 using test method RE-3 to positive and negative design wind pressure as defined by applicable local building code.
C. Pipe and Penetration Flashing: Base of rounded aluminum, compatible with TPO roof systems, and capable of accommodating pipes sized between 3/8 inch and 12 inch.
D. Pipe Penetration Wall Seal: Seal for HVAC piping wall penetrations with wall mounted rigid plastic outlet cover and elastomeric wall seal gasket.
   1. Outlet Cover Color: Gray.
E. Pipe Penetration Wall Seal and Insulated Piping Protection System: Seal for HVAC piping wall penetrations with wall mounted rigid plastic outlet cover and elastomeric wall seal gasket and having mechanical line insulation with PVC protective cover.
   1. Outlet Cover Color: Gray.
   2. PVC Insulation Cover Color: Black with full-length velcro fastener.

2.02 ACCESSORIES
A. Sealant for Joints in Linear Components: As recommended by component manufacturer.
B. Adhesive for Anchoring to Roof Membrane: Compatible with roof membrane and approved by roof membrane manufacturer.
C. Insulation Board Adhesive: Two-component, low-rise polyurethane foam adhesive used for adhering insulation to low slope roof deck materials.
PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that deck, curbs, roof membrane, base flashing, and other items affecting work of this Section are in place and positioned correctly.
      1. Refer to Section 07 72 00 for information on roofing related accessories.

3.02 INSTALLATION
   A. Install components in accordance with manufacturer's instructions and NRCA (RM) applicable requirements.
   B. Seal joints within components when required by component manufacturer.
   C. Anchor components securely.
   D. Coordinate installation of components of this section with installation of roofing membrane and base flashings.
   E. Coordinate installation of sealants and roofing cement with work of this section to ensure water tightness.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Curbs.
B. Roof penetrations mounting curbs.
C. Roof walkways and platforms.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Submit detailed layout developed for this project and provide dimensioned location and number for each type of roof accessory.
C. Warranty Documentation:
   1. Submit manufacturer warranty.
   2. Ensure that forms have been completed in Owner's name and registered with manufacturer.
   3. Submit documentation that roof accessories are acceptable to roofing manufacturer, and do not limit the roofing warranty.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Store products in manufacturer's unopened packaging until ready for installation.
B. Store products under cover and elevated above grade.

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 ROOF CURBS
A. Roof Curbs Mounting Assemblies: Factory fabricated hollow sheet metal construction, internally reinforced, and capable of supporting superimposed live and dead loads and designated equipment load with fully mitered and sealed corner joints welded or mechanically fastened, and integral counter flashing with top and edges formed to shed water.
   1. Applications: Roof curbs used for roof penetrations/openings as indicated on drawings.
   2. Roof Curb Mounting Substrate: Curb substrate consists of flat roof deck sheathing with insulation.
   3. Sheet Metal Material:
   4. Roofing Cants: Provide integral sheet metal roofing cants dimensioned to begin slope at top of roofing system at 1:1 slope; minimum cant height 4 inches.
   5. Provide layouts and configurations indicated on drawings.

2.02 NON-PENETRATING ROOFTOP SUPPORTS/ASSEMBLIES
A. Non-Penetrating Rooftop Support/Assemblies: Manufacturer-engineered and factory-fabricated, with pedestal bases that rest on top of roofing membrane, and not requiring any attachment to roof structure and not penetrating roofing assembly.
1. Design Loadings and Configurations: As required by applicable codes.
2. Support Spacing and Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
3. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
4. Hardware, Bolts, Nuts, and Washers: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.

B. Pipe Supports: Provide attachment fixtures complying with MSS SP-58 and 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. Clean surfaces thoroughly prior to installation.
   B. Prepare surfaces using methods recommended by manufacturer for achieving acceptable results for applicable substrate under project conditions.

3.03 INSTALLATION
   A. Install in accordance with manufacturer's instructions, in manner that maintains roofing system weather-tight integrity.

3.04 CLEANING
   A. Clean installed work to like-new condition.

3.05 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
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Fireproofing of interior structural steel not exposed to damage or moisture.
   B. Preparation of fireproofing for application of exposed finish specified elsewhere.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordinate with placement of ceiling hanger tabs, mechanical component hangers, and electrical components.
   B. Preinstallation Meeting: Convene one week before starting work of this section.

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.

1.06 FIELD CONDITIONS
   A. Do not apply fireproofing when temperature of substrate material and surrounding air is below 40 degrees F or when temperature is predicted to be below said temperature for 24 hours after application.
   B. Provide ventilation in areas to receive fireproofing during application and 24 hours afterward, to dry applied material.
   C. Provide temporary enclosure to prevent spray from contaminating air.

1.07 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Correct defective Work within a two year period after Date of Substantial Completion.
      1. Include coverage for fireproofing to remain free from cracking, checking, dusting, flaking, spalling, separation, and blistering.
      2. Reinstall or repair failures that occur within warranty period.

PART 2 PRODUCTS

2.01 FIREPROOFING ASSEMBLIES
   A. Provide assemblies as indicated on drawings.

2.02 MATERIALS
   A. Applied Fireproofing Material for Interior Applications, Concealed: Manufacturer's standard factory mixed material, which when combined with water is capable of providing indicated fire resistance, and complying with following requirements:
      1. Bond Strength: 150 pounds per square foot, minimum, when tested in accordance with ASTM E736/E736M when set and dry.
2. Compressive Strength: 8.33 pounds per square inch, minimum.
3. Effect of Impact on Bonding: No cracking, spalling or delamination, when tested in accordance with ASTM E760/E760M.
4. Corrosivity: No evidence of corrosion, when tested in accordance with ASTM E937/E937M.
5. Surface Burning Characteristics: Maximum flame spread index of 0 (zero) and maximum smoke developed index of 0 (zero), when tested in accordance with ASTM E84.

B. Applied Fireproofing Material Exposed to Damage or Moisture: Manufacturer's standard factory mixed material, which when combined with water is capable of providing indicated fire resistance, and complying with following requirements:
   1. Bond Strength: 1,000 psf, minimum, when tested in accordance with ASTM E736/E736M when set and dry.
   2. Effect of Impact on Bonding: No cracking, spalling or delamination, when tested in accordance with ASTM E760/E760M.
   3. Corrosivity: No evidence of corrosion, when tested in accordance with ASTM E937/E937M.
   4. Air Erosion Resistance: Weight loss of 0.025 g/sq ft, maximum, when tested in accordance with ASTM E859/E859M after 24 hours.
   5. Surface Burning Characteristics: Maximum flame spread index of 0 (zero) and maximum smoke developed index of 0 (zero), when tested in accordance with ASTM E84.

2.03 ACCESSORIES
   A. Primer Adhesive: Of type recommended by applied fireproofing manufacturer.
   B. Overcoat: As recommended by manufacturer of applied fireproofing material.
   C. Water: Clean, potable.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that surfaces are ready to receive fireproofing.
   B. Verify that clips, hangers, supports, sleeves, and other items required to penetrate fireproofing are in place.
   C. Verify that ducts, piping, equipment, or other items that would interfere with application of fireproofing have not been installed.
   D. Verify that voids and cracks in substrate have been filled.
   E. Verify that projections have been removed where fireproofing will be exposed to view as a finish material.

3.02 PREPARATION
   A. Perform tests as recommended by fireproofing manufacturer in applications where adhesion of fireproofing to substrate is in question.
   B. Remove incompatible materials that could effect bond by scraping, brushing, scrubbing, or sandblasting.
   C. Prepare substrates to receive fireproofing in strict accordance with instructions of fireproofing manufacturer.
   D. Apply fireproofing manufacturer's recommended bonding agent on primed steel.
   E. Protect surfaces not scheduled for fireproofing and equipment from damage by overspray, fall-out, and dusting.
   F. Close off and seal duct work in areas where fireproofing is being applied.

3.03 APPLICATION
   A. Apply primer adhesive in accordance with manufacturer's instructions.
   B. Apply fireproofing in uniform thickness and density as necessary to achieve required ratings.
C. Apply overcoat at the rate recommended by fireproofing manufacturer.

3.04 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 40 00 - Quality Requirements.
B. Inspect installed fireproofing after application and curing for integrity, prior to its concealment.
C. Ensure that actual thicknesses, densities, and bond strengths meet requirements for specified ratings and requirements of authorities having jurisdiction (AHJ).
D. Repair or replace applied fireproofing at locations where test results indicate fireproofing does not meet specified requirements.
E. Re-inspect installed fireproofing for integrity of fire protection, after installation of subsequent Work.

3.05 CLEANING

A. Remove excess material, overspray, droppings, and debris.
B. Remove fireproofing from materials and surfaces not required to be fireproofed.
C. At exposed fireproofing, clean surfaces that have become soiled or stained, using manufacturer's recommended procedures.

END OF SECTION
SECTION 07 81 23
INTUMESCENT FIREPROOFING

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Thin-film intumescent mastic fireproofing.
B. Protective and/or decorative topcoats.

1.02 REFERENCE STANDARDS
B. SSPC-PA 2 - Procedure For Determining Conformance To Dry Coating Thickness Requirements; 2015.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.
B. Field Quality Control Submittals: Submit field test report.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Deliver materials in manufacturer's original, unopened containers with identification labels and testing agency markings intact and legible.
B. Store products in manufacturer's unopened packaging until ready for installation.
   1. Store at temperatures not less than 50 degrees F in dry, protected area.
   2. Protect from freezing, and do not store in direct sunlight.
   3. Dispose of any materials that have come into contact with contaminants of any kind prior to application.
C. 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. Protect areas of application from windblown dust and rain.
B. Maintain ambient field conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under ambient conditions outside manufacturer's absolute limits.
   1. Provide temporary enclosures as required to control ambient conditions.
   2. Do not apply intumescent fireproofing when ambient temperatures are below 50 degrees F without specific approval from manufacturer.
   3. Maintain relative humidity between 40 and 60 percent in areas of application.
   4. Maintain ventilation in enclosed spaces during application and for not less than 72 hours afterward.

PART 2 PRODUCTS
2.01 SYSTEM REQUIREMENTS
A. Fireproofing: Provide intumescent thin-film fire resistive coating systems tested by an independent testing agency in accordance with ASTM E119 and acceptable to authorities having jurisdiction (AHJ).

2.02 MATERIALS
A. Fire Resistant Coating System: Thin film intumescent mastic fireproofing system for fire protection of structural steel, gypsum board, wood, oriented strand board (OSB), concrete, and concrete masonry units (CMU).
B. Sealers and Primer: As required by tested and listed assemblies, and recommended by fireproofing manufacturer to suit specific substrate conditions.
PART 3 EXECUTION

3.01 EXAMINATION
A. Examine substrates to determine if they are in satisfactory condition to receive intumescent fireproofing; verify that substrates are clean and free of oil, grease, incompatible primers, or other foreign substances capable of impairing bond to fireproofing system.
B. Do not begin installation until substrates have been properly prepared.
C. If substrate preparation is responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION
A. Thoroughly clean surfaces to receive fireproofing.
B. Repair substrates to remove surface imperfections that could effect uniformity of texture and thickness of fireproofing system, and remove minor projections and fill voids that could telegraph through finished work.
C. Cover or otherwise protect other work that might be damaged by fallout or overspray of fireproofing system, and provide temporary enclosures as necessary to confine operations and maintain required ambient field conditions.

3.03 APPLICATION
A. Comply with manufacturer's instructions for particular conditions of installation applications.
B. Apply manufacturer’s recommended primer to required coating thickness.
C. Apply fireproofing to full thickness over entire area of each substrate to be protected.
D. Apply coats at manufacturer’s recommended rate to achieve dry film thickness (DFT) as required for fire resistance ratings designated for each condition.
E. Apply intumescent fireproofing by spraying to maximum extent possible, and as necessary complete coverage by roller application or other method acceptable to manufacturer.

3.04 FIELD QUALITY CONTROL
A. Perform field inspection and testing in accordance with Section 01 40 00 - Quality Requirements.
   1. Arrange for testing of installed intumescent mastic fireproofing by an independent testing laboratory using magnetic pull-off dry film thickness gage in accordance with SSPC-PA 2, and ensure it meets requirements of authorities having jurisdiction (AHJ).
   2. Submit field test reports promptly to Contractor and Architect.
B. Repair or replace intumescent mastic fireproofing at locations where test results indicate fireproofing does not meet specified requirements.

3.05 CLEANING
A. Immediately after installation of fireproofing in each area, remove overspray and fallout from other surfaces and clean soiled areas.

3.06 PROTECTION
A. Protect installed intumescent mastic fireproofing from damage due to subsequent construction activities, so fireproofing is without damage or deterioration before Date of Substantial Completion.
B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION
SECTION 07 84 00
FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Firestopping systems.
B. Firestopping of all joints and penetrations in fire resistance rated and smoke resistant assemblies, whether indicated on drawings or not, and other openings indicated.

1.02 REFERENCE STANDARDS

H. ITS (DIR) - Directory of Listed Products; current edition.

1.03 SUBMITTALS

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

PART 2 PRODUCTS

2.01 MATERIALS

A. Firestopping Materials: Any materials meeting requirements.
B. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.
C. Fire Ratings: Refer to drawings for required systems and ratings.

2.02 FIRESTOPPING ASSEMBLY REQUIREMENTS

A. Perimeter Fire Containment Firestopping: Use system that has been tested according to ASTM E2307 to have fire resistance F Rating equal to required fire rating of floor assembly.
B. Head-of-Wall Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of floor or wall, whichever is greater.
C. Floor-to-Floor, Wall-to-Wall, and Wall-to-Floor Joints, Except Perimeter, Where Both Are Fire-Rated: Use system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
D. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.

2.03 FIRESTOPPING SYSTEMS
A. Firestopping: Any material meeting requirements.
   1. Fire Ratings: Use system that is listed by FM (AG), ITS (DIR), or UL (FRD) and tested in accordance with ASTM E814, ASTM E119, or UL 1479 with F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and in compliance with other specified requirements.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION
A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.
B. Remove incompatible materials that could adversely affect bond.
C. Install backing materials to prevent liquid material from leakage.

3.03 INSTALLATION
A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
B. Do not cover installed firestopping until inspected by Owner's Independent Testing Agency.
C. Do not cover installed firestopping until inspected by authorities having jurisdiction.
D. Install labeling required by code.

3.04 FIELD QUALITY CONTROL
A. Independent Testing Agency: Inspection agency employed and paid by Owner, will examine penetration firestopping in accordance with ASTM E2174, and ASTM E2393.
B. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

3.05 CLEANING
A. Clean adjacent surfaces of firestopping materials.

3.06 PROTECTION
A. Protect adjacent surfaces from damage by material installation.

END OF SECTION
SECTION 07 92 00
JOINT SEALANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nonsag gunnable joint sealants.
B. Self-leveling pourable joint sealants.
C. Joint backings and accessories.
D. Owner-provided field quality control.

1.02 REFERENCE STANDARDS

C. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2012 (Reapproved 2017).

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Preconstruction Laboratory Test Reports: Submit at least four weeks prior to start of installation.
C. Field Quality Control Plan: Submit at least two weeks prior to start of installation.
D. Field Quality Control Log: Submit filled out log for each length or instance of sealant installed, within 10 days after completion of inspections/tests; include bagged test samples and photographic records, if any.

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.

B. Owner will employ an independent testing agency to perform the field quality control inspection and testing as referenced in PART 3 of this section and as follows, to prepare and submit the field quality control plan and log, and to provide recommendations of remedies in the case of failure.

C. Field Quality Control Plan:
   1. Visual inspection of entire length of sealant joints.
2. Destructive field adhesion testing of sealant joints, except interior acrylic latex sealant.
   a. For each different sealant and substrate combination, allow for one test every 100 feet in the first 1000 linear feet, and one test per 1000 linear feet thereafter, or once per floor on each elevation.
   b. If any failures occur in the first 1000 linear feet, continue testing at frequency of one test per 500 linear feet at no extra cost to Owner.
3. Field Quality Control Log Form: Show same data fields as on Preinstallation Field Adhesion Test Log, with known information filled out and lines for multiple tests per sealant/substrate combinations; include visual inspection and specified field testing; allow for possibility that more tests than minimum specified may be necessary.

D. Field Adhesion Test Procedures:
   1. Allow sealants to fully cure as recommended by manufacturer before testing.
   2. Have a copy of the test method document available during tests.
   3. Record the type of failure that occurred, other information required by test method, and the information required on the Field Quality Control Log.
   4. When performing destructive tests, also inspect the opened joint for proper installation characteristics recommended by manufacturer, and report any deficiencies.
   5. Deliver the samples removed during destructive tests in separate sealed plastic bags, identified with project, location, test date, and test results, to Owner.
   6. If any combination of sealant type and substrate does not show evidence of minimum adhesion or shows cohesion failure before minimum adhesion, report results to Architect.

E. Destructive Field Adhesion Test: Test for adhesion in accordance with ASTM C1521, using Destructive Tail Procedure.
   1. Sample: At least 18 inch long.
   2. Minimum Elongation Without Adhesive Failure: Consider the tail at rest, not under any elongation stress; multiply the stated movement capability of the sealant in percent by two; then multiply 1 inch by that percentage; if adhesion failure occurs before the “1 inch mark” is that distance from the substrate, the test has failed.
   3. If either adhesive or cohesive failure occurs prior to minimum elongation, take necessary measures to correct conditions and re-test; record each modification to products or installation procedures.

105 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. In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, piping, and other openings; between wall/ceiling and other construction; and other flanking sound paths.

c. 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.

1. In Sound-Rated Assemblies: Acrylic emulsion latex sealant.

2.02 JOINT SEALANTS - GENERAL

A. Sealants and Primers: Provide products having lower volatile organic compound (VOC) content than indicated in SCAQMD 1168.

B. Colors: As indicated on drawings.

2.03 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.

1. Closed Cell and Bi-Cellular: 25 to 33 percent larger in diameter than joint width.

B. Overlay Extrusion for Glazing System Joint Protection: Rubber profiled extrusions placed over joints in glazing system and provided with watertight seal.

1. Profile: As required to match existing metal glazing cap requirements.

C. Preformed Extruded Silicone Joint Seal: Pre-cured low-modulus silicone extrusion, in sizes to fit applications indicated on drawings, combined with a neutral-curing liquid silicone sealant for bonding joint seal to substrates.

1. Size: 1 inch wide, in rolls 100 feet long.

2. Thickness: 0.78 inch, with ridges along outside bottom edges for bonding area.

D. 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.

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. Perform acoustical sealant application work in accordance with ASTM C919.
D. Install bond breaker backing tape where backer rod cannot be used.
E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
F. 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.
G. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

3.04 FIELD QUALITY CONTROL
A. Owner will employ an independent testing agency to perform field quality control inspection and testing as specified in PART 1 under QUALITY ASSURANCE article.
B. Destructive Adhesion Testing: If there are any failures in first 1000 linear feet, notify Architect immediately.
C. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.
D. Repair destructive test location damage immediately after evaluation and recording of results.

END OF SECTION
CSI MASTERFORMAT SECTION NUMBER   08 390 FLOOD RESISTANT AND HURRICANE DOORS
CSI MASTERFORMAT SECTION TITLE   ALUMINUM-FRAMED ENTRANCES & STOREFRONTS
HURRICANE RESISTANT PRODUCT SERIES   FLOOD MITIGATING ENTRANCES

PART 1 GENERAL
Furnish all necessary materials, labor, and equipment for the complete installation of the aluminum swing doors, door frames, hardware, and storefront framing system as shown on the drawings and specified herein.

1.01 SUMMARY
A. Section includes: Aluminum Out-Swing Doors, including:
B. Related Sections:
   1. Glass: Contact Savannah Flood Protection for approved glass types.
   2. Glazing: Structural silicone sealant.
   3. Single Source Requirement:
      a. Section 08 32 13 Flood Resistant Glazing System
C. Important Note: (Builders Hardware not rated to be water tight when located below the projected water height.)

1.02 SYSTEM PERFORMANCE DESCRIPTION
A. Performance Requirements: Aluminum swing doors shall meet all requirements of ASTM E 1886, ASTM E 1996 and South Florida Building Code Protocols TAS 201, TAS 202, and TAS 203 and comply with the following specific performance requirements indicated.
   1. Air Infiltration (Single Acting Butt Hinges, Continuous Hinges, or Offset Pivots): Air infiltration shall be tested in accordance with ASTM E 283 at static pressure of 1.57 PSF (75 Pa). Infiltration shall not exceed 0.50 CFM/FT² for single door or 1.00 CFM/FT² for pair doors.
   2. Water Infiltration: No uncontrolled water other than condensation on indoor face of any component tested in accordance with ASTM E 331 at a test pressure differential of 10.5 psf (503 Pa). Water test to be performed immediately after design pressure test. Standard 35H Entrances are intended for 1st floor applications.
   3. Structural: Door corner structural strength shall be tested per YKK AP’s dual moment test procedure and certified by an independent testing laboratory to ensure corner integrity and weld compliance. Certified test procedures and results are available upon request.
   4. Structural Uniform Load Test:
      a. Doors:  1) Positive Pressure:
         70 PSF – For Air Only or Air and Water Threshold; monolithic glazing.
         90 PSF – For Air Only Threshold, 70 PSF – Air and Water Threshold; insulating glazing.
      2) Negative Pressure:  90 PSF
   5. Forced Entry Resistance: Tests performed simultaneously with 300 lb. forces applied to the active door panel within 3” of the locks in the direction that would tend to open the door while 150 lb. forces are applied in both perpendicular directions to the 300 lb. force simultaneously.
   6. Thermal Performance: When tested in accordance with AAMA 1503 and NFRC 102:
      b. Thermal Transmittance U Value: 0.77 BTU/HR/FT²/°F or less.
   7. Flood resistant test to 60 inches of hydrostatic water depth with Maximum seepage of 10 gph, But Seepage Increases Because of Pressure Reduction At Lower Levels.

1.03 SUBMITTALS
A. General: Prepare, review, approve, and submit specified submittals in accordance with "Conditions of the Contract" and Division 1 Submittals Section. Product data, shop drawings, samples, and similar submittals are defined in "Conditions of the Contract".
B. Product Data: Submit product data for each entrance series specified.
C. Substitutions: Whenever substitute products are to be considered, supporting technical data, samples, and test reports must be submitted ten (10) working days prior to bid date in order to make a valid comparison.
D. Shop Drawings: Submit shop drawings showing layout, profiles, and product components, including anchorage, accessories, and finish colors.
E. Samples: Submit verification samples for colors if specified Minimum 2 inch by 3 inch samples on actual aluminum substrates indicating full color range expected in installed system.

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F. Quality Assurance / Control Submittals:
   1. Test Reports: Submit certified test reports showing compliance with specified characteristics and physical properties.
   2. Installer Qualification Data: Submit installer qualification data.

G. Close-out Submittals:
   1. Warranty: Submit executed warranty documents specified herein, endorsed by YKK AP authorized official and installer.
   2. Project Record Documents: Submit project record documents, including operation and maintenance data for installed materials in accordance with Division 1 Project Close-out (Project Record Documents) Section.

1.04 QUALITY ASSURANCE
A. Qualifications:
   1. Installer Qualifications: Installer experienced (as determined by contractor) to perform work of this section who has specialized in the installation of work similar to that required for this project. If requested by Owner, submit reference list of completed projects.

B. Pre-Installation Meetings: Conduct pre-installation meeting to verify project requirements, substrate conditions, Manufacturer’s installation instructions and manufacturer's warranty requirements.

1.05 PRODUCT CONDITIONS / SITE CONDITIONS
A. Field Measurements By General Contractor or Installer: Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on shop drawings. Coordinate field measurements, fabrication schedule with construction progress to avoid construction delays.

1.06 WARRANTY
A. Project Warranty: Refer to "Conditions of the Contract" for project warranty provisions.
B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by an authorized company official.
   1. Warranty Period: Manufacturer’s one (1) year standard warranty commencing on the substantial date of completion for the project provided that the warranty, in no event, shall start later than four (4) months from the date of shipment by Savannah Flood Protection.

PART 2 PRODUCTS
It is the intent of this specification to have a single source responsibility for the supply of the aluminum doors and framing systems on this project. Any deviation from the acceptable manufacturers listed below must be approved in writing by the architect at least ten (10) days prior to bid date.

2.01 MANUFACTURERS (Acceptable Manufacturers/Products)
A. Acceptable Products: Savannah Flood Protection 3567 91 street #4, Lake Park Florida, 33403 888-640-0850
   Substitutions must be submitted for approval and must be pre-approved by addendum to qualify.
   1. Impact Resistant and Flood Resistant Doors and Frames
      a. 35H Description: 3-7/8" (98.36 mm) Door Stile, 2-3/8" thick.
   2. Corner Construction: Fabricate door corners joined by concealed reinforcement secured with screws and sigma deep penetration welding.
   3. Glazing: Manufacturer's standard glazing stops with EPDM glazing gaskets to prevent water infiltration at the exterior and structural silicone sealant for wet glazing, EPDM silicone compatible gasket for dry glazing with fixed stops at the interior.
   4. Water-stripping: Manufacturer's standard elastomer type in Corners for stiles and rails.

   5a. Standard Hardware:
      (1-1/2 to 2) pair of Grade 1 mortised butt hinges per leaf. Ball bearing 4-1/2" x 4" NRP Stainless Steel US32D finish.
      (1) H-4202 Keyed cylinders (H-4204 thumbturn on inside optional).
      Type "A" standard Savannah push/pull (Type "C" 1" diameter tubular push/pull is optional).
      LCN 4040 surface mounted closer (hold open optional).
      (1) Adams E9-0503 mill finish (air only) threshold.

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6. (NOTE: Builders Hardware not rated to be water tight when located below the projected water height.)

2.02 MATERIALS
A. Extrusions: ASTM B 221 (ASTM B 221M), 6063-T5 Aluminum Alloy.
B. Aluminum Sheet:
   1. Anodized Finish: ASTM B 209 (ASTM B 209M), 5005-H14 Aluminum Alloy, 0.050" (1.27 mm) minimum thickness.
   2. Painted Finish: ASTM B 209 (ASTM B 209M), 3003-H14 Aluminum Alloy, 0.080" (1.95 mm) minimum thickness.

2.03 ACCESSORIES
A. Manufacturer's Standard Accessories:
   1. Fasteners: Zinc plated steel concealed fasteners; Hardened aluminum alloys or AISI 300 series less steel exposed fasteners, countersunk, finish to match aluminum color.
   2. Perimeter Sealant: Non-skinning type, AAMA 803.3.
   3. Glazing: Setting blocks, edge blocks, and spacers in accordance with ASTM C 864, shore durometer hardness as recommended by manufacturer. Glazing gaskets in accordance with ASTM C 864.

2.04 FABRICATION
A. Shop Assembly: Fabricate and assemble units with joints only at intersection of aluminum members with uniform hairline joints; rigidly secure, and sealed in accordance with manufacturer's recommendations.
   1. Hardware: Drill and cut to template for hardware. Reinforce frames and door stiles to receive hardware in accordance with manufacturer's recommendations.
   2. Welding: Conceal welds on aluminum members in accordance with AWS recommendations or methods recommended by manufacturer. Members showing welding bloom or discoloration on finish or material distortion will be rejected.

2.05 FINISHES AND COLORS
A. AP America Anodized Plus® Finish: (Recommended)
   CODE DESCRIPTION
   YS1N* Clear Anodized Plus®
   YH3N Champagne Anodized Plus®
   YB1N Medium Bronze Anodized Plus®
   YB5N* Dark Bronze Anodized Plus®
   YK1N* Black Anodized Plus®
   YW3N White Anodized Plus®
   M Mill Finish
   * Indicates standard finish usually carried as inventory.
   Anodized Plus® is an advanced sealing technology that completely seals the anodic film yielding superior durability (See AAMA 612).
B. Anodized Finishing: Prepare aluminum surfaces for specified finish; apply shop finish in accordance with the following:
   1. Anodic Coating: Electrolytic color coating followed by an organic seal applied in accordance with the requirements of AAMA 612-02. Aluminum extrusions shall be produced from quality controlled billets meeting AA-6063-T5.
      a. Exposed Surfaces shall be free of scratches and other serious blemishes.
      b. Extrusions shall be given a caustic etch followed by an anodic oxide treatment and then sealed with an organic coating applied with an electrode position process.
      c. The anodized coating shall comply with all of the requirements of AAMA 612-02: Voluntary Specifications, Performance Requirements and Test Procedures for Combined Coatings of Anodic Oxide and Transparent Organic Coatings on Architectural Aluminum. Testing shall demonstrate the ability of the finish to resist damage from mortar, salt spray, and chemicals commonly found on construction sites, and to resist the loss of color and gloss.
      d. Overall coating thickness for finishes shall be a minimum of 0.7 mils.
C. High Performance Organic Coating Finish, **Optional At Additional Cost.**

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1. Fluoropolymer Type: Factory applied two-coat 70% Kynar resin by Arkema or 70% Hylar resin by Solvay Solexis, fluoropolymer based coating system, Polyvinylidene Fluoride (PVF-2), applied in accordance with YKK AP procedures and meeting AAMA 2605 specifications.

2. Colors: Selected by Architect from the following:
   a. Standard coating color charts.
   b. Custom coating color charts.-Premium Cost
   c. Color Name and Number:

D. Finishes Testing:
   1. Apply 0.5% solution NaOh, sodium hydroxide, to small area of finished sample area; leave in place for sixty minutes; lightly wipe off NaOh. Do not clean area further.
   2. Submit samples with test area noted on each sample.

PART 3 EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS / RECOMMENDATIONS
   A. Compliance: Comply with manufacturer's product data, including product technical bulletins, installation instructions, and product carton instructions. The latest installation instructions for this product are available at www.ykkap.com.

3.02 EXAMINATION
   A. Site Verification of Conditions: Verify conditions (which have been previously installed under other sections) are acceptable for product installation in accordance with manufacturer's instructions.
      1. Verify location of preset anchors, perimeter fasteners, and block-outs are in accordance with shop drawings.

3.03 PREPARATION
   A. Adjacent Surfaces Protection: Protect adjacent work areas and finish surfaces from damage during product installation.
      1. Aluminum Surface Protection: Protect aluminum surfaces from contact with lime, mortar, cement, acids, and other harmful contaminants.

3.04 INSTALLATION
   A. General: Install manufacturer's system in accordance with shop drawings, and within specified tolerances. Follow Installation Instructions For Water Intrusion Per Savannah Trims, Inc.

3.05 FIELD QUALITY CONTROL
   A. Manufacturer's Field Services: Upon request, provide manufacturer's field service consisting of site visit for inspection of product installation in accordance with manufacturer's instructions.

3.06 ADJUSTING AND CLEANING
   A. Adjusting: Installer must Adjust swing doors for operation in accordance with manufacturer's recommendations.
   B. Cleaning: The General Contractor shall clean installed products in accordance with manufacturer's instructions prior to owner's acceptance, and remove construction debris from project site. Legally dispose of debris.
   C. Protection: The General Contractor shall protect the installed product's finish surfaces from damage during construction.

END OF SECTION

Document Number 01-3001-03
This document supersedes all previous versions.
SECTION 08 43 13
ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Aluminum-framed storefront, with vision glass.
B. Infill panels of metal and glass.
C. Weatherstripping.

1.02 RELATED REQUIREMENTS
A. Section 08 80 00 - Glazing: Glass and glazing accessories.

1.03 REFERENCE STANDARDS
A. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site; 2015.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordinate with installation of other components that comprise the exterior enclosure.
B. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Handle products of this section in accordance with AAMA CW-10.
B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.07 FIELD CONDITIONS
A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

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

PART 2 PRODUCTS

2.01 STOREFRONT
A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
   1. Glazing Rabbet: For 1 inch insulating glazing.
   2. Glazing Position: Centered (front to back).
   3. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep.
      a. Factory finish all surfaces that will be exposed in completed assemblies.
b. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.

5. Finish Color: Black.

6. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.


8. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.

9. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.

10. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.

11. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

2.02 COMPONENTS

A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.


2.03 MATERIALS


B. Fasteners: Stainless steel.

C. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

2.04 HARDWARE

A. Weatherstripping: Wool pile, continuous and replaceable; provide on all doors.

B. Sill Sweep Strips: Resilient seal type, retracting, of neoprene; provide on all doors.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify dimensions, tolerances, and method of attachment with other work.

B. Verify that wall openings and adjoining air and vapor seal materials are ready to receive work of this section.

3.02 INSTALLATION

A. Install wall system in accordance with manufacturer's instructions.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

C. Provide alignment attachments and shims to permanently fasten system to building structure.

D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

E. Provide thermal isolation where components penetrate or disrupt building insulation.

F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.

G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

I. Install hardware using templates provided.

J. Install glass and infill panels in accordance with Section 08 80 00, using glazing method required to achieve performance criteria.

K. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

A. Maximum Variation from Plumb: 0.06 inch per 3 feet non-cumulative or 0.06 inch per 10 feet, whichever is less.

B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.04 FIELD QUALITY CONTROL

A. Provide services of storefront manufacturer's field representative to observe for proper installation of system and submit report.

B. Water-Spray Test: Provide water spray quality test of installed storefront components in accordance with AAMA 501.2 during construction process and before installation of interior finishes.
   1. Perform a minimum of two tests in each designated area as indicated on drawings.
   2. Conduct tests in each area prior to 10 percent and 50 percent completion of this work.

3.05 ADJUSTING

A. Adjust operating hardware and sash for smooth operation.

3.06 CLEANING

A. Remove protective material from pre-finished aluminum surfaces.

B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, and take care to remove dirt from corners and to wipe surfaces clean.

C. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

3.07 PROTECTION

A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION
SECTION 08 44 13
GLAZED ALUMINUM CURTAIN WALLS

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Aluminum-framed curtain wall, with vision glazing and glass infill panels.

1.02  RELATED REQUIREMENTS
A. Section 08 80 00 - Glazing.

1.03  REFERENCE STANDARDS

1.04  ADMINISTRATIVE REQUIREMENTS
A. Coordinate with installation of other components that comprise the exterior enclosure.

1.05  SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, internal drainage details, glazing, and infill.
C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.
D. Test Reports: Submit results of full-size mock-up testing. Reports of tests previously performed on the same design are acceptable.

PART 2  PRODUCTS

2.01  CURTAIN WALL
A. Aluminum-Framed Curtain Wall: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
   1. Outside glazed, with pressure plate and mullion cover.
   2. Vertical Mullion Dimensions: 2 inches wide by 6-1/2 inches deep.
   3. Finish: Class I color anodized.
      a. Factory finish surfaces that will be exposed in completed assemblies.
      b. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.
   4. Provide flush joints and corners, weathersealed, accurately fitted and secured; prepared to receive anchors; fasteners and attachments concealed from view; reinforced as required for imposed loads.
   6. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
B. Structural Performance Requirements: Design and size components to withstand the following load requirements without damage or permanent set.
   1. Design Wind Loads: Comply with Structural General Notes..
   2. Movement: Accommodate the following movement without damage to components or deterioration of seals.
a. Expansion and contraction caused by 180 degrees F surface temperature.
b. Expansion and contraction caused by cycling temperature range of 170 degrees F over a 12 hour period.
c. Movement of curtain wall relative to perimeter framing.
d. Deflection of structural support framing, under permanent and dynamic loads.

C. Water Penetration Resistance on Manufactured Assembly: No uncontrolled water on indoor face when tested as follows:
   1. Test Pressure Differential: 10 psf.

D. Air Leakage Laboratory Test: Maximum of 0.06 cu ft/min sq ft of wall area, when tested in accordance with ASTM E283 at 6.27 psf pressure differential across assembly.

2.02 COMPONENTS
   A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
      1. Cross-Section: 2" by 6 1/2" inch nominal dimension.
   B. Glazing: As specified in Section 08 80 00.

2.03 FINISHES
   A. Class I Color Anodized Finish: AAMA 611 AA-M12C22A42 Integrally colored anodic coating not less than 0.7 mils thick.
   B. Color: Black.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Install curtain wall system in accordance with manufacturer's instructions.
   B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
   C. Provide alignment attachments and shims to permanently fasten system to building structure.
   D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
   E. Provide thermal isolation where components penetrate or disrupt building insulation.
   F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
   G. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

END OF SECTION
SECTION 08 53 13
VINYL WINDOWS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Vinyl-framed, factory-glazed windows.
B. Insect screens.

1.02 REFERENCE STANDARDS

1.03 ADMINISTRATIVE REQUIREMENTS
A. Preinstallation Meeting: Convene one week before starting work of this section.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner’s name and registered with manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Protect finished surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond when exposed to sunlight or weather.
B. Jig, brace, and box the window frame assemblies for transport to minimize flexing of members or joints.

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

PART 2 PRODUCTS

2.01 DESCRIPTION
A. Vinyl Windows: Factory fabricated frame and sash members of extruded, hollow, ultra-violet-resistant, polyvinyl chloride (PVC) with integral color; with factory-installed glazing, hardware, related flashings, anchorage and attachment devices.
1. Configuration: As indicated on drawings.
2. Color: to match break metal at Park/Curtis glazed corner.
3. Size to fit openings with minimum clearance around perimeter of assembly providing necessary space for perimeter seals.
4. Operable Units: Double weatherstripped.
5. Framing Members: Fusion welded corners and joints, with internal reinforcement where required for structural rigidity; concealed fasteners.
6. System Internal Drainage: Drain to exterior side by means of weep drainage network any water entering joints, condensation within glazing channel, or other migrating moisture within system.
7. Glazing Stops, Trim, Flashings, and Accessory Pieces: Formed of rigid PVC, fitting tightly into frame assembly.
8. Mounting Flange: Integral to frame assembly, providing weather stop at entire perimeter of frame.
2.02 COMPONENTS
A. Glazing: Insulated double pane, 60% transmittance, annealed glass, clear, low-E coated, argon filled, with glass thicknesses as recommended by manufacturer for specified wind conditions and acoustic rating indicated.
B. Insect Screens: Aluminum, extruded or roll-formed frame with mitered and reinforced corners; apply screen mesh taut to frame; secure to window with hardware to allow easy removal.
   1. Hardware: Manufacturer's standard; quantity as required per screen.
   2. Screen Mesh: Vinyl-coated fiberglass, window manufacturer's 18 x 16 mesh.
   3. Frame Finish: Manufacturer's standard, color to match window frame and sash color.
C. Operable Sash Weatherstripping: per manufacturer; permanently resilient, profiled to maintain weather seal in accordance with AAMA 701/702.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify wall openings and adjoining air and vapor seal materials are ready to receive this work.

3.02 INSTALLATION
A. Install window unit assemblies in accordance with manufacturers instructions and applicable building codes.
B. Install windows in accordance with ASTM E2112.
C. Attach window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities as necessary.
D. Align window plumb and level, free of warp or twist, and maintain dimensional tolerances and alignment with adjacent work.

3.03 TOLERANCES
A. Maximum Variation from Level or Plumb: 0.06 inches every 3 ft non-cumulative or 0.5 inches per 100 ft, whichever is less.

3.04 ADJUSTING
A. Adjust hardware for smooth operation and secure weathertight closure.

3.05 CLEANING
A. Refer to Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.

END OF SECTION
SECTION 08 80 00
GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Insulating glass units.
B. Glazing compounds and accessories.

1.02 REFERENCE STANDARDS

1.03 ADMINISTRATIVE REQUIREMENTS
A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by each of the affected installers.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.

1.05 FIELD CONDITIONS
A. Do not install glazing when ambient temperature is less than 40 degrees F.
B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.06 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
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.
   4. Fully Tempered Safety Glass: Complies with ANSI Z97.1 or 16 CFR 1201 criteria for safety glazing used in hazardous locations.
   5. Thicknesses: As indicated; provide greater thickness as required for exterior glazing wind load design.

B. Laminated Glass: Float glass laminated in accordance with ASTM C1172.
   1. Laminated Safety Glass: Complies with ANSI Z97.1 - Class B or 16 CFR 1201 - Category I impact test requirements.

2.03 INSULATING GLASS UNITS

A. Manufacturers:
   1. Any of the manufacturers specified for float glass.
   2. Fabricator certified by glass manufacturer for type of glass, coating, and treatment involved and capable of providing specified warranty.

B. 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.

C. Type IG-1 - Insulating Glass Units: Vision glass, double glazed.
   1. Applications: Exterior glazing unless otherwise indicated.
   2. Space between lites filled with argon.
   3. Outboard Lite: Annealed float glass, 1/4 inch thick, minimum.
a. Tint: Clear.

4. Inboard Lite: Annealed float glass, 1/4 inch thick, minimum.
   a. Tint: Clear.

5. Total Thickness: 1 inch.

6. Thermal Transmittance (U-Value), Summer - Center of Glass: .38, nominal.


D. Type IG-5 - Insulating Glass Units: Safety glazing.

1. Applications:
   a. Glazed lites in exterior doors.
   b. Glazed sidelights and panels next to doors.
   c. Other locations required by applicable federal, state, and local codes and regulations.

2. Space between lites filled with argon.

3. Glass Type: Same as Type IG-1 except use fully tempered float glass for both outboard and inboard lites.

4. Total Thickness: 1 inch.

5. Thermal Transmittance (U-Value), Summer - Center of Glass: .38, nominal.


2.04 ACCESSORIES

A. Setting Blocks: Silicone, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II.
   Length of 0.1 inch for each square foot of glazing or minimum 4 inch by width of glazing rabbet space minus 1/16 inch by height to suit glazing method and pane weight and area.

B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness; ASTM C864 Option II.
   Minimum 3 inch long by one half the height of the glazing stop by thickness to suit application, self adhesive on one face.

C. Glazing Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.

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 PREPARATION

A. Clean contact surfaces with appropriate solvent and wipe dry within maximum of 24 hours before glazing. Remove coatings that are not tightly bonded to substrates.

B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.

C. Prime surfaces scheduled to receive sealant where required for proper sealant adhesion.

3.03 INSTALLATION, GENERAL

A. Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.

3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Glass and Glazing product manufacturers to provide field surveillance of the installation of their products.

C. Monitor and report installation procedures and unacceptable conditions.
3.05 CLEANING
A. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.
B. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.
C. Remove non-permanent labels immediately after glazing installation is complete.
D. Clean glass and adjacent surfaces after sealants are fully cured.
E. 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.

3.06 PROTECTION
A. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.
B. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

END OF SECTION
SECTION 09 21 16
GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Performance criteria for gypsum board assemblies.
B. Metal stud wall framing.
C. Metal channel ceiling framing.
D. Acoustic insulation.
E. Gypsum sheathing.
F. Gypsum wallboard.
G. Joint treatment and accessories.
H. Textured finish system.
I. Water-resistant barrier over exterior wall sheathing.

1.02 RELATED REQUIREMENTS

A. Section 05 40 00 - Cold-Formed Metal Framing: Exterior wind-load-bearing metal stud framing.
B. Section 07 25 00 - Weather Barriers: Water-resistant barrier over sheathing.
C. Section 09 22 16 - Non-Structural Metal Framing.
D. Section 09 30 00 - Tiling: Tile backing board.

1.03 REFERENCE STANDARDS

F. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2015.
G. 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; 2016.
M. ASTM E413 - Classification for Rating Sound Insulation; 2016.
1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES
   A. Provide completed assemblies complying with ASTM C840 and GA-216.
   B. Interior Partitions, Indicated as Acoustic: Provide completed assemblies with the following characteristics:
      1. Acoustic Attenuation: STC of 45-49 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
   C. Shaft Walls at HVAC Shafts: Provide completed assemblies with the following characteristics:
      1. Air Pressure Within Shaft: Sustained loads of 5 lbf/sq ft with maximum mid-span deflection of L/240.
      2. Acoustic Attenuation: STC of 35-39 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
   D. Shaft Walls at Elevator Shafts: Provide completed assemblies with the following characteristics:
      1. Air Pressure Within Shaft: Intermittent loads of 5 lbf/sq ft with maximum mid-span deflection of L/240.
      2. Acoustic Attenuation: STC of 35-39 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

2.02 METAL FRAMING MATERIALS
   A. Exterior Non-Loadbearing Studs and Furring for Application of Gypsum Board: As specified in Section 09 22 16.
   B. Loadbearing Studs for Application of Gypsum Board: As specified in Section 05 40 00.
   C. Non-Loadbearing 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 flat or formed webs with knurled faces.
      2. Runners: U shaped, sized to match studs.
      3. Ceiling Channels: C-shaped.
      5. Resilient Furring Channels: Single or double leg configuration; 1/2 inch channel depth.
   D. Shaft Wall Studs and Accessories: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 and specified performance requirements.
   E. Area Separation Wall Studs and Accessories: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with specified performance requirements.
   F. Partition Head To Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and fastened as indicated on drawings.
   G. Non-Loadbearing Framing Accessories:
      1. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
      2. Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.

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. At Assemblies Indicated with Fire-Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
B. Backing Board For Wet Areas:
   1. Application: Surfaces behind tile in wet areas including tub and shower surrounds and shower ceilings.
   2. Application: Horizontal surfaces behind tile in wet areas including countertops.

C. Exterior Sheathing Board: Sizes to minimize joints in place; ends square cut.
   1. Application: Exterior sheathing, unless otherwise indicated.
   2. Edges: Square.

2.04 GYPSUM WALLBOARD ACCESSORIES
A. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
B. Water-Resistive Barrier: As specified in Section 07 25 00.
C. Finishing Accessories: ASTM C1047, galvanized steel or rolled zinc, unless noted otherwise.
   1. Types: As detailed or required for finished appearance.
D. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
F. 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.
G. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill 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 SHAFT WALL INSTALLATION
A. Shaft Wall Framing: Install in accordance with manufacturer's installation instructions.
   1. Install studs at spacing required to meet performance requirements.
B. Shaft Wall Liner: Cut panels to accurate dimension and install sequentially between special friction studs.

3.03 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.
C. Studs: Space studs as indicated.
   1. Extend partition framing to structure where indicated and to ceiling in other locations.
   2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
   3. Partitions Terminating at Structure: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.
D. Standard Wall Furring: Install at concrete walls scheduled to receive gypsum board, not more than 4 inches from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 24 inches on center.
E. Furring for Fire Ratings: Install as required for fire resistance ratings indicated and to GA-600 requirements.

3.04 ACOUSTIC ACCESSORIES INSTALLATION
A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
B. Acoustic Sealant: Install in accordance with manufacturer's instructions.
   1. Place one bead continuously on substrate before installation of perimeter framing members.

C. Acoustical Shielding: Install in accordance with manufacturer's instructions for application between studs and gypsum board.

3.05 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. Fire-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
C. Exterior Sheathing: Comply with ASTM C1280. Install sheathing vertically, with edges butted tight and ends occurring over firm bearing.
   1. Paper-Faced Sheathing: Immediately after installation, protect from weather by application of water-resistive barrier.

3.06 INSTALLATION OF TRIM AND ACCESSORIES
A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
B. Corner Beads: Install at external corners, using longest practical lengths.

3.07 JOINT TREATMENT
A. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
   1. Level 1: Fire rated wall areas above finished ceilings, whether or not accessible in the completed construction.
B. 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.

3.08 TEXTURE FINISH
A. Apply finish texture coating by means of spraying apparatus in accordance with manufacturer's instructions and to match approved sample.

3.09 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 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Fire extinguishers.
   B. Fire extinguisher cabinets.
   C. Accessories.

1.02 REFERENCE STANDARDS

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

1.04 FIELD CONDITIONS
   A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

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.

2.02 SELF-SERVICE RELOADABLE FIRE EXTINGUISHERS
   A. Self-Service Reloadable Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
   B. Multipurpose Monoammonium Phosphate Dry Chemical Type Fire Extinguishers: Polymeric body, including discharge head, carbon dioxide cartridge, extinguisher agent cartridge and valve assembly.
      1. Temperature range: Minus 40 degrees F to 120 degrees F.

2.03 FIRE EXTINGUISHER CABINETS
   A. Fire Rating: Listed and labeled in accordance with ASTM E814 requirements for fire resistance rating of walls where being installed.
   B. Fire Rated Cabinet Construction: One-hour fire rated.
   C. Finish of Cabinet Exterior Trim and Door: No. 4 - Brushed stainless steel.
   D. Finish of Cabinet Interior: White colored enamel.

2.04 ACCESSORIES
   A. Extinguisher Brackets: Formed steel, chrome-plated.

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 in accordance with manufacturer's instructions.
   B. Secure rigidly in place.
   C. Place extinguishers in cabinets.
3.03 MAINTENANCE

A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

3.04 MAINTENANCE - SELF-SERVICE FIRE EXTINGUISHERS

A. Monthly Inspections: Inspect self-service fire extinguishers on monthly basis in accordance with manufacturer’s instructions, and requirements of the authorities having jurisdiction (AHJ).

B. Annual Inspections: Inspect self-service fire extinguishers on annual basis in accordance with manufacturer’s instructions, and requirements of the authorities having jurisdiction (AHJ).

C. Inspection Certification Tag: Provide new tag indicating acceptable condition of fire extinguisher, date of inspection, and name of self-service inspector for each inspection.

END OF SECTION
SECTION 10 55 00
POSTAL SPECIALTIES

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Central mail delivery boxes.

1.02 REFERENCE STANDARDS

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

1.04 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide manufacturer's warranty against defects in materials or workmanship for a period of 5 years from Date of Substantial Completion.

PART 2 PRODUCTS
2.01 CENTRAL MAIL DELIVERY BOXES
   A. Central Mail Delivery Boxes: Provide products approved for United States Postal Service (USPS) delivery.
      1. Materials: Aluminum with stainless steel hardware.
      2. Finish: Powder coat in color selected by Architect from manufacturer's standard colors.
      3. Unit Types and Sizes: As indicated on drawings.
      4. Configurations: See drawings for overall dimensions and layouts.
      1. Unit A: Front-loading with master door, single-column design, 10 customer compartments, 1 outgoing mail compartment, and 1 parcel compartment.

2.02 COMPONENTS
   A. Locking - Front Loading Master Door: Three-point latching mechanism with USPS master lock furnished and installed by postmaster.
   B. Locking - Customer Compartment Doors: USPS approved cam lock, 3 keys each lock.
   C. Locking - Parcel Compartment Doors: Double-lock arrangement with USPS approved cam lock for customer access, and USPS master lock furnished and installed by postmaster.
   D. Identification - Customer and Parcel Compartments: Sequential numerical or alphabetic characters, top to bottom, left to right; factory-installed.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that rough-openings are ready to receive wall-mounted units.
   B. Do not begin installation until unacceptable conditions are corrected.

3.02 INSTALLATION
   A. Install postal specialties in accordance with approved shop drawings, manufacturer's instructions, and USPS requirements.
   B. Adjust and lubricate door hardware to operate properly.

END OF SECTION
SECTION 14 21 00
ELECTRIC TRACTION ELEVATORS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Complete electric traction elevator systems.
   1. Passenger type.
B. Elevator Maintenance Contract.

1.02 RELATED REQUIREMENTS
A. Section 04 20 00 - Unit Masonry: Masonry hoistway enclosure; building-in and grouting hoistway door frames.
B. Section 22 05 13 - Common Motor Requirements for Plumbing Equipment: Motor for sump pump in pit.
C. Section 26 05 33.13 - Conduit for Electrical Systems:
D. Section 26 05 83 - Wiring Connections:

1.03 PRICE AND PAYMENT PROCEDURES
A. Allowances: See Section 01 21 00 - Allowances, for cash, testing, quantity, and _____ allowances affecting this section.

1.04 REFERENCE STANDARDS
I. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.
J. NEMA MG 1 - Motors and Generators; 2017.
K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
M. PS 1 - Structural Plywood; 2009.

1.05 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate work with other installers to provide necessary conduits for proper installation of wiring, including but not limited to, the following:
   2. Coordinate work with other installers for equipment provisions necessary for proper elevator operation, including but not limited to, the following:
B. Preinstallation Meeting: Convene meeting at least one week prior to start of this work.
   1. Review schedule of installation, proper procedures and conditions, and coordination with related work.
C. Construction Use of Elevator: Not permitted.
1.06 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit data on following items:
   1. Signal and operating fixtures, operating panels, and indicators.
   2. Car design, dimensions, layout, and components.
   3. Car and hoistway door and frame details.
   4. Electrical characteristics and connection requirements.
C. Shop Drawings: Include appropriate plans, elevations, sections, diagrams, and details on following items:
   1. Elevator Equipment and Machines: Size and location of driving machines, power units, controllers, governors, and other components.
   2. Hoistway Components: Size and location of car machine beams, guide rails, buffers, ropes, and other components.
   3. Rail bracket spacing; maximum loads imposed on guide rails requiring load transfer to building structural framing.
   4. Clearances and over-travel of car and counterweight.
   5. Locations in hoistway of traveling cables and connections for car lighting and telephone.
   6. Location and sizes of hoistway and car doors and frames.
   7. Electrical characteristics and connection requirements.
   8. Indicate arrangement of elevator equipment and allow for clear passage of equipment through access openings.
D. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
E. Initial Maintenance Contract.
F. Maintenance Contract: Submit proposal to Owner for standard one year continuing maintenance contract agreement in accordance with ASME A17.1 and requirements as indicated, starting on date initial maintenance contract is scheduled to expire.
   1. Indicate in proposal the services, obligations, conditions, and terms for agreement period and for renewal options.

1.07 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Provide manufacturer's warranty for elevator operating equipment and devices for one year from Date of Substantial Completion.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Basis of Design - Electric Traction Elevators: Schindler; 3300.

2.02 COMPONENTS
A. Elevator Equipment:
   1. Motors, Controllers, Controls, Buttons, Wiring, Devices, and Indicators: Comply with NFPA 70 requirements, and refer to Section 26 05 83 for additional requirements.
   2. Guide Rails, Cables, Counterweights, Sheaves, Buffers, Attachment Brackets and Anchors: Design criteria for components includes safety factors in accordance with applicable requirements of Elevator Code, ASME A17.1.
   3. Buffers:
   4. Lubrication Equipment:
      a. Provide grease fittings for periodic lubrication of bearings.
      b. Grease Cups: Automatic feed type.
      c. Lubrication Points: Visible and easily accessible.
B. Electrical Equipment:
   1. Motors: NEMA MG 1.
2. Boxes, Conduit, Wiring, and Devices: Complying with NFPA 70 and in accordance with Sections 26 05 33.13 and 26 05 83.
3. Sump Pump in Pit: Refer to Section 22 05 13.
4. Spare Conductors: Provide ten percent in extra conductors and two pairs of shielded audio cables in traveling cables.
5. Include wiring and connections to elevator devices remote from hoistway and between elevator machine room. Provide additional components and wiring to suit machine room layout. Refer to Section 26 05 83.

2.03 PERFORMANCE REQUIREMENTS
A. Regulatory Requirements: Comply with ASME A17.1, applicable local codes, and authorities having jurisdiction (AHJ).
B. Accessibility Requirements: Comply with ADA Standards.
C. Perform structural steel design, fabrication, and installation in accordance with AISC 360.
D. Perform welding of steel in accordance with AWS D1.1/D1.1M.
E. Fabricate and install door and frame assemblies in accordance with NFPA 80 and complying with requirements of authorities having jurisdiction (AHJ).
F. Perform electrical work in accordance with NFPA 70.

2.04 OPERATION CONTROLS
A. Elevator Controls: Provide landing operating panels and landing indicator panels.
   1. Landing Operating Panels: Metallic type, one for originating "Up" and one for originating "Down" calls, one button only at terminating landings; with illuminating indicators.
   3. Comply with ADA Standards for elevator controls.
B. Interconnect elevator control system with building security, fire alarm, card access, smoke alarm, and building management control systems.
C. Door Operation Controls:
   1. Program door control to open doors automatically when car arrives at floor landing.
   2. Render "Door Close" button inoperative when car is standing at dispatch landing with doors open.
   3. Door Safety Devices: Moveable, retractable safety edges, quiet in operation; equipped with photo-electric light rays.
D. Provide "Firefighter's Emergency Operation" in accordance with ASME A17.1, applicable building codes, and authorities having jurisdiction (AHJ).
   1. Designated Landing: Main Lobby.

2.05 OPERATION CONTROL TYPE
A. Selective Collective Automatic Operation Control: Applies to car in single elevator shaft.
   1. Refer to description provided in ASME A17.1.
   2. Automatic operation by means of one button in the car for each landing served and by "UP" and "DOWN" buttons at the landings.
   3. Stops are registered by momentary actuation of landing car buttons without consideration of the number of buttons actuated or the sequence buttons are actuated, but the stops are made in the order that landings are reached in each direction of travel.
   4. All "UP" landing calls are made when car is traveling in the up direction.
   5. All "DOWN" landing calls are made when car is traveling in the down direction.
   6. Uppermost and lowermost calls are answered as soon as they are reached without consideration of the car travel direction.

2.06 EMERGENCY POWER
A. Set-up elevator operation to run with building emergency power supply when the normal building power supply fails, and in compliance with ASME A17.1 requirements.
B. Building Emergency Power Supply: Supplied by backup generator; provide elevator system components as required for emergency power characteristics with phase rotation the same as for normal power.
   1. Provide transfer switches and auxiliary contacts.
   2. Install connections to power feeders.

C. Emergency Lighting: Comply with ASME A17.1 elevator lighting requirements.

D. Provide operational control circuitry for adapting the change from normal to emergency power.

E. Upon transfer to emergency power, advance one elevator at a time to a pre-selected landing, stop car, open doors, disable operating circuits, and hold in standby condition.

2.07 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M), natural anodized finish unless otherwise indicated.

B. Plywood: PS 1, Structural I, Grade C-D or better, sanded.

C. Plastic Laminate: NEMA LD 3, Type HGS, color as selected by Architect from manufacturer's standard line of colors.

2.08 CAR AND HOISTWAY ENTRANCES

A. Elevator, No. 1:
   1. Car and Hoistway Entrances, Main Elevator Lobby:
      a. Hoistway Fire Rating: 2 Hours.
      c. Car Door Material: Powder coat on steel, with rigid sandwich panel construction.
      d. Hoistway Door Material: Powder coat on steel, with rigid sandwich panel construction.

2.09 CAR EQUIPMENT AND MATERIALS

A. Elevator Car, No. 1:
   2. Car Operating Panel: Provide main and auxiliary; flush-mounted applied face plate, with illuminated call buttons corresponding to floors served with "Door Open/Door Close" buttons, "Door Open" button, "Door Close" button, and alarm button.
      a. Panel Material: Integral with front return; one per car.
      b. Car Floor Position Indicator: Above door with illuminating position indicators.
      c. Locate alarm button where it is unlikely to be accidentally actuated; not more than 54 inch above car finished floor.

   5. Wall Base: Resilient base, 4 inch high.
   6. Front Return Panel: Match material of car door.
   7. Door Wall: Plastic laminate on plywood.
   8. Hand Rail: Aluminum, at three side walls. Provide open clearance space 1-1/2 inch (38 mm) wide to face of wall.
   9. Ceiling:
      b. Lighting: Compact fluorescent downlights.
   10. Provide emergency access panel for egress from car at ceiling.

2.10 FINISHES

A. Powder Coat on Steel: Clean and degrease metal surface; apply one coat of primer; two coats of powder coat.

B. Finish Paint for Metal Surfaces: Alkyd enamel, semi-gloss, color as selected, comply with VOC limitations of authorities having jurisdiction (AHJ).
C. Clear Anodized Finish: Class I, AAMA 611 AA-M12C22A41 Clear anodic coating with electrolytically deposited organic seal; not less than 0.7 mils, 0.0007 inch thick.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting this work.
B. Verify that hoistway and pit are ready for work of this section.
C. Verify hoistway shaft and openings are of correct size and within tolerance.
D. Verify location and size of machine foundation and position of machine foundation bolts.
E. Verify that electrical power is available and of correct characteristics.

3.02 PREPARATION

A. Arrange for temporary electrical power for installation work and testing of elevator components. Comply with requirements of Section 01 50 00 - Temporary Facilities and Controls.
B. Maintain elevator pit excavation free of water.

3.03 INSTALLATION

A. Coordinate this work with installation of hoistway wall construction.
B. Install system components, and connect equipment to building utilities.
C. Provide conduit, electrical boxes, wiring, and accessories. Refer to Sections 26 05 33.13 and 26 05 83.
D. Mount machines and motors on vibration and acoustic isolators.
   1. Place on structural supports and bearing plates.
   2. Securely fasten to building supports.
   3. Prevent lateral displacement.
E. Install hoistway, elevator equipment, and components in accordance with approved shop drawings.
F. Install guide rails to allow for expansion and contraction movement of guide rails.
G. Accurately machine and align guide rails, forming smooth joints with machined splice plates.
H. Install hoistway door sills, frames, and headers in hoistway walls; grout sills in place, set hoistway floor entrances in alignment with car openings, and align plumb with hoistway.
I. Fill hoistway door frames solid with grout in accordance with Section 04 20 00.
J. Structural Metal Surfaces: Clean surfaces of rust, oil or grease; wipe clean with solvent; prime with two coats.
K. Wood Surfaces not Exposed to Public View: Finish with one coat primer; one coat enamel.
L. Adjust equipment for smooth and quiet operation.

3.04 TOLERANCES

A. Guide Rail Alignment: Plumb and parallel to each other in accordance with ASME A17.1 and ASME A17.2.
B. Car Movement on Aligned Guide Rails: Smooth movement, without any objectionable lateral or oscillating movement or vibration.

3.05 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

3.06 ADJUSTING

A. Adjust for smooth acceleration and deceleration of car to minimize passenger discomfort.
B. Adjust with automatic floor leveling feature at each floor landing to reach 1/4 inch maximum from flush with sill.
3.07 CLEANING
   A. Remove protective coverings from finished surfaces.
   B. Clean surfaces and components in accordance with manufacturers written instructions.
   C. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.

3.08 CLOSEOUT ACTIVITIES
   A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
   B. See Section 01 79 00 - Demonstration and Training, for additional requirements.
   C. Demonstrate proper operation of equipment to Owner's designated representative.
   D. Demonstration: Demonstrate operation of system to Owner's personnel.
      1. Use operation and maintenance data as reference during demonstration.
      2. Briefly describe function, operation, cleaning and maintenance of each component.
   E. Training: Train Owner's personnel on cleaning and operation and maintenance of system.
      1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
      2. Provide minimum of two hours of training.
      3. Instructor: Manufacturer's training personnel.
      4. Location: At project site, unless otherwise indicated.

3.09 PROTECTION
   A. Do not permit construction traffic within car after cleaning.
   B. Protect installed products until Date of Substantial Completion.
   C. Touch-up, repair, or replace damaged products and materials before Date of Substantial Completion.

3.10 MAINTENANCE
   A. Provide Initial Maintenance Contract of elevator system and components in accordance with ASME A17.1 and requirements as indicated for three months from Date of Substantial Completion.
   B. Perform maintenance contract services using competent and qualified personnel under the supervision and direct employ of the elevator manufacturer or installer.
   C. Include systematic examination, adjustment, and lubrication of elevator equipment.
   D. Perform work without removing cars from use during peak traffic periods.

END OF SECTION
SECTION 22 0513
COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES
A. General construction and requirements.
B. Applications.
C. Three phase electric motors.

1.02 REFERENCE STANDARDS
A. NEMA MG 1 - Motors and Generators.
B. NFPA 70 - National Electrical Code.

1.03 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.

1.04 QUALITY ASSURANCE
A. Comply with NFPA 70.

PART 2 PRODUCTS

2.01 GENERAL CONSTRUCTION AND REQUIREMENTS
A. Electrical Service: Refer to Section 26 0583 for required electrical characteristics.
B. Construction:
   1. Open drip-proof type except where specifically noted otherwise.
   2. Design for continuous operation in 104 degrees F environment.
   3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
D. Wiring Terminations:
   1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
   2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.02 APPLICATIONS
A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.

2.03 THREE PHASE POWER - SQUIRREL CAGE MOTORS
A. Starting Torque: Between 1 and 1-1/2 times full load torque.
B. Starting Current: Six times full load current.
C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
PART 3 EXECUTION

3.01 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
   C. Check line voltage and phase and ensure agreement with nameplate.

3.02 SCHEDULES
   A. NEMA Open Motor Service Factors.
      1. 1/6-1/3 hp:
         a. 3600 rpm: 1.35.
         b. 1800 rpm: 1.35.
         c. 1200 rpm: 1.35.
         d. 900 rpm: 1.35.
      2. 1/2 hp:
         a. 3600 rpm: 1.25.
         b. 1800 rpm: 1.25.
         c. 1200 rpm: 1.25.
         d. 900 rpm: 1.15.
      3. 3/4 hp:
         a. 3600 rpm: 1.25.
         b. 1800 rpm: 1.25.
         c. 1200 rpm: 1.15.
         d. 900 rpm: 1.15.
      4. 1 hp:
         a. 3600 rpm: 1.25.
         b. 1800 rpm: 1.15.
         c. 1200 rpm: 1.15.
         d. 900 rpm: 1.15.
      5. 1.5-150 hp:
         a. 3600 rpm: 1.15.
         b. 1800 rpm: 1.15.
         c. 1200 rpm: 1.15.
         d. 900 rpm: 1.15.

END OF SECTION
SECTION 22 0517
SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Pipe sleeves.
B. Manufactured sleeve-seal systems.

1.02 RELATED REQUIREMENTS
A. Section 22 0719 - Plumbing Piping Insulation.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS
2.01 PIPE SLEEVES
A. Vertical Piping:
   1. Sleeve Length: 1 inch above finished floor.
   2. Provide sealant for watertight joint.
B. Plastic or Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
C. Pipe Passing Through Mechanical, Laundry, and Animal Room Floors above Basement:
   1. Galvanized steel pipe or black iron pipe with asphalt coating.
   2. Connect sleeve with floor plate except in mechanical rooms.

2.02 MANUFACTURED SLEEVE-SEAL SYSTEMS
A. Modular/Mechanical Seal:
   1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
   2. Provide watertight seal between pipe and wall/casing opening.
   3. Elastomer element size and material in accordance with manufacturer's recommendations.
   4. Glass reinforced plastic pressure end plates.

PART 3 EXECUTION
3.01 INSTALLATION
A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
B. Install piping to conserve building space, to not interfere with use of space and other work.
C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
D. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
   1. Underground Piping: Caulk pipe sleeve watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.
   2. Aboveground Piping:
b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.

E. Manufactured Sleeve-Seal Systems:
   1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
   2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
   3. Locate piping in center of sleeve or penetration.
   4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
   5. Tighten bolting for a water-tight seal.
   6. Install in accordance with manufacturer’s recommendations.

F. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

END OF SECTION
SECTION 22 0519
METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Pressure gauges and pressure gauge taps.
   B. Thermometers and thermometer wells.

1.02 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES
   A. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
      1. Case: Steel with brass bourdon tube.
      2. Size: 4-1/2 inch diameter.
      3. Mid-Scale Accuracy: One percent.

2.02 PRESSURE GAUGE TAPPINGS
   A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi.

2.03 STEM TYPE THERMOMETERS
   A. Thermometers - Fixed Mounting: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish.
      1. Size: 9 inch scale.
      2. Window: Clear Lexan.
      3. Accuracy: 2 percent, per ASTM E77.
      4. Calibration: Degrees F.

   B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
      1. Size: 9 inch scale.
      2. Window: Clear Lexan.
      3. Accuracy: 2 percent, per ASTM E77.
      4. Calibration: Degrees F.

2.04 THERMOMETER SUPPORTS
   A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
C. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

D. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

END OF SECTION
SECTION 22 0523
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Applications.
B. General requirements.
C. Angle valves.
D. Ball valves.
E. Butterfly valves.
F. Check valves.

1.02 RELATED REQUIREMENTS
A. Section 22 0719 - Plumbing Piping Insulation.
B. Section 22 1005 - Plumbing Piping.

1.03 REFERENCE STANDARDS
A. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
C. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard.
D. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves.
E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
F. ASME B16.34 - Valves - Flanged, Threaded and Welding End.
I. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
J. MSS SP-45 - Bypass and Drain Connections.
K. MSS SP-67 - Butterfly Valves.
L. MSS SP-71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
M. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service.
N. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.
O. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
P. NSF 61 - Drinking Water System Components - Health Effects.
Q. NSF 372 - Drinking Water System Components - Lead Content.

1.04 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
D. Operation and Maintenance Data: Include manufacturer’s descriptive literature, operating instructions, maintenance and repair data, and parts listings.

E. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.
   1. See Section 01 6000 - Product Requirements, for additional provisions.

PART 2 PRODUCTS

2.01 APPLICATIONS

A. See drawings for specific valve locations.

B. Provide the following valves for the applications if not indicated on drawings:
   1. Shutoff: Ball, butterfly, plug.
   2. Dead-End: Single-flange butterfly (lug) type.
   3. Throttling: Provide angle, ball, or butterfly.

C. Substitutions of valves with higher CWP classes or SWP ratings for same valve types are permitted when specified CWP ratings or SWP classes are not available.

D. Domestic, Hot and Cold Water Valves:
   1. 2 NPS and Smaller:
      a. Bronze: Provide with solder-joint or threaded ends.
      b. Bronze Angle: Class 125, bronze disc.
      c. Ball: One piece, full port, bronze with brass trim.
      d. Bronze Swing Check: Class 125, bronze disc.
   2. 2-1/2 NPS and Larger:
      a. Iron, 2-1/2 NPS to 4 NPS: Provide with threaded or flanged ends.
      b. Iron Ball: Class 150.
      d. Iron Swing Check: Class 125, metal seats.

2.02 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:
   2. Wrench: Plug valves with square heads.

D. Valves in Insulated Piping: With 2 NPS stem extensions and the following features:
   1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
   3. Memory Stops: Fully adjustable after insulation is installed.

E. Valve-End Connections:

F. General ASME Compliance:


H. Bronze Valves:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

I. Valve Bypass and Drain Connections: MSS SP-45.

J. Source Limitations: Obtain each valve type from a single manufacturer.

2.03 BRONZE ANGLE VALVES

A. Class 125: CWP Rating: 200 psig, and Class 150: CWP Rating: 300 psig:
   1. Comply with MSS SP-80, Type 1.
   3. Ends: Threaded.
   4. Stem: Bronze.
   5. Disc: Bronze.
   7. Handwheel: Bronze or aluminum.

2.04 BRONZE BALL VALVES

A. One Piece, Reduced Port with Bronze Trim:
   1. Comply with MSS SP-110.
   2. SWP Rating: 400 psig.
   3. CWP Rating: 600 psig.
   5. Ends: Threaded.
   6. Seats: PTFE or TFE.

B. Two Piece, Full Port with Bronze Trim:
   1. Comply with MSS SP-110.
   2. SWP Rating: 150 psig.
   3. CWP Rating: 600 psig.
   5. Ends: Threaded.
   6. Seats: PTFE or TFE.

2.05 IRON BALL VALVES

A. Class 125, Full Port, Stainless Steel Trim:
   1. Comply with MSS SP-72.
   2. CWP Rating: 200 psig.
   5. Seats: PTFE, TFE, or Teflon.
   6. Operator: Lever, with locking handle.

2.06 IRON, SINGLE FLANGE BUTTERFLY VALVES

A. Lug type: Bi-directional dead-end service without use of downstream flange.
   1. Comply with MSS SP-67, Type I.
   2. CWP Rating: 200 psig.
   3. Body: ASTM A126, cast iron or ASTM A536, ductile iron.
   4. Stem: One or two-piece stainless steel.
   5. Seat: EPDM.
   6. Disc: Coated ductile iron.

2.07 BRONZE SWING CHECK VALVES

A. Class 125: CWP Rating: 200 psig (1380 kPa) and Class 150: CWP Rating: 300 psig (2070 kPa).
   1. Comply with MSS SP-80, Type 3.
   2. Design: Horizontal flow.
   4. Ends: Threaded as indicated.
   5. Disc: Bronze.
2.08 IRON SWING CHECK VALVES

A. Class 125:
   1. Comply with MSS SP-71, Type I.
   2. CWP Rating: 200 psig.
   3. Design: Clear or full waterway.
   5. Ends: Flanged as indicated.
   6. Trim: Composition.
   7. Seat Ring and Disc Holder: Bronze.
   8. Disc: PTFE or TFE.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

C. Install check valves where necessary to maintain direction of flow as follows:
   1. Swing Check: Install horizontal maintaining hinge pin level.

END OF SECTION
SECTION 22 0529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1  GENERAL

1.01  REFERENCE STANDARDS

F. MFMA-4 - Metal Framing Standards Publication.

1.02  SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, non-penetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.

1.03  QUALITY ASSURANCE

A. Comply with applicable building code.

PART 2  PRODUCTS

2.01  SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
   2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
   3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
   4. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
      a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Metal Channel (Strut) Framing Systems:

C. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.

D. Thermal Insulated Pipe Supports:
   1. General Construction and Requirements:
      a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
      b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
      c. Pipe supports to be provided for nominally sized, 1/2 inch to 30 inch iron pipes.
      d. Insulation inserts to consist of polyisocyanurate (urethane) insulation surrounded by a 360 degree, PVC jacketing.
   2. PVC Jacket:
a. Pipe insulation protection shields to be provided with a ball bearing hinge and locking seam.
b. Moisture Vapor Transmission: 0.0071 perm inch, when tested in accordance with ASTM E96/E96M.
c. Thickness: 60 mil.

E. Anchors and Fasteners:
   1. Manufacturers - Mechanical Anchors:
      b. ITW Red Head, a division of Illinois Tool Works, Inc; __________: www.itwredhead.com/#sle.
   2. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

PART 3  EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify that mounting surfaces are ready to receive support and attachment components.
   C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
   A. Install products in accordance with manufacturer's instructions.
   B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
   C. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
   D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
   E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
   F. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.
   G. Equipment Support and Attachment:
      1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
      2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
      3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
      4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
   H. Secure fasteners according to manufacturer's recommended torque settings.
   I. Remove temporary supports.

END OF SECTION
PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Self-regulating parallel resistance electric heating cable.
   B. Cable outer jacket markings.
   C. Connection kits.

1.02 RELATED REQUIREMENTS
   A. Section 22 0553 - Identification for Plumbing Piping and Equipment
   B. Section 22 0719 - Plumbing Piping Insulation.
   C. Section 22 1005 - Plumbing Piping.
   D. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables.
   E. Section 26 0526 - Grounding and Bonding for Electrical Systems.
   F. Section 26 0533.13 - Conduit for Electrical Systems.
   G. Section 26 0583 - Wiring Connections.

1.03 REFERENCE STANDARDS
   B. ITS (DIR) - Directory of Listed Products.
   C. NFPA 70 - National Electrical Code.
   D. UL (DIR) - Online Certifications Directory.

1.04 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data for electric heat tracing.

1.05 QUALITY ASSURANCE

PART 2 PRODUCTS
2.01 SELF-REGULATING PARALLEL RESISTANCE ELECTRIC HEATING CABLE
   A. Provide products listed, classified, and labeled by UL (DIR), ITS (DIR), or testing firm acceptable to authorities having jurisdiction (AHJ).
   C. Heating Element:
      1. Provide pair of parallel No.16 tinned or nickel coated stranded copper bus wires embedded in cross linked conductive polymer core with varying heat output in response to temperature along its length.
      2. Terminations: Waterproof, factory assembled, non-heating leads with connector at one end and water-tight seal at opposite end.
      3. Capable of crossing over itself without overheating.
   D. Insulated Jacket: Flame retardant polyolefin.
   E. Cable Cover: Provide tinned copper and polyolefin outer jacket with UV inhibitor.
   F. Maximum Power-On Operating Temperature: 150 degrees F.
G. Maximum Power-Off Exposure Temperature: 185 degrees F.
H. Electrical Characteristics:

2.02 CABLE OUTER JACKET MARKINGS
A. Name of manufacturer, trademark, or other recognized symbol of identification.
B. Catalog number, reference number, or model.
C. Month and year of manufacture, date coding, applicable serial number, or equivalent.
D. Agency listing or approval.

2.03 CONNECTION KITS
A. Provide power connection, splice/tee, and end seal kits compatible with the heating cable and without requiring cutting of the cable core to expose bus wires.
B. Provide with NEMA 4X rating for prevention of corrosion and water ingress.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install in accordance with manufacturer's written installation instructions.
B. Comply with installation requirements of IEEE 515.1 and NFPA 70, Article 427.
C. Apply heating cable linearly on pipe with fiberglass tape only after piping has successfully completed any required pressure testing.
D. Comply with applicable local building codes and requirements of authorities having jurisdiction.
E. Identification:
   1. After thermal insulation installation, apply external pipeline decals to indicate presence of the thermal insulation cladding at intervals not to exceed 20 ft including cladding over each valve or other equipment that may require maintenance.

END OF SECTION
SECTION 22 0553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Tags.
   B. Pipe markers.
1.02 REFERENCE STANDARDS

PART 2 PRODUCTS
2.01 TAGS
   A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
   B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
2.02 PIPE MARKERS
   A. Comply with ASME A13.1.
   B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
   C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

PART 3 EXECUTION
3.01 INSTALLATION
   A. Install tags with corrosion resistant chain.
   B. Install plastic pipe markers in accordance with manufacturer's instructions.
   C. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

END OF SECTION
SECTION 22 0719
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Piping insulation.
B. Jackets and accessories.

1.02 RELATED REQUIREMENTS
A. Section 07 8400 - Firestopping.
B. Section 22 1005 - Plumbing Piping: Placement of hangers and hanger inserts.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS
A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER
A. Insulation: ASTM C547; semi-rigid, noncombustible, end grain adhered to jacket.
   1. K Value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum Service Temperature: 650 degrees F.
   3. Maximum Moisture Absorption: 0.2 percent by volume.
B. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
C. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
D. Indoor Vapor Barrier Finish:
   1. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.03 JACKETS
A. PVC Plastic.
   1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
      a. Minimum Service Temperature: 0 degrees F.
      b. Maximum Service Temperature: 150 degrees F.
c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
d. Thickness: 10 mil.
e. Connections: Brush on welding adhesive.

**PART 3 EXECUTION**

### 3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Glass fiber insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

C. Glass fiber insulated pipes conveying fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

D. Inserts and Shields:
   1. Application: Piping 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
   3. Insert Location: Between support shield and piping and under the finish jacket.
   4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
   5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

E. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 8400.

### 3.02 SCHEDULES

A. Plumbing Systems:
   1. Domestic Cold Water, NPS 1 and smaller:
      a. Glass Fiber, preformed pipe insulation:
         1) Thickness: 1/2 inch.
         2) With vapor barrier.
   2. Domestic Cold Water, NPS 1-1/4” and larger:
      a. Glass Fiber, preformed pipe insulation:
         1) Thickness: 1 inch.
         2) With vapor barrier.
   3. Domestic Hot and Recirculated Hot Water, NPS 1-1/4” and smaller:
      a. Glass Fiber, preformed pipe insulation:
         1) Thickness: 1 inch.
         2) With vapor barrier.
   4. Condensate and Equipment Drain Water Below 60 Degrees F, all sizes:
      a. Glass Fiber, preformed pipe insulation:
         1) Thickness: 1/2 inch.
         2) With vapor barrier.

**END OF SECTION**
SECTION 22 1005
PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe, pipe fittings, specialties, and connections for piping systems.
   1. Sanitary sewer.
   2. Domestic water.
   3. Storm water.
   4. Flanges, unions, and couplings.
   5. Pipe hangers and supports.
   6. Manufactured sleeve-seal systems.
   7. Valves.
   8. Check.
   9. Relief valves.
   10. Strainers.

1.02 RELATED REQUIREMENTS

A. Section 08 3100 - Access Doors and Panels.
B. Section 22 0553 - Identification for Plumbing Piping and Equipment.
C. Section 22 0719 - Plumbing Piping Insulation.
D. Section 31 2316 - Excavation.
E. Section 31 2316.13 - Trenching.
F. Section 31 2323 - Fill.

1.03 REFERENCE STANDARDS

B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
E. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
F. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
G. ASME B31.1 - Power Piping.
H. ASME B31.9 - Building Services Piping.
J. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators.
P. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
W. ASTM D2855 - Standard Practice for the Two-Step (Primer & Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
AC. AWWA C651 - Disinfecting Water Mains.
AG. MSS SP-67 - Butterfly Valves.
AH. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
AI. NSF 61 - Drinking Water System Components - Health Effects.
AJ. NSF 372 - Drinking Water System Components - Lead Content.
AK. PPI TR-4 - PPI Listing of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB), and Minimum Required Strength (MRS) Ratings For Thermoplastic Piping Materials or Pipe.

1.04 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
C. Welder Certificate: Include welders certification of compliance with ASME BPVC-IX.
D. Shop Drawings: For non-penetrating rooftop supports, submit detailed layout developed for this project, with design calculations for loadings and spacings.
E. Project Record Documents: Record actual locations of valves.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.
B. Valves: Manufacturer's name and pressure rating marked on valve body.
C. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.
E. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.02 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe: ASTM A74 extra heavy weight.
   1. Fittings: Cast iron.
   2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.

   1. Fittings: PVC.

2.03 SANITARY SEWER PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.

B. Copper Tube: ASTM B306, DWV.

C. PVC Pipe: ASTM D2665.
   1. Fittings: PVC.

2.04 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cross-Linked Polyethylene (PEX) Pipe: ASTM F876 or ASTM F877.
   1. PPI TR-4 Pressure Design Basis:
      a. 160 psig at maximum 73 degrees F.

2.05 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.

B. Cross-Linked Polyethylene (PEX) Pipe: ASTM F876 or ASTM F877.
   1. PPI TR-4 Pressure Design Basis:
      a. 160 psig at maximum 73 degrees F.
2. Fittings: Brass and copper.

2.06 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING
   A. Cast Iron Pipe: ASTM A74 extra heavy weight.
      1. Fittings: Cast iron.
      2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.
   B. PVC Pipe: ASTM D2665 or ASTM D3034.
      1. Fittings: PVC.

2.07 STORM WATER PIPING, ABOVE GRADE
   A. Cast Iron Pipe: CISPI 301, hubless, service weight.
      1. Fittings: Cast iron.
   B. PVC Pipe: ASTM D2665 or ASTM D3034.
      1. Fittings: PVC.

2.08 NATURAL GAS PIPING, ABOVE GRADE
   A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
      2. Joints: Threaded or welded to ASME B31.1.

2.09 FLANGES, UNIONS, AND COUPLINGS
   A. Unions for Pipe Sizes 3 Inches and Under:
      1. Ferrous pipe: Class 150 malleable iron threaded unions.
      2. Copper tube and pipe: Class 150 bronze unions with soldered joints.
   B. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.10 PIPE HANGERS AND SUPPORTS
   A. Provide hangers and supports that comply with MSS SP-58.
      1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
      2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
      3. Trapeze Hangers: Welded steel channel frames attached to structure.

2.11 MANUFACTURED SLEEVE-SEAL SYSTEMS
   A. Modular/Mechanical Seal:
      1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
      2. Provide watertight seal between pipe and wall/casing opening.
      3. Elastomer element size and material in accordance with manufacturer's recommendations.
      4. Glass reinforced plastic pressure end plates.

2.12 BALL VALVES
   A. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded or grooved ends with union.

2.13 BUTTERFLY VALVES
   A. Construction 1-1/2 Inches and Larger: MSS SP-67, 200 psi CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle.
B. Provide gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

2.14 RELIEF VALVES

A. Temperature and Pressure:

2.15 STRAINERS

A. Size 2 inch and Under:
   1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
   2. Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

B. Size 1-1/2 inch to 4 inch:
   1. Class 125, flanged iron body, Y pattern with 1/16 inch stainless steel perforated screen.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

D. Install piping to maintain headroom, conserve space, and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

G. Provide access where valves and fittings are not exposed.
   1. Coordinate size and location of access doors with Section 08 3100.

H. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.

I. Excavate in accordance with Section 31 2316.

J. Backfill in accordance with Section 31 2323.

K. Install bell and spigot pipe with bell end upstream.

L. Install valves with stems upright or horizontal, not inverted. Refer to Section 22 0523.

M. Install water piping to ASME B31.9.

N. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.

O. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
P. Sleeve pipes passing through partitions, walls and floors.

Q. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

R. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Support horizontal piping as indicated.
   4. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   5. Provide copper plated hangers and supports for copper piping.
   6. Support cast iron drainage piping at every joint.

S. Manufactured Sleeve-Seal Systems:
   1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
   2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
   3. Locate piping in center of sleeve or penetration.
   4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
   5. Tighten bolting for a water-tight seal.
   6. Install in accordance with manufacturer's recommendations.

T. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.04 TOLERANCES

A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope.

B. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

3.05 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete, flushed and clean.

B. Ensure acidity (pH) of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Drains.
   B. Cleanouts.
   C. Hose bibbs.
   D. Hydrants.
   E. Washing machine boxes and valves.
   F. Refrigerator valve and recessed box.
   G. Backflow preventers.
   H. Double check valve assemblies.
   I. Water hammer arrestors.
   J. Mixing valves.

1.02 RELATED REQUIREMENTS
   A. Section 22 1005 - Plumbing Piping.
   B. Section 22 3000 - Plumbing Equipment.
   C. Section 22 4000 - Plumbing Fixtures.

1.03 REFERENCE STANDARDS
   A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design.
   B. ASME A112.6.3 - Floor and Trench Drains.
   C. ASME A112.6.4 - Roof, Deck, and Balcony Drains.
   D. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.
   E. ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent.
   F. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers.
   G. ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance.
   H. NSF 61 - Drinking Water System Components - Health Effects.
   I. NSF 372 - Drinking Water System Components - Lead Content.
   J. PDI-WH 201 - Water Hammer Arresters.

1.04 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
   C. Operation Data: Indicate frequency of treatment required for interceptors.
   D. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS
   A. Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

2.02 DRAINS
   A. Roof Drains:
      1. Assembly: ASME A112.6.4.
      2. Body: Lacquered cast iron with sump.
   B. Roof Overflow Drains:
      1. Lacquered cast iron body and clamp collar and bottom clamp ring; pipe extended to 2 inches above flood elevation.
   C. Downspout Nozzles:
      1. Bronze linear with straight bottom section.
   D. Area Drains:
      1. Assembly: ASME A112.6.4.
      2. Body: Lacquered cast iron with sump.
      4. Accessories: Membrane flange and membrane clamp with integral gravel stop, with adjustable under deck clamp.
   E. Floor Drain:
      1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer.
   F. Prefabricated Trench Drain (TD-1): Trench drain system assembled from factory fabricated, polymer concrete castings in standard lengths and variable depths, with integral joint flanges and integral grating support rails; includes joint gaskets and grating.
      1. Grating Material and Style: ADA Standards compliant ductile iron.
      2. Grating Support Rail: Stainless steel.
   G. Floor Sink:
      1. Lacquered cast iron body with dome strainer and seepage flange.

2.03 CLEANOUTS
   A. Cleanouts at Exterior Surfaced Areas:
      1. Round cast nickel bronze access frame and non-skid cover.
   B. Cleanouts at Exterior Unsurfaced Areas:
      1. Line type with lacquered cast iron body and round epoxy coated gasketed cover.
   C. Cleanouts at Interior Finished Floor Areas:
      1. Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.
   D. Cleanouts at Interior Finished Wall Areas:
      1. Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.
   E. Cleanouts at Interior Unfinished Accessible Areas: Calked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

2.04 HOSE BIBBS
   A. Interior Hose Bibbs:
1. Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, chrome plated where exposed with handwheel, integral vacuum breaker in compliance with ASSE 1011.

2.05 HYDRANTS

A. Wall Hydrants:
   1. ASSE 1019; freeze resistant, self-draining type with chrome plated wall plate hose thread spout, handwheel, and integral vacuum breaker.

2.06 WASHING MACHINE BOXES AND VALVES

A. Description: Plastic preformed rough-in box with brass long shank valves with wheel handles, socket for 2 inch waste, slip in finishing cover.

2.07 REFRIGERATOR VALVE AND RECESSED BOX

A. Description: Plastic preformed rough-in box with brass valves with wheel handle, slip in finishing cover.

2.08 BACKFLOW PREVENTERS

A. Reduced Pressure Backflow Preventers:
   1. ASSE 1013; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

2.09 DOUBLE CHECK VALVE ASSEMBLIES

A. Manufacturers:

B. Double Check Valve Assemblies:
   1. ASSE 1012; Bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.

2.10 WATER HAMMER ARRESTORS

A. Water Hammer Arrestors:
   1. Stainless steel construction, bellows type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range minus 100 to 300 degrees F and maximum 250 psi working pressure.

2.11 MIXING VALVES

A. Thermostatic Mixing Valves:
   1. Valve: Chrome plated cast brass body, stainless steel or copper alloy bellows, integral temperature adjustment.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in concrete flush with grade.

D. Install floor cleanouts at elevation to accommodate finished floor.

E. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.

F. Pipe relief from backflow preventer to nearest drain.
G. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to washing machine outlets.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Water Heaters:
   1. Residential gas fired.

B. Diaphragm-type compression tanks.

C. Submersible sump pumps.

1.02 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittals procedures.

B. Product Data:
   1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
   2. Indicate pump type, capacity, power requirements.
   3. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
   4. Provide electrical characteristics and connection requirements.

C. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

D. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.03 QUALITY ASSURANCE

A. Certifications:
   2. Gas Water Heaters: Certified by CSA International to ANSI Z21.10.1, as applicable, in addition to requirements specified elsewhere.

1.04 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for domestic water heaters.

PART 2 PRODUCTS

2.01 WATER HEATERS

A. Residential Gas Fired:
   1. Type: Automatic, natural gas-fired.
   2. Performance:
   3. Controls: Automatic water thermostat and built-in gas pressure regulator; temperature range adjustable from 120 to 170 degrees F, cast iron or sheet metal burner, hot surface ignition and power venter.
   4. Accessories:
      b. Dip Tube: Brass.

2.02 DIAPHRAGM-TYPE COMPRESSION TANKS

A. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.
B. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psig.

2.03 SUBMERSIBLE SUMP PUMPS

A. Type: Completely submersible, vertical, centrifugal.
B. Casing: Cast iron pump body and oil filled motor chamber.
C. Impeller: Cast iron; open non-clog, stainless steel shaft.
D. Bearings: Ball bearings.
E. Sump: Fiberglass basin with steel cover plate; 24 inches diameter, 24 inches deep.
F. Accessories: Oil resistant 6 foot cord and plug with three-prong connector for connection to electric wiring system including grounding connector.
G. Servicing: Slide-away coupling consisting of discharge elbow secure to sump floor, movable bracket, guide pipe system, lifting chain and chain hooks.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install plumbing equipment in accordance with manufacturer’s instructions, as required by code, and complying with conditions of certification, if any.
B. Coordinate with plumbing piping and related fuel piping work to achieve operating system.
C. Domestic Water Storage Tanks:
   1. Provide steel pipe support, independent of building structural framing members.
   2. Clean and flush prior to delivery to site. Seal until pipe connections are made.
D. Pumps:
   1. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

END OF SECTION
SECTION 22 4000
PLUMBING FIXTURES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Water closets.
B. Lavatories.
C. Sinks.
D. Under-lavatory pipe supply covers.
E. Bathtubs.
F. Showers.

1.02 RELATED REQUIREMENTS
A. Section 22 1005 - Plumbing Piping.
B. Section 22 1006 - Plumbing Piping Specialties.
C. Section 22 3000 - Plumbing Equipment.

1.03 REFERENCE STANDARDS
A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design.
B. ASME A112.18.9 - Protectors/Insulators for Exposed Waste and Supplies on Accessible Fixtures.
C. IAPMO Z124 - Plastic Plumbing Fixtures.
D. ASME A112.18.1 - Plumbing Supply Fittings.
E. ASME A112.19.2 - Ceramic Plumbing Fixtures.
F. ASME A112.19.3 - Stainless Steel Plumbing Fixtures.
G. ASSE 1014 - Performance Requirements for Backflow Prevention Devices for Hand-Held Showers.
J. ISFA 2-01 - Classification and Standards for Solid Surfacing Material.
K. NEMA LD 3 - High-Pressure Decorative Laminates.
L. NSF 61 - Drinking Water System Components - Health Effects.
M. NSF 372 - Drinking Water System Components - Lead Content.

1.04 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
C. Maintenance Data: Include fixture trim exploded view and replacement parts lists.
D. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Extra Faucet Washers: One set of each type and size.
3. Extra Lavatory Supply Fittings: One set of each type and size.
4. Extra Shower Heads: One of each type and size.
5. Extra Toilet Seats: One of each type and size.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.07 WARRANTY
A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Provide five year manufacturer warranty for electric water cooler.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS
A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.02 TANK TYPE WATER CLOSETS
A. Bowl: ASME A112.19.2; floor mounted, vitreous china reverse trap, close-coupled closet combination with regular rim, insulated vitreous china closet tank with fittings and lever flushing valve, bolt caps.
   1. Water Consumption: Maximum 1.28 gallons per flush.
B. Seat: Solid white plastic, closed front, brass bolts, with cover.

2.03 LAVATORIES
A. Vitreous China Counter Top Basin: ASME A112.19.2; vitreous china self-rimming counter top lavatory, 19 inch width, or as otherwise specified by owner, with drillings on 4 inch centers, front overflow, seal of putty, calking, or concealed vinyl gasket.
B. Vitreous China Under-Mount Basin: ASME A112.19.2; vitreous china under-mount lavatory, front overflow, mounting kit and template by manufacturer.
C. Supply Faucet: ASME A112.18.1; chrome plated combination supply fitting with pop-up waste, water economy aerator with maximum flow of 2.2 gallons per minute, indexed handles.
D. Accessories:
   1. Chrome plated 17 gage, 0.0538 inch brass P-trap with clean-out plug and arm with escutcheon.
   2. Wheel handle stops.
   3. Flexible supplies.

2.04 SINKS
A. Single Compartment Bowl: ASME A112.19.3; 19 by 18 by 21 inch outside dimensions, or as specified by owner, 20 gage, 0.0359 inch thick, Type 302 stainless steel, self rimming and undercoated, with ledge back drilled for trim.
B. Double Compartment Bowl: ASME A112.19.3; 22 by 31 by 21 inch outside dimensions, or as specified by owner, 20 gage, 0.0359 inch thick, Type 302 stainless steel, self rimming and undercoated, with ledge back drilled for trim.

2.05 UNDER-LAVATORY PIPE SUPPLY COVERS
A. General:
   1. Insulate exposed drainage piping including hot, cold and tempered water supplies under lavatories or sinks per ADA Standards.
2. Construction: 1/8 inch PVC with antimicrobial, antifungal and UV resistant properties.
   a. Comply with ASME A112.18.9 for covers on accessible lavatory piping.

2.06 BATHTUBS AND SHOWERS

A. Bathtub:
   1. IAPMO Z124; molded glass fiber reinforced polyester, with slip-resistant bottom surface, contoured shape, white color.

B. Bath Trim: ASME A112.18.1; concealed over rim supply with spout and indexed handles, lever operated pop-up waste and overflow.

C. Bath and Shower Trim: ASME A112.18.1; concealed shower and over rim supply with diverter spout, indexed handles, bent shower arm with adjustable spray ball joint showerhead with maximum 2.5 gallons per minute flow and escutcheon, lever operated pop-up waste and overflow.

2.07 SHOWER RECEPTORS

A. Solid Surfacing Shower Receptors: Solid plastic resin casting, self-supporting, for installation over conventional subfloor; complying with IAPMO Z124.
   1. Material: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, renewable material filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
   2. Surface Burning Characteristics: Flame spread index of 25 or less, and smoke developed index of 450 or less, Class A, when tested in accordance with ASTM E84.
   3. Finish on Exposed Surfaces: Provide satin or matte, gloss rating of 3 to 20.

B. Drain Trim: Removable chrome plated strainer and tail piece.

2.08 SHOWERS

A. Trim: ASME A112.18.1; concealed shower supply with indexed handles, bent shower arm with adjustable spray ball joint showerhead with maximum 2.5 gallons per minute flow, and escutcheon.

B. Shower Valve:
   1. Comply with ASME A112.18.1.
   2. Provide two handle in wall diverter valve body with integral thermostatic mixing valve to supply 1.5 gpm.

C. Shower Head:
   1. ASME A112.18.1; chrome plated vandal-proof institutional head with integral wall bracket, built-in 2.5 gpm flow control.

D. Low-Flow Shower Head:
   1. ASME A112.18.1; chrome plated vandal-proof institutional head with integral wall bracket, built-in 1.5 gpm flow control.

E. Hand-Held Shower Head:
   1. ASME A112.18.1, adjustable spray hand-held shower head with swivel fitting, with ASSE 1014 backflow preventer.
   2. Include 60 inch minimum flexible polished stainless steel hose and in-line vacuum breaker
   3. Provide wall bracket to mount hand spray, allowing use of the unit as either a hand-held spray or a fixed shower head.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.
3.02 PREPARATION
   A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 INSTALLATION
   A. Install each fixture with trap, easily removable for servicing and cleaning.
   B. Install components level and plumb.
   C. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

3.04 INTERFACE WITH WORK OF OTHER SECTIONS
   A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.05 ADJUSTING
   A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.06 CLEANING
   A. Clean plumbing fixtures and equipment.

3.07 PROTECTION
   A. Protect installed products from damage due to subsequent construction operations.
   B. Do not permit use of fixtures by construction personnel.
   C. Repair or replace damaged products before Date of Substantial Completion.

END OF SECTION
SECTION 23 0130.51
HVAC AIR-DISTRIBUTION SYSTEM CLEANING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Cleaning of HVAC duct system, equipment, and related components.
B. Testing and inspection agency employed by Owner.

1.02 PRICE AND PAYMENT PROCEDURES
A. See Section 01 2100 - Allowances, for cash, testing, and quantity allowances affecting this section.
B. See Section 01 2200 - Unit Prices, for additional unit price requirements.

1.03 DEFINITIONS
A. HVAC System: For purposes of this section, the surfaces to be cleaned include all interior surfaces of the heating, air-conditioning and ventilation system from the points where the air enters the system to the points where the air is discharged from the system, including the inside of air distribution equipment, coils, and condensate drain pans; see NADCA ACR for more details.
1. Above-ceiling plenum for supply air is required to be cleaned.
2. Above-ceiling plenum for return air is required to be cleaned.
3. Exhaust-only system is required to be cleaned.

1.04 REFERENCE STANDARDS
B. NADCA ACR - Assessment, Cleaning and Restoration of HVAC Systems.
C. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.
D. UL 181A - Closure Systems for Use with Rigid Air Ducts.

1.05 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's data sheets on each product to be used.
C. Qualifications Statement: Submit qualifications of proposed cleaning contractor for approval.
D. Qualifications Statement: Submit qualifications of proposed testing and inspection agency for approval.
E. Project Cleanliness Evaluation and Cleaning Plan, as specified.
F. Material Safety Data Sheets (MSDS): For all chemical products proposed to be used in the cleaning process; submit directly to Owner.
G. Project Closeout Report: Include field quality control reports, evidence of satisfactory cleaning, and documentation of items needing further repair.

1.06 QUALITY ASSURANCE
A. Information Available to Contractor: Upon request, Owner will provide the following:
   1. One copy of original construction drawings of HVAC system.
   2. One copy of original construction specifications of HVAC system.
   3. Cleanliness inspection report performed by separate contractor.
   4. Indoor air quality report performed by separate contractor.
   5. Hazardous material report performed by separate contractor.
B. Cleaning Contractor Qualifications: Company specializing in the cleaning and restoration of HVAC systems as specified in this section.
   1. Certified by one of the following:
PART 2 PRODUCTS

2.01 TOOLS AND EQUIPMENT

A. Vacuum Devices and Other Tools: Exceptionally clean, in good working order, and sealed when brought into the facility.

B. Vacuum Devices That Exhaust Air Inside Building, Including Hand-Held and Wet Vacuums: Equipped with HEPA filtration with 99.97 percent collection efficiency for minimum 0.3-micron size particles and DOP test number.

C. Vacuum Devices That Exhaust Air Outside Building, Including Truck- and Trailer-Mounted Types: Equipped with particulate collection including adequate filtration to contain debris removed from the HVAC system; exhausted in manner that prevents contaminant re-entry to building; compliant with applicable regulations as to outdoor environmental contamination.

2.02 REPLACEMENT PRODUCTS

A. Fibrous Glass Insulation: Provide material complying with UL 181 equivalent to existing material in quality and thickness.

2.03 SURFACE TREATMENTS

A. Surface Coating for Fibrous Glass Materials: Water-based, zero VOC; flame spread index less that 25, smoke developed index less than 450, Class A, when tested in accordance with ASTM E84.

PART 3 EXECUTION

3.01 PROJECT CONDITIONS

A. Comply with applicable federal, state, and local requirements.

B. Perform cleaning, inspection, and remediation in accordance with the recommendations of NADCA "Assessment, Cleaning and Restoration of HVAC Systems" (ACR) and as specified herein.

C. Where NADCA ACR uses the terms "recommended", "highly recommended", or "ideally" in regard to a certain procedure or activity, do that unless it is clearly inapplicable to the project.

D. Take precautions to prevent introduction of additional hazards into occupied spaces.

E. Obtain Owner's approval of proposed temporary locations for large equipment.

F. Designate a decontamination area and obtain Owner's approval.

G. If unforeseen mold or other biological contamination is encountered, notify Architect immediately, identifying areas affected and extent and type of contamination.

3.02 EXAMINATION

A. Prior to the commencement of any cleaning work, prepare and submit to Architect a project evaluation and plan for this project, including considerations recommended in NADCA ACR.

B. Inspect the system as required to determine appropriate methods, tools, equipment, and protection.

C. Start of cleaning work constitutes acceptance of existing conditions.

D. When concealed spaces are later made accessible, examine and document interior conditions prior to beginning cleaning.
E. Document all instances of mold growth, rodent droppings, other biological hazards, and damaged system components.

3.03 PREPARATION

A. When cleaning work might adversely affect life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with authorities having jurisdiction.

B. Ensure that electrical components that might be adversely affected by cleaning are de-energized, locked out, and protected prior to beginning work.

C. Air-Volume Control Devices: Mark the original position of dampers and other air-directional mechanical devices inside the HVAC system prior to starting cleaning.

D. Access to Concealed Spaces: Use existing service openings and make additional service openings as required to accomplish cleaning and inspection.
   1. Do not cut openings in non-HVAC components without obtaining the prior approval of Owner.
   2. Make new openings in HVAC components in accordance with NADCA Standard 05; do not compromise the structural integrity of the system.
   3. Do not cut service openings into flexible duct; disconnect at ends for cleaning and inspection.

E. Ceiling Tile: Lay-in ceiling tile may be removed to gain access to HVAC systems during the cleaning process; protect tile from damage and reinstall upon completion; replace damaged tile.

3.04 CLEANING

A. Use any cleaning method recommended by NADCA ACR unless otherwise specified; do not use methods prohibited by NADCA ACR, or that will damage HVAC components or other work, or that will significantly alter the integrity of the system.

B. Obtain Owner's approval before using wet cleaning methods; ensure that drainage is adequate before beginning.

C. Ducts: Mechanically clean all portions of ducts.

D. Hoses, Cables, and Extension Rods: Clean using suitable sanitary damp wipes at the time they are being removed or withdrawn from their normal position.

E. Registers, Diffusers, and Grilles: When removing, take care to prevent containment exposure due to accumulated debris.

F. Coils: Follow NADCA ACR completely including measuring static pressure drop before and after cleaning; do not remove refrigeration coils from system to clean; report coils that are permanently impacted.

G. Fibrous Glass Material: Use HEPA vacuuming equipment, under constant negative pressure, do not permit to get wet, and do not damage surfaces; replace material damaged by cleaning operations.

H. Existing Damaged Fibrous Glass Material: Report to Architect all evidence of damage, deterioration, delaminating, friable material, mold or fungus growth, or moisture that cannot be remedied by cleaning or resurfacing with an acceptable insulation repair coating.
   1. Remove unremediable material and clean underlying surfaces.

I. Collect debris removed during cleaning; ensure that debris is not dispersed outside the HVAC system during the cleaning process.

J. Store contaminated tools and equipment in polyethylene bags until cleaned in the designated decontamination area.

3.05 REPAIR

A. Repair openings cut in the ventilation system so that they do not significantly alter the airflow or adversely impact the facility's indoor air quality.

B. At insulated ducts and components, accomplish repairs in such a manner as to achieve the equivalent thermal value.
C. Reseal new openings in accordance with NADCA Standard 05.
D. Reseal rigid fiber glass duct systems using closure techniques that comply with UL 181 or UL 181A.
E. When new openings are intended to be capable of being re-opened in the future, clearly mark them and report their locations to Owner in project report documents.

3.06 FIELD QUALITY CONTROL
   A. Ensure that the following field quality control activities are completed prior to application of any treatments or coatings and prior to returning HVAC system to normal operation.
   B. Visually inspect all portions of the cleaned components; if not visibly clean as defined in NADCA ACR, re-clean and reinspect.
   C. Coils: Cleaning must restore the coil pressure drop to within 10 percent of the coil's original installed pressure drop; if original pressure drop is not known, coil will be considered clean if free of foreign matter and chemical residue based on visual inspection.
   D. Notify Architect when cleaned components are ready for inspection.
   E. Notify Owner’s testing and inspection agency when cleaned components are ready for inspection.
   F. Owner reserves the right to verify cleanliness using NADCA ACR Surface Comparison Testing or NADCA Vacuum Test.
   G. When directed, re-clean components until they pass.
   H. Contractor shall bear the costs of retesting due to inadequate cleaning.
   I. Submit evidence that all portions of the system required to be cleaned have been cleaned satisfactorily.

3.07 ADJUSTING
   A. After satisfactory completion of field quality control activities, restore adjustable devices to original settings, including, but not limited to, dampers, air directional devices, valves, fuses, and circuit breakers.

3.08 WASTE MANAGEMENT
   A. Double-bag waste and debris in 6 mil, 0.006 inch thick polyethylene plastic bags.
   B. Dispose of debris off-site in accordance with applicable federal, state and local requirements.

END OF SECTION
SECTION 23 0513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General construction and requirements.
B. Applications.
C. Single phase electric motors.
D. Three phase electric motors.
E. Electronically Commutated Motors (ECM).

1.02 RELATED REQUIREMENTS

A. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. NEMA MG 1 - Motors and Generators.
B. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
C. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
D. Operation Data: Include instructions for safe operating procedures.
E. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 QUALITY ASSURANCE

A. Comply with NFPA 70.
B. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of high efficiency motors.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service: Refer to Section 26 0583 for required electrical characteristics.

B. Electrical Service:
   1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.
   2. Motors Larger than 1/2 Horsepower: 208 volts, three phase, 60 Hz.

C. Construction:
1. Open drip-proof type except where specifically noted otherwise.
2. Design for continuous operation in 104 degrees F environment.
3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

E. Wiring Terminations:
   1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
   2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.02 APPLICATIONS

A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.

B. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.

C. Single phase motors for fans, blowers, and pumps: Capacitor start, capacitor run type.

D. Motors located in exterior locations, wet air streams downstream of sprayed coil dehumidifiers, draw through cooling towers, air cooled condensers, humidifiers, direct drive axial fans, roll filters, explosion proof environments, and dust collection systems: Totally enclosed type.

2.03 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.04 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

2.05 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.


2.06 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. Applications:
   1. Residential:
      a. Furnace:
         1) Operating Mode: Constant cfm.
         2) Input: Motor manufacturer to coordinate control requirements with the control board of the furnace.
         3) RPM: 300 through 1250.
      b. Condenser Fan:
1) Operating Mode: Constant speed.
2) Input: Motor manufacturer to coordinate control requirements with the control board of the condenser fan.
3) RPM: 300 through 1250.

2. Commercial:
   a. DX Fan Coil Unit:
      1) Operating Mode: Constant cfm.
      2) Input: Motor manufacturer to coordinate control requirements with the control board of the DX fan coil unit and/or specified sequence of operation.
      3) Shaft Extension: Single.
      4) Options: Remote mount control/User-Interface.
      5) RPM: 300 through 1250.
   b. Power Roof Ventilator (PRV):
      1) Operating Mode: Constant cfm.
      2) Input: Motor manufacturer to coordinate control requirements with the control board of the PRV and/or specified sequence of operation.
      3) Shaft Extension: Single.
      4) Options: Remote mount control.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
   C. Check line voltage and phase and ensure agreement with nameplate.

3.02 SCHEDULE
   A. NEMA Open Motor Service Factors.
      1. 1/6-1/3 hp:
         a. 3600 rpm: 1.35.
         b. 1800 rpm: 1.35.
         c. 1200 rpm: 1.35.
         d. 900 rpm: 1.35.
      2. 1/2 hp:
         a. 3600 rpm: 1.25.
         b. 1800 rpm: 1.25.
         c. 1200 rpm: 1.25.
         d. 900 rpm: 1.15.
      3. 3/4 hp:
         a. 3600 rpm: 1.25.
         b. 1800 rpm: 1.25.
         c. 1200 rpm: 1.15.
         d. 900 rpm: 1.15.
      4. 1 hp:
         a. 3600 rpm: 1.25.
         b. 1800 rpm: 1.15.
         c. 1200 rpm: 1.15.
         d. 900 rpm: 1.15.
      5. 1.5-150 hp:
         a. 3600 rpm: 1.15.
         b. 1800 rpm: 1.15.
         c. 1200 rpm: 1.15.
         d. 900 rpm: 1.15.

END OF SECTION
SECTION 23 0529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Support and attachment components for equipment, piping, and other HVAC/hydronic work.

1.02 RELATED REQUIREMENTS
   A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
   B. Section 05 5000 - Metal Fabrications: Materials and requirements for fabricated metal supports.
   C. Section 23 0548 - Vibration and Seismic Controls for HVAC.

1.03 REFERENCE STANDARDS
   A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel
      Products.
   F. MFMA-4 - Metal Framing Standards Publication.

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components
         to be installed.
      2. Coordinate the work with other trades to provide additional framing and materials required for
         installation.
      3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed
         locations.
      4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts
         installed under other sections or by others.
      5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before
         proceeding with work.
   B. Sequencing:
      1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in
         accordance with Section 03 3000.

1.05 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing
      systems, non-penetrating rooftop supports, post-installed concrete and masonry anchors, and thermal
      insulated pipe supports.
   C. Evaluation Reports: For products specified as requiring evaluation and recognition by ICC Evaluation
      Service, LLC (ICC-ES), provide current ICC-ES evaluation reports upon request.
   D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product
      testing agency. Include instructions for storage, handling, protection, examination, preparation, and
      installation of product.
1.06 QUALITY ASSURANCE
   A. Comply with applicable building code.
   B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
   C. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.
   D. Installer Qualifications for Field-Welding: As specified in Section 05 5000.
   E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS
   A. General Requirements:
      1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
      2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
      3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of _____ . Include consideration for vibration, equipment operation, and shock loads where applicable.
      4. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
         a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
         b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
   B. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
      1. Provide factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
      2. Comply with MFMA-4.
      3. Channel Material:
         a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
         b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
      4. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
   C. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
      1. Minimum Size, Unless Otherwise Indicated or Required:
         a. Equipment Supports: 1/2 inch diameter.
         b. Piping up to 1 inch (27 mm) nominal: 1/4 inch diameter.
         c. Piping larger than 1 inch (27 mm) nominal: 3/8 inch diameter.
         d. Trapeze Support for Multiple Pipes: 3/8 inch diameter.
   D. Thermal Insulated Pipe Supports:
      1. General Construction and Requirements:
         a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
         b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
         c. Pipe supports to be provided for nominally sized, 1/2 inch to 30 inch iron pipes.
         d. Insulation inserts to consist of polysisocyanurate (urethane) insulation surrounded by a 360 degree, PVC jacketing.
      2. PVC Jacket:
Pipe insulation protection shields to be provided with a ball bearing hinge and locking seam.

Moisture Vapor Transmission: 0.0071 perm inch, when tested in accordance with ASTM E96/E96M.

Thickness: 60 mil.

E. Non-Penetrating Rooftop Supports for Low-Slope Roofs:
   1. Provide steel pedestals with thermoplastic or rubber base that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
   2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
   3. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
   4. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

F. Anchors and Fasteners:
   1. Manufacturers - Mechanical Anchors:
      b. ITW Red Head, a division of Illinois Tool Works, Inc; __________: www.itwredhead.com/#sle.
      e. Substitutions: See Section 01 6000 - Product Requirements.
   2. Manufacturers - Powder-Actuated Fastening Systems:
      b. ITW Ramset, a division of Illinois Tool Works, Inc; __________: www.ramset.com/#sle.
      e. Substitutions: See Section 01 6000 - Product Requirements.
   3. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
   4. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
   5. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
   8. Steel: Use beam clamps, machine bolts, or welded threaded studs.
   11. Plastic and lead anchors are not permitted.
   12. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
      b. Channel Material: Use galvanized steel.
      c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that field measurements are as indicated.
B. Verify that mounting surfaces are ready to receive support and attachment components.
C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
A. Install products in accordance with manufacturer’s instructions.
B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
C. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

F. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

G. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

H. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

I. Secure fasteners according to manufacturer’s recommended torque settings.

J. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION
SECTION 23 0548
VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Vibration-isolated equipment support bases.
   B. Vibration isolators.
   C. Seismic restraint systems.
   D. Vibration-isolated and/or seismically engineered roof curbs.

1.02 REFERENCE STANDARDS
   A. ASCE 19 - Structural Applications of Steel Cables for Buildings.
   B. MFMA-4 - Metal Framing Standards Publication.

1.03 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

1.04 QUALITY ASSURANCE
   A. Comply with applicable building code.

PART 2 PRODUCTS

2.01 VIBRATION-ISOLATED EQUIPMENT SUPPORT BASES

2.02 VIBRATION ISOLATORS
   A. General Requirements:

2.03 SEISMIC RESTRAINT SYSTEMS
   A. Description: System components and accessories specifically designed for field assembly and attachment of seismic restraints.
      B. Cable Restraints:
         2. Cables: Pre-stretched, galvanized steel wire rope with certified break strength.
         3. Cable Connections: Use only swaged end fittings. Cable clips and wedge type end fittings are not permitted in accordance with ASCE 19.
         4. Use protective thimbles for cable loops where potential for cable damage exists.
      C. Rigid Restraints: Use MFMA-4 steel channel (strut), steel angle, or steel pipe for structural element; suitable for both compressive and tensile design loads.

2.04 VIBRATION-ISOLATED AND/OR SEISMICALLY ENGINEERED ROOF CURBS
   A. Vibration Isolation Curbs:
      1. Non-Seismic Curb Rail:
         a. Location: Between existing roof curb and rooftop equipment.
         b. Construction: Aluminum.
         c. Integral vibration isolation to comply with requirements of this section.
         d. Weather exposed components consist of corrosion resistant materials.
      2. Non-Seismic Curb:
         a. Location: Between structure and rooftop equipment.
         b. Construction: Aluminum.
         c. Integral vibration isolation to comply with requirements of this section.
         d. Weather exposed components consist of corrosion resistant materials.
3. Seismic Curb:
   a. Location: Between structure and rooftop equipment.
   b. Construction: Steel.
   c. Integral vibration isolation to comply with requirements of this section.
   d. Snubbers consist of minimum 0.25 inch thick resilient pads to avoid metal-to-metal contact without compromising vibration isolating capabilities.
   e. Weather exposed components consist of corrosion resistant materials.

B. Seismic Type Non-Isolated Curb and Fabricated Equipment Piers:
   1. Location: Between structure and rooftop equipment.
   2. Construction: Steel.
   3. Weather exposed components consist of corrosion resistant materials.

PART 3 EXECUTION

3.01 INSTALLATION

   A. Install products in accordance with manufacturer's instructions.
   B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
   C. Secure fasteners according to manufacturer's recommended torque settings.
   D. Install flexible piping connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.

3.02 FIELD QUALITY CONTROL

   A. See Section 01 4000 - Quality Requirements, for additional requirements.
   B. Inspect vibration isolation and/or seismic control components for damage and defects.
   C. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.

END OF SECTION
SECTION 23 0553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1  GENERAL

1.01  SECTION INCLUDES
   A. Nameplates.
   B. Tags.
   C. Pipe markers.
   D. Ceiling tacks.

1.02  RELATED REQUIREMENTS
   A. Section 09 9123 - Interior Painting: Identification painting.

1.03  REFERENCE STANDARDS

1.04  SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements for submittal procedures.
   B. Product Data: Provide manufacturers catalog literature for each product required.
   C. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

PART 2  PRODUCTS

2.01  IDENTIFICATION APPLICATIONS
   A. Air Handling Units: Nameplates.
   B. Air Terminal Units: Tags.
   C. Control Panels: Nameplates.
   D. Dampers: Ceiling tacks, where located above lay-in ceiling.
   F. Instrumentation: Tags.
   G. Major Control Components: Nameplates.
   H. Piping: Tags.
   I. Pumps: Nameplates.
   J. Relays: Tags.
   K. Small-sized Equipment: Tags.
   L. Tanks: Nameplates.
   M. Thermostats: Nameplates.

2.02  NAMEPLATES
   A. Manufacturers:
      1. Advanced Graphic Engraving, LLC; ______: www.advancedgraphicengraving.com/#sle.
5. Substitutions: See Section 01 6000 - Product Requirements.

C. Letter Height: 1/4 inch.
D. Background Color: Black.
E. Plastic: Comply with ASTM D709.

2.03 TAGS
A. Manufacturers:
   1. Advanced Graphic Engraving; ______: www.advancedgraphicengraving.com/#sle.
   5. Seton Identification Products, a Tricor Company; ______: www.seton.com/#sle.
   6. Substitutions: See Section 01 6000 - Product Requirements.

B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

2.04 PIPE MARKERS
A. Manufacturers:
   4. MIFAB, Inc; ______: www.mifab.com/#sle.
   5. Seton Identification Products, a Tricor Company; ______: www.seton.com/#sle.
   6. Substitutions: See Section 01 6000 - Product Requirements.

B. Color: Comply with ASME A13.1.
C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
E. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.05 CEILING TACKS
A. Manufacturers:
   2. Substitutions: See Section 01 6000 - Product Requirements.

B. Description: Steel with 3/4 inch diameter color coded head.
C. Color code as follows:
   1. HVAC Equipment: Yellow.
   2. Fire Dampers and Smoke Dampers: Red.

PART 3 EXECUTION
3.01 PREPARATION
A. Degrease and clean surfaces to receive adhesive for identification materials.
3.02 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Install plastic pipe markers in accordance with manufacturer's instructions.

D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

F. Use tags on piping 3/4 inch diameter and smaller.
   1. Identify service, flow direction, and pressure.
   2. Install in clear view and align with axis of piping.
   3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

G. Install ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

H. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION
SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Testing, adjustment, and balancing of air systems.
B. Measurement of final operating condition of HVAC systems.
C. Vibration measurement of equipment operating conditions.
D. Commissioning activities.

1.02 PRICE AND PAYMENT PROCEDURES
A. Cash Allowance: See Section 01 2100 for additional requirements.
B. Allowance includes testing, adjusting, and balancing of mechanical systems.

1.03 REFERENCE STANDARDS
C. NEBB (TAB) - Procedural Standards for Testing Adjusting and Balancing of Environmental Systems.
D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing.

1.04 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
   1. Submit to the Commissioning Authority.
   2. Submit six weeks prior to starting the testing, adjusting, and balancing work.
   3. Include at least the following in the plan:
      a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
      b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
      c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
      d. Final test report forms to be used.
      e. Procedures for formal deficiency reports, including scope, frequency and distribution.
C. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
   1. Revise TAB plan to reflect actual procedures and submit as part of final report.
   2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
   3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
   4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
   5. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
   6. Include the following on the title page of each report:
      a. Name of Testing, Adjusting, and Balancing Agency.
      b. Address of Testing, Adjusting, and Balancing Agency.
      c. Telephone number of Testing, Adjusting, and Balancing Agency.
      d. Project name.
      e. Project location.
      f. Project Architect.
g. Project Engineer.
h. Project Contractor.
i. Project altitude.
j. Report date.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS
A. Perform total system balance in accordance with one of the following:
   1. SMACNA (TAB).
B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
D. TAB Agency Qualifications:
   1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
   2. Certified by one of the following:
      b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION
A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
   1. Systems are started and operating in a safe and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Proper thermal overload protection is in place for electrical equipment.
   4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
   5. Duct systems are clean of debris.
   6. Fans are rotating correctly.
   7. Fire and volume dampers are in place and open.
   8. Air coil fins are cleaned and combed.
   9. Access doors are closed and duct end caps are in place.
  10. Air outlets are installed and connected.
  11. Duct system leakage is minimized.
  12. Pumps are rotating correctly.
B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION
A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
  1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

3.04 ADJUSTMENT TOLERANCES
A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
3.05 RECORDING AND ADJUSTING
A. Ensure recorded data represents actual measured or observed conditions.
B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
C. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
D. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
F. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

3.06 AIR SYSTEM PROCEDURE
A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
C. Measure air quantities at air inlets and outlets.
D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
K. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

3.07 COMMISSIONING
A. See Sections 01 9113 - General Commissioning Requirements and 23 0800 for additional requirements.
B. Perform prerequisites prior to starting commissioning activities.
C. Fill out Prefunctional Checklists for:
   1. Air side systems.
   2. Water side systems.
D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.
E. Re-check minimum outdoor air intake flows and maximum and intermediate total airflow rates for ____ percent of the air handlers plus a random sample equivalent to ____ percent of the final TAB report data as directed by Commissioning Authority.
   1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
   2. Use the same test instruments as used in the original TAB work.
3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.

4. For purposes of re-check, failure is defined as follows:
   a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
   b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
   c. Temperatures: Deviation of more than one degree F.
   d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
   e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.

5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.

F. In the presence of the Commissioning Authority, verify that:
   1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
   2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
   3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.

3.08 SCOPE

A. Test, adjust, and balance the following:
   1. Plumbing Pumps.
   2. Forced Air Furnaces.
   3. Air Cooled Refrigerant Condensers.
   4. Air Coils.
   5. Terminal Heat Transfer Units.
   6. Air Handling Units.
   7. Fans.
   8. Air Filters.
   9. Air Inlets and Outlets.

3.09 MINIMUM DATA TO BE REPORTED

A. Electric Motors:
   1. Manufacturer.
   2. Model/Frame.
   3. HP/BHP.
   4. Phase, voltage, amperage; nameplate, actual, no load.
   5. RPM.
   7. Starter size, rating, heater elements.
   8. Sheave Make/Size/Bore.

B. Pumps:
   1. Identification/number.
   2. Manufacturer.
   3. Size/model.
   4. Impeller.
   5. Service.
   6. Design flow rate, pressure drop, BHP.
7. Actual flow rate, pressure drop, BHP.
8. Discharge pressure.
10. Total operating head pressure.
11. Shut off, discharge and suction pressures.
12. Shut off, total head pressure.

C. Air Cooled Condensers:
   1. Identification/number.
   2. Location.
   3. Manufacturer.
   4. Model number.
   5. Serial number.
   6. Entering DB air temperature, design and actual.
   7. Leaving DB air temperature, design and actual.
   8. Number of compressors.

D. Air Moving Equipment:
   1. Location.
   2. Manufacturer.
   3. Model number.
   4. Serial number.
   5. Arrangement/Class/Discharge.
   6. Air flow, specified and actual.
   7. Return air flow, specified and actual.
   8. Outside air flow, specified and actual.
   9. Total static pressure (total external), specified and actual.
  10. Inlet pressure.
  11. Discharge pressure.
  13. Number of Belts/Make/Size.
  14. Fan RPM.

E. Exhaust Fans:
   1. Location.
   2. Manufacturer.
   3. Model number.
   4. Serial number.
   5. Air flow, specified and actual.
   6. Total static pressure (total external), specified and actual.
  7. Inlet pressure.
  8. Discharge pressure.
 10. Fan RPM.

F. Duct Leak Tests:
   1. Description of ductwork under test.
   2. Duct design operating pressure.
   3. Duct design test static pressure.
   4. Duct capacity, air flow.
   5. Maximum allowable leakage duct capacity times leak factor.
   6. Test apparatus:
      a. Blower.
   7. Test static pressure.
   8. Leakage.

G. Air Distribution Tests:
   1. Room number/location.
   2. Terminal type.
   3. Terminal size.
   4. Design velocity.
5. Design air flow.
6. Test (final) velocity.
7. Test (final) air flow.
8. Percent of design air flow.

H. Sound Level Reports:
   1. Location.
   2. Octave bands - equipment off.
   3. Octave bands - equipment on.

I. Vibration Tests:
   1. Test readings:
      a. Horizontal, velocity and displacement.
      b. Vertical, velocity and displacement.
      c. Axial, velocity and displacement.
   2. Normally acceptable readings, velocity and acceleration.
   3. Unusual conditions at time of test.
   4. Vibration source (if non-complying).

END OF SECTION
SECTION 23 0713
DUCK INSULATION

PART 1  GENERAL
1.01  SECTION INCLUDES
   A. Duct insulation.
   B. Duct liner.
   C. Insulation jackets.

1.02  RELATED REQUIREMENTS
   A. Section 07 8400 - Firestopping.
   B. Section 09 9113 - Exterior Painting: Painting insulation jackets.
   C. Section 09 9123 - Interior Painting: Painting insulation jackets.
   D. Section 23 0553 - Identification for HVAC Piping and Equipment.
   E. Section 23 3100 - HVAC Ducts and Casings: Glass fiber ducts.

1.03  REFERENCE STANDARDS
   K. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

1.04  SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
   C. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.05  QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.
1.06 DELIVERY, STORAGE, AND HANDLING
A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS
A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS
A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE
A. Manufacturer:
   5. Substitutions: See Section 01 6000 - Product Requirements.
B. Insulation: ASTM C553; flexible, noncombustible blanket.
   1. 'K' value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
   2. Maximum Service Temperature: 1200 degrees F.
   3. Maximum Water Vapor Absorption: 5.0 percent by weight.
C. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
   3. Secure with pressure sensitive tape.
D. Vapor Barrier Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
E. Outdoor Vapor Barrier Mastic:
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
F. Tie Wire: Annealed steel, 16 gage, 0.0508 inch diameter.

2.03 GLASS FIBER, RIGID
A. Manufacturer:
   5. Substitutions: See Section 01 6000 - Product Requirements.
B. Insulation: ASTM C612; rigid, noncombustible blanket.
   1. 'K' Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
   2. Maximum Service Temperature: 450 degrees F.
   3. Maximum Water Vapor Absorption: 5.0 percent.
C. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
   3. Secure with pressure sensitive tape.

D. Vapor Barrier Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

E. Indoor Vapor Barrier Finish:
   2. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:
   1. Armacell LLC; AP Armaflex; ______: www.armacell.us/#sle.
   2. K-Flex USA LLC; Insul-Sheet: www.kflexusa.com/#sle.
   3. Substitutions: See Section 01 6000 - Product Requirements.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
   1. Minimum Service Temperature: Minus 40 degrees F.
   2. Maximum Service Temperature: 180 degrees F.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.05 JACKETS

A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
   1. Lagging Adhesive:
      a. Compatible with insulation.

B. Mineral Fiber (Outdoor) Jacket: Asphalt impregnated and coated sheet, 50 lb/square.

   1. Thickness: 0.016 inch sheet.
   2. Finish: Smooth.
   4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
   5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
   6. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

2.06 DUCT LINER

A. Manufacturers:
   1. Armacell LLC; AP Coilflex: www.armacell.us/#sle.
   4. Owens Corning Corporation; QuietR Rotary Duct Insulation; ______: www.ocbuildingspec.com/#sle.
   5. CertainTeed Corporation; ______: www.certainteed.com/#sle.
   6. Substitutions: See Section 01 6000 - Product Requirements.

B. Elastomeric Foam Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
   1. Minimum Service Temperature: Minus 40 degrees F.
   2. Maximum Service Temperature: 180 degrees F.
   3. Fungal Resistance: No growth when tested according to ASTM G21.
   4. Apparent Thermal Conductivity: Maximum of 0.28 at 75 degrees F.
   5. Minimum Noise Reduction Coefficients:
      a. 1 inch Thickness: 0.40.
      b. 1-1/2 inches Thickness: 0.50.


D. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that ducts have been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Insulated ducts conveying air below ambient temperature:
   1. Provide insulation with vapor barrier jackets.
   2. Finish with tape and vapor barrier jacket.
   3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
   4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. Insulated ducts conveying air above ambient temperature:
   1. Provide with or without standard vapor barrier jacket.
   2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

D. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor):
   Finish with canvas jacket sized for finish painting.

E. External Duct Insulation Application:
   1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
   2. Secure insulation without vapor barrier with staples, tape, or wires.
   3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
   4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
   5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

F. Duct and Plenum Liner Application:
   1. Adhere insulation with adhesive for 90 percent coverage.
   2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
   4. Seal liner surface penetrations with adhesive.
   5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.03 SCHEDULES

A. Combustion Air Duct:
   1. Flexible Glass Fiber Duct Insulation: 1-1/2 inches thick.
   2. Rigid Glass Fiber Duct Insulation: 1-1/2 inches thick.

B. Evaporative Condenser Intake and Exhaust:
C. Exhaust Ducts Within 10 ft of Exterior Openings:
D. Exhaust Ducts Exposed to Outdoor Air:
E. Outside Air Intake Ducts:
F. Plenums (Cooling System):

G. Supply Ducts:

H. Ducts Exposed to Outdoors:

END OF SECTION
SECTION 23 0719
HVAC PIPING INSULATION

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Piping insulation.
B. Flexible removable and reusable blanket insulation.
C. Jackets and accessories.
D. Engineered wall outlet seals and refrigerant piping insulation protection.

1.02 RELATED REQUIREMENTS
A. Section 07 8400 - Firestopping.
B. Section 09 9123 - Interior Painting: Painting insulation jacket.
C. Section 22 1005 - Plumbing Piping: Placement of hangers and hanger inserts.
D. Section 23 2300 - Refrigerant Piping: Placement of inserts.

1.03 REFERENCE STANDARDS
A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
M. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.

1.04 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

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

1.06 DELIVERY, STORAGE, AND HANDLING
A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS
A. Maintain ambient conditions required by manufacturers of each product.
B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS
A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, RIGID
A. Manufacturers:
   6. Substitutions: See Section 01 6000 - Product Requirements.
B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
   1. K Value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum Service Temperature: 850 degrees F.
   3. Maximum Moisture Absorption: 0.2 percent by volume.
C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
E. Vapor Barrier Lap Adhesive: Compatible with insulation.
F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
G. Fibrous Glass Fabric:
   1. Cloth: Untreated; 9 oz/sq yd weight.
   2. Blanket: 1.0 lb/cu ft density.
   3. Weave: 5 by 5.
H. Indoor Vapor Barrier Finish:
   1. Cloth: Untreated; 9 oz/sq yd weight.
2. Vinyl emulsion type acrylic, compatible with insulation, black color.

   I. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
   J. Outdoor Breather Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

2.03 FLEXIBLE REMOVABLE AND REUSABLE BLANKET INSULATION

A. Insulation: ASTM C553 Type V; flexible, noncombustible.

2.04 CELLULAR GLASS

A. Block Insulation: ASTM C552, Type I, Grade 6.
   1. K Value: 0.35 at 100 degrees F.
   2. Service Temperature: 800 degrees F, maximum.
   3. Water Vapor Permeability: 0.005 perm inch maximum per inch.
   4. Water Absorption: 0.5 percent by volume, maximum.

2.05 EXPANDED POLYSTYRENE

A. Insulation: ASTM C578; rigid closed cell.
   1. K Value: 0.23 at 75 degrees F.
   2. Maximum Service Temperature: 165 degrees F.
   3. Maximum Water Vapor Permeance: 5.0 perms

2.06 POLYISOCYANURATE CELLULAR PLASTIC

A. Insulation Material: ASTM C591, rigid molded modified polyisocyanurate cellular plastic.
   1. Dimension: Comply with requirements of ASTM C585.
   2. K Value: 0.18 at 75 degrees F, when tested in accordance with ASTM C518.
   3. Minimum Service Temperature: Minus 70 degrees F.
   4. Maximum Service Temperature: 300 degrees F.
   5. Water Absorption: 0.5 percent by volume, maximum, when tested in accordance with ASTM D2842.

2.07 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
   1. Minimum Service Temperature: Minus 40 degrees F.
   2. Maximum Service Temperature: 180 degrees F.

B. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.08 JACKETS

A. PVC Plastic.
   1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
      a. Minimum Service Temperature: 0 degrees F.
      b. Maximum Service Temperature: 150 degrees F.
      c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
      d. Thickness: 10 mil.
      e. Connections: Brush on welding adhesive.
   2. Covering Adhesive Mastic: Compatible with insulation.

B. ABS Plastic:
   1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
      a. Minimum Service Temperature: Minus 40 degrees F.
      b. Maximum Service Temperature: 180 degrees F.
      c. Moisture Vapor Permeability: 0.012 perm inch, when tested in accordance with ASTM E96/E96M.
      d. Thickness: 30 mil.
e. Connections: Brush on welding adhesive.

C. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
   1. Lagging Adhesive: Compatible with insulation.

   1. Thickness: 0.016 inch sheet.
   2. Finish: Smooth.
   4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.

E. Stainless Steel Jacket: ASTM A666, Type 304 stainless steel.
   1. Thickness: 0.010 inch.
   2. Finish: Smooth.
   3. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

2.09 ENGINEERED WALL OUTLET SEALS AND REFRIGERANT PIPING INSULATION PROTECTION

A. Manufacturers:
   2. Substitutions: See Section 01 6000 - Product Requirements.

B. Pipe Penetration Wall Seal: Seals HVAC piping wall penetrations with compression gasket wall mounted rigid plastic outlet cover.
   1. Wall Outlet Size, Stucco and Masonry Applications: 7-1/2 inch wide by 10 inch high.
   2. Outlet Cover Color: Gray.

C. Insulation Protection System: Refrigerant piping insulation PVC protective cover.
   1. PVC Insulation Cover Color: Black with full-length velcro fastener.
   2. Flame Spread and Smoke Development Rating of 24/450: Comply with ASTM E84 or UL 723.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Exposed Piping: Locate insulation and cover seams in least visible locations.

C. Insulated pipes conveying fluids below ambient temperature; insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

D. Glass fiber insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

E. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

F. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

G. Glass fiber insulated pipes conveying fluids above ambient temperature.
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

H. Inserts and Shields:
1. Application: Piping 1-1/2 inches diameter or larger.
2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
3. Insert location: Between support shield and piping and under the finish jacket.
4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 8400.

J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting.

K. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.

L. Buried Piping: Provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

M. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

END OF SECTION
SECTION 23 0800
COMMISSIONING OF HVAC

PART 1 GENERAL

1.01 SUMMARY
A. See Section 01 9113 - General Commissioning Requirements for overall objectives; comply with the requirements of Section 01 9113.

B. This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.

C. The Commissioning Authority (CA) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use.

D. The entire HVAC system is to be commissioned, including commissioning activities for the following specific items:
   1. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.

E. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
A. Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.

B. DRAFT Prefunctional Checklists and Functional Test Procedures for Control System: Detailed written plan indicating the procedures to be followed to test, checkout and adjust the control system prior to full system Functional Testing; include at least the following for each type of equipment controlled:
   1. System name.
   2. List of devices.
   3. Step-by-step procedures for testing each controller after installation, including:
      a. Process of verifying proper hardware and wiring installation.
      b. Process of downloading programs to local controllers and verifying that they are addressed correctly.
      c. Process of performing operational checks of each controlled component.
      d. Plan and process for calibrating valve and damper actuators and all sensors.
      e. Description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
   4. Copy of proposed log and field checkout sheets to be used to document the process; include space for initial and final read values during calibration of each point and space to specifically indicate when a sensor or controller has "passed" and is operating within the contract parameters.
   5. Description of the instrumentation required for testing.
   6. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the Commissioning Authority and TAB contractor for this determination.

C. Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval of Commissioning Authority.

D. HVAC Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:
   1. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system.
Provide an index and clear table of contents. Include the detailed technical manual for programming and customizing control loops and algorithms.

2. Full as-built set of control drawings.
3. Full as-built sequence of operations for each piece of equipment.
4. Full points list; in addition to the information on the original points list submittal, include a listing of all rooms with the following information for each room:
   a. Floor.
   b. Room number.
   c. Room name.
   d. Air handler unit ID.
   e. Reference drawing number.
   f. Air terminal unit tag ID.
   g. Heating and/or cooling valve tag ID.
   h. Minimum air flow rate.
   i. Maximum air flow rate.
5. Full print out of all schedules and set points after testing and acceptance of the system.
6. Full as-built print out of software program.
7. Electronic copy on disk of the entire program for this facility.
8. Marking of all system sensors and thermostats on the as-built floor plan and HVAC drawings with their control system designations.
9. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
10. Control equipment component submittals, parts lists, etc.
11. Warranty requirements.
12. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).
13. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:
   a. Sequences of operation.
   b. Control drawings.
   c. Points lists.
   d. Controller and/or module data.
   e. Thermostats and timers.
   f. Sensors and DP switches.
   g. Valves and valve actuators.
   h. Dampers and damper actuators.
   i. Program setups (software program printouts).

E. Project Record Documents: See Section 01 7800 for additional requirements.
   1. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
   2. Show actual locations of all static and differential pressure sensors (air, water and building pressure) and air-flow stations on project record drawings.

F. Draft Training Plan: In addition to requirements specified in Section 01 7900, include:
   1. Follow the recommendations of ASHRAE Guideline 1.1.
   2. Control system manufacturer's recommended training.
   3. Demonstration and instruction on function and overrides of any local packaged controls not controlled by the HVAC control system.

G. Training Manuals: See Section 01 7900 for additional requirements.
   1. Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.
B. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

PART 3 EXECUTION

3.01 PREPARATION

A. Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.

B. Furnish additional information requested by the Commissioning Authority.

C. Prepare a preliminary schedule for HVAC pipe and duct system testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion for use by the Commissioning Authority; update the schedule as appropriate.

D. Notify the Commissioning Authority when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur; when commissioning activities not yet performed or not yet scheduled will delay construction notify ahead of time and be proactive in seeing that the Commissioning Authority has the scheduling information needed to efficiently execute the commissioning process.

E. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.

F. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.

G. Provide temperature and pressure taps in accordance with Contract Documents.

3.02 INSPECTING AND TESTING - GENERAL

A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.

B. Perform the Functional Tests directed by the Commissioning Authority for each item of equipment or other assembly to be commissioned.

C. Provide two-way radios for use during the testing.

D. Valve/Damper Stroke Setup and Check:
   1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
   2. Set pump/fan to normal operating mode.
   3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
   4. Command valve/damper open; verify position is full open and adjust output signal as required.
   5. Command valve/damper to a few intermediate positions.
   6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

E. Isolation Valve or System Valve Leak Check: For valves not by coils.
   1. With full pressure in the system, command valve closed.
   2. Use an ultra-sonic flow meter to detect flow or leakage.

F. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.03 TAB COORDINATION

A. TAB: Testing, adjusting, and balancing of HVAC.

B. Coordinate commissioning schedule with TAB schedule.

C. Review the TAB plan to determine the capabilities of the control system toward completing TAB.
D. Provide all necessary unique instruments and instruct the TAB technicians in their use; such as handheld control system interface for setting terminal unit boxes, etc.

E. Have all required Prefunctional Checklists, calibrations, startup and component Functional Tests of the system completed and approved by the Commissioning Authority prior to starting TAB.

F. Provide a qualified control system technician to operate the controls to assist the TAB technicians or provide sufficient training for the TAB technicians to operate the system without assistance.

3.04 CONTROL SYSTEM FUNCTIONAL TESTING

A. Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.

B. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with Contract Documents.

C. Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by the Commissioning Authority.

D. Functional Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.
   1. The scope of trend logging is partially specified; trend log up to 50 percent more points than specified at no extra cost to Owner.
   2. Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures.

E. Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.

F. Demonstrate the following to the Commissioning Authority during testing of controlled equipment; coordinate with commissioning of equipment.
   1. Setpoint changing features and functions.
   2. Sensor calibrations.

G. Demonstrate to the Commissioning Authority:
   1. That all specified functions and features are set up, debugged and fully operable.
   2. That scheduling features are fully functional and setup, including holidays.
   3. That all graphic screens and value readouts are completed.
   4. Correct date and time setting in central computer.
   5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent; if any of those fail test all remaining units at no extra cost to Owner.
   6. Functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad; demonstrate 100 percent of panels and 10 percent of ports; if any ports fail, sample another 10 percent; if any of those fail, test all remaining units at no extra cost to Owner.
   7. Power failure and battery backup and power-up restart functions.
   8. Global commands features.
   9. Security and access codes.
   10. Occupant over-rides (manual, telephone, key, keypad, etc.).
   11. O&M schedules and alarms.
   12. Occupancy sensors and controls.
   13. All control strategies and sequences not tested during controlled equipment testing.

H. If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

3.05 OPERATION AND MAINTENANCE MANUALS

A. See Section 01 7800 for additional requirements.
B. Add design intent documentation furnished by Architect to manuals prior to submission to Owner.

C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.

D. Commissioning Authority will add commissioning records to manuals after submission to Owner.

3.06 DEMONSTRATION AND TRAINING

A. See Section 01 7900 for additional requirements.

B. Demonstrate operation and maintenance of HVAC system to Owner’s personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.

C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Authority during Functional Testing.

D. Provide classroom and hands-on training of Owner’s designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned. Provide the following minimum durations of training:

E. TAB Review: Instruct Owner’s personnel for minimum ____ hours, after completion of TAB, on the following:
   1. Review final TAB report, explaining the layout and meanings of each data type.
   2. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
   3. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
   4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
   5. Other salient information that may be useful for facility operations, relative to TAB.

F. HVAC Control System Training: Perform training in at least three phases:
   1. Phase 1 - Basic Control System: Provide minimum of ____ hours of actual training on the control system itself. Upon completion of training, each attendee, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
      a. This training may be held on-site or at the manufacturer’s facility.
      b. If held off-site, the training may occur prior to final completion of the system installation.
      c. For off-site training, Contractor shall pay expenses of up to two attendees.
   2. Phase 2 - Integrating with HVAC Systems: Provide minimum of ____ hours of on-site, hands-on training after completion of Functional Testing. Include instruction on:
      a. The specific hardware configuration of installed systems in this facility and specific instruction for operating the installed system, including interfaces with other systems, if any.
      b. Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
      c. Trend logging and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends; provide practice in setting up trend logging and monitoring during training session.
      d. Every display screen, allowing time for questions.
      e. Point database entry and modifications.
   3. Phase 3 - Post-Occupancy: Six months after occupancy conduct minimum of ____ hours of training. Tailor training session to questions and topics solicited beforehand from Owner. Also be prepared to address topics brought up and answer questions concerning operation of the system.

G. Provide the services of manufacturer representatives to assist instructors where necessary.
H. Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Control panels.
B. Dampers.
C. Damper Operators:
   1. Electric operators.
D. Input/Output Sensors:
   1. Damper position indicators.
   3. Carbon monoxide sensors.
E. Thermostats:
   1. Electric room thermostats.
   2. Line voltage thermostats.
   3. Room thermostat accessories.
F. Time clocks.

1.02 REFERENCE STANDARDS

A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating.
B. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code).
C. NEMA DC 3 - Residential Controls - Electrical Wall-Mounted Room Thermostats.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.

1.04 QUALITY ASSURANCE

A. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed in Colorado.

1.05 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Correct defective work within a five year period after Substantial Completion.

PART 2 PRODUCTS

2.01 EQUIPMENT - GENERAL

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.02 CONTROL PANELS

A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.
2.03 DAMPERS

A. Performance: Test in accordance with AMCA 500-D.

B. Frames: Galvanized steel, welded or riveted with corner reinforcement, minimum 12 gage, 0.1046 inch.

C. Blades: Galvanized steel, maximum blade size 8 inches wide, 48 inches long, minimum 22 gage, 0.0299 inch, attached to minimum 1/2 inch shafts with set screws.

D. Blade Seals: Synthetic elastomeric, inflatable, mechanically attached, field replaceable.

E. Jamb Seals: Spring stainless steel.

F. Leakage: Less than one percent based on approach velocity of 2000 ft per min and 4 inches wg.

G. Temperature Limits: Minus 40 to 200 degrees F.

2.04 DAMPER OPERATORS

A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.

1. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.

B. Electric Operators:

1. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.

2.05 INPUT/OUTPUT SENSORS

A. Damper Position Indicators: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 to 100 percent damper travel.

B. Nitrogen Dioxide Sensors, for Single-Gang Electrical Box Mounting:

1. General:
   a. Provide gas platform, wired to the building controller, with replaceable sensor.
   b. Input Power: Class 2; 15 to 30 VDC, plus/minus 20 percent, 50/60 Hz.
   c. Relay Ratings: 1A/30VAC/DC, normally open.
   d. Operating Temperature Range: Minus 4 degrees F to 122 degrees F.
   e. Operating Humidity Range: 0 to 90 percent RH non-condensing.
   f. Terminal Block Wire Size: 30 AWG (0.255 mm) to 12 AWG (2.05 mm).
   g. Terminal Block Torque: 0.37 to 0.44 inch-lbf.
   h. Protection Class: IP20 in accordance with IEC 60529.

   2. Sensor:
      a. Sensor Type: Electrochemical.
      b. Measurement Range: 0 to 15 ppm.
      c. Accuracy: Plus/minus 5 percent of range at 25 degrees F.
      d. Resolution: 0.1 ppm.
      e. Sensor Warranty: 2 years from manufacture date.
      f. Low Setpoint Value: 1 ppm (fixed).
      g. High Setpoint Value: 180 ppm (fixed).
      h. Operating Temperature Range: Minus 4 degrees F to 122 degrees F.
      i. Operating Humidity Range: 0 to 90 percent RH non-condensing.

C. Carbon Monoxide Sensors, for Single-Gang Electrical Box Mounting:

1. General:
   a. Provide gas platform, wired to the building controller, with replaceable sensor.
   b. Input Power: Class 2; 15 to 30 VDC/24 VAC plus/minus 20 percent, 50/60 Hz.
   c. Relay Ratings: 1A/30VAC/DC, normally open.
   d. Operating Temperature Range: Minus 4 degrees F to 122 degrees F.
   e. Operating Humidity Range: 0 to 90 percent RH non-condensing.
   f. Terminal Block Wire Size: 30 AWG (0.255 mm) by 12 AWG (2.05 mm).
   g. Terminal Block Torque: 0.37 to 0.44 inch-lbf.
2. Sensor:
   a. Sensor Type: Electrochemical.
   b. Measurement Range: 0 to 200 ppm.
   c. Accuracy: Plus/minus 5 percent of range.
   d. Resolution: 1 ppm.
   e. Sensor Warranty: 2 years from manufacture date.
   f. Low Setpoint Value: 25 ppm or 50 ppm switch selectable.
   g. High Setpoint Value: 180 ppm (fixed).
   h. Operating Temperature Range: Minus 4 degrees F to 122 degrees F.
   i. Operating Humidity Range: 0 to 90 percent RH non-condensing.

2.06 THERMOSTATS

A. Electric Room Thermostats:
   1. Type: NEMA DC 3, 24 volts, with setback/setup temperature control.
   2. Service: One step cooling and one step heating.
   3. Covers: Locking with set point adjustment and setpoint indication, with thermometer.

B. Line Voltage Thermostats:
   1. Integral manual On/Off/Auto selector switch, single or two pole as required.
   2. Dead Band: Maximum 2 degrees F.
   3. Cover: Locking with set point adjustment, with thermometer.

C. Room Thermostat Accessories:
   1. Thermostat Covers: Brushed aluminum.
   2. Insulating Bases: For thermostats located on exterior walls.
   3. Thermostat Guards: Locking transparent plastic mounted on separate base.
   4. Adjusting Key: As required for device.

2.07 TIME CLOCKS

A. Seven day programming switch timer with synchronous timing motor and seven day dial, continuously charged Ni-cad battery driven power failure 8 hour carry over and multiple switch trippers to control systems for minimum of two and maximum of eight signals per day with two normally open and two normally closed output switches.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check and verify location of thermostats with plans and room details before installation. Locate 60 inches above floor. Align with lighting switches and humidistats. Refer to Section 26 2726.

C. Provide thermostats in aspirating boxes in front entrances.

D. Provide guards on thermostats in entrances.

E. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.

F. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

G. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
H. Provide conduit and electrical wiring in accordance with Section 26 0583. Electrical material and installation shall be in accordance with appropriate requirements of.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Pipe, pipe fittings, valves, and connections for natural gas piping systems.

1.02 REFERENCE STANDARDS
   A. ANSI Z21.18/CSA 6.3 - Gas Appliance Pressure Regulators.
   D. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators.
   E. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
   F. ASME B31.1 - Power Piping.
   G. ASME B31.9 - Building Services Piping.
   M. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
   N. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
   O. AWWA C606 - Grooved and Shouldered Joints.
   Q. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.
   S. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
   T. MSS SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
   U. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.03 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
   C. Welder Certificate: Include welders certification of compliance with ASME BPVC-IX.
   D. Shop Drawings: For non-penetrating rooftop supports, submit detailed layout developed for this project, with design calculations for loadings and spacings.
E. Sustainable Design Documentation: For soldered copper joints, submit installer's certification that the specified installation method and materials were used.

F. Project Record Documents: Record actual locations of valves.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.

1.04 QUALITY ASSURANCE
A. Perform work in accordance with applicable codes.
B. Valves: Manufacturer's name and pressure rating marked on valve body.
C. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.
E. Identify pipe with marking including size, ASTM material classification, and ASTM specification.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Provide temporary protective coating on cast iron and steel valves.
C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.06 FIELD CONDITIONS
A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 NATURAL GAS PIPING, BURIED BEYOND 5 FEET OF BUILDING
A. Steel Pipe: ASTM A53/A53M, Schedule 40 black.
   1. Fittings: ASTM A234/A234M, wrought steel welding type, with AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.
   3. Mechanical Press Sealed Fittings: Double pressed type and approved or certified, utilizing EPDM, non toxic synthetic rubber sealing elements.
B. Polyethylene Pipe: ASTM D2513, SDR 11.
   1. Fittings: ASTM D2683 or ASTM D2513 socket type.

2.02 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING
A. Steel Pipe: ASTM A53/A53M, Schedule 40 black.
   3. Jacket: AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.
   4. Mechanical Press Sealed Fittings: Double pressed type and approved or certified, utilizing EPDM, non toxic synthetic rubber sealing elements.

2.03 NATURAL GAS PIPING, ABOVE GRADE
A. Steel Pipe: ASTM A53/A53M, Schedule 40 black.
   2. Joints: Threaded or welded to ASME B31.1.
   3. Mechanical Press Sealed Fittings: Double pressed type and approved or certified, utilizing EPDM, non toxic synthetic rubber sealing elements.
2.04 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 Inches and Under:
1. Ferrous pipe: Class 150 malleable iron threaded unions.

B. Flanges for Pipe Size Over 1 Inch:
1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.

C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
1. Dimensions and Testing: In accordance with AWWA C606.
2. Housing Material: Provide ASTM A47/A47M malleable iron, ductile iron, or ______, galvanized.
4. When pipe is field grooved, provide coupling manufacturer's grooving tools.

2.05 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
3. Trapeze Hangers: Welded steel channel frames attached to structure.
5. Floor Supports: Concrete pier or steel pedestal with floor flange; fixture attachment.
6. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
   b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
   c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
   d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
   e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.

B. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
6. Other Types: As required.

2.06 BALL VALVES

A. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze, ductile iron, or ______ body, 304 stainless steel, chrome plated brass, or ______ ball, regular port, Teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder, threaded, grooved, or ______ ends with union.

2.07 PLUG VALVES

A. Construction 2-1/2 Inches and Larger: MSS SP-78, 175 psi CWP, cast iron body and plug, pressure lubricated, Teflon or Buna N packing, flanged or grooved ends. Provide lever operator with set screw.

2.08 STRainers

A. Size 2 inch and Under:
1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
2. Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

B. Size 1-1/2 inch to 4 inch:
1. Class 125, flanged iron body, Y pattern with 1/16 inch stainless steel perforated screen.

2.09 LINE PRESSURE REGULATORS AND APPLIANCE REGULATORS INDICATORS

A. Manufacturers:
   2. Dungs Combustion Controls; ______: www.dungs.com/#sle.
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Compliance Requirements:

C. Materials in Contact With Gas:
   1. Housing: Aluminum, steel (free of non-ferrous metals).
   2. Seals and Diaphragms: NBR-based rubber.

D. Maximum Inlet Operating Pressure: 10 psi
   1. Appliance Regulator: 10 psi.
   2. Line Pressure Regulator: 10 psi.

E. Maximum Body Pressure: 10 psi.

F. Output Pressure Range: 1 inch wc to 80 inch wc.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

D. Install piping to maintain headroom, conserve space, and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 0516.

G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

H. Provide access where valves and fittings are not exposed.

I. Establish elevations of buried piping outside the building to ensure not less than 1.5 ft of cover.

J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

K. Provide support for utility meters in accordance with requirements of utility companies.

L. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.
M. Install valves with stems upright or horizontal, not inverted.

N. Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.

O. Sleeve pipes passing through partitions, walls and floors.

P. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

Q. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Support horizontal piping as indicated.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   8. Provide copper plated hangers and supports for copper piping.

3.04 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.

B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

C. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

D. Provide plug valves in natural gas systems for shut-off service.

3.05 SERVICE CONNECTIONS

A. Provide new gas service complete with gas meter and regulators in accordance with Section 33 5216. Gas service distribution piping to have initial minimum pressure of 7 inch wg. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping.
B. Refrigerant.
C. Moisture and liquid indicators.
D. Valves.
E. Strainers.
F. Check valves.
G. Pressure regulators.
H. Pressure relief valves.
I. Filter-driers.
J. Solenoid valves.
K. Expansion valves.
L. Receivers.
M. Flexible connections.
N. Engineered wall seals and insulation protection.

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.
B. Section 08 3100 - Access Doors and Panels.
C. Section 09 9123 - Interior Painting.
D. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. AHRI 495 - Performance Rating of Refrigerant Liquid Receivers.
B. AHRI 710 - Performance Rating of Liquid-Line Driers.
C. AHRI 750 - Thermostatic Refrigerant Expansion Valves.
D. AHRI 760 - Performance Rating of Solenoid Valves for Use With Volatile Refrigerants.
F. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels.
G. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
H. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
I. ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
J. ASME B31.9 - Building Services Piping.
M. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
U. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
W. UL 429 - Electrically Operated Valves.

1.04 SYSTEM DESCRIPTION
A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
B. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.
C. Liquid Indicators:
   1. Use line size liquid indicators in main liquid line leaving condenser.
   2. If receiver is provided, install in liquid line leaving receiver.
   3. Use line size on leaving side of liquid solenoid valves.
D. Valves:
   1. Use service valves on suction and discharge of compressors.
   2. Use gauge taps at compressor inlet and outlet.
   3. Use check valves on compressor discharge.
E. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.
F. Strainers:
   1. Use line size strainer upstream of each automatic valve.
   2. Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.
   3. Use shut-off valve on each side of strainer.
G. Pressure Relief Valves: Use on ASME receivers and pipe to outdoors.
H. Filter-Driers:
   1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.
I. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.05 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.
C. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.

D. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.

B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Comply with ASME B31.9 for installation of piping system.

B. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

2.02 PIPING

A. Copper Tube: ASTM B280, H58 hard drawn or O60 soft annealed.
   2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.

B. Copper Tube to 7/8 inch OD: ASTM B88 (ASTM B88M), Type K (A), annealed.

C. Pipe Supports and Anchors:
   1. Provide hangers and supports that comply with MSS SP-58.
      a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
   3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   4. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
   5. Vertical Support: Steel riser clamp.
   6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
   7. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
   8. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
   9. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
      a. Bases: High density, UV tolerant, polypropylene or reinforced PVC.
      b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
      c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
      d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
      e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.

2.03 REFRIGERANT

A. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.
2.04 MOISTURE AND LIQUID INDICATORS

A. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.05 VALVES

A. Diaphragm Packless Valves:
   1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.

B. Packed Angle Valves:
   1. Forged brass or nickel plated forged steel, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.

C. Ball Valves:
   1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F.

D. Service Valves:
   1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psi.

2.06 STRAINERS

A. Straight Line or Angle Line Type:
   1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

B. Straight Line, Non-Cleanable Type:
   1. Steel shell, copper plated fittings, stainless steel wire screen, for maximum working pressure of _____ psi.

2.07 CHECK VALVES

A. Globe Type:
   1. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum temperature of 300 degrees F and maximum working pressure of 425 psi.

B. Straight Through Type:
   1. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 200 degrees F.

2.08 PRESSURE REGULATORS

A. Brass body, stainless steel diaphragm, direct acting, adjustable over 0 to 80 psi range, for maximum working pressure of 450 psi.

2.09 PRESSURE RELIEF VALVES

A. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB, selected to ASHRAE Std 15, with standard setting of 235 psi.

2.10 FILTER-DRIERS

A. Performance:
   1. Flow Capacity - Liquid Line: _____ ton, minimum, rated in accordance with AHRI 710.
   2. Pressure Drop: 2 psi, maximum, when operating at full connected evaporator capacity.
B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.

C. Construction: UL listed.
   1. Connections: As specified for applicable pipe type.

2.11 SOLENOID VALVES

A. Valve: AHRI 760 I-P, pilot operated, copper, brass or steel body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psi.

B. Coil Assembly: UL 429, UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.

2.12 EXPANSION VALVES

A. Angle or Straight Through Type: AHRI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, adjustable superheat setting, replaceable inlet strainer, with non-replaceable capillary tube and remote sensing bulb and remote bulb well.

B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.13 ELECTRONIC EXPANSION VALVES

A. Valve:
   1. Brass body with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.

B. Evaporation Control System:
   1. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, preselection allowance for electrical defrost and hot gas bypass.

C. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

2.14 RECEIVERS

A. Internal Diameter 6 inch and Smaller:
   1. AHRI 495, UL listed, steel, brazed; 400 psi maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.

B. Internal Diameter Over 6 inch:
   1. AHRI 495, welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; 400 psi with tappings for liquid inlet and outlet valves, pressure relief valve, and magnetic liquid level indicator.

2.15 FLEXIBLE CONNECTORS

A. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure of 500 psi.

2.16 ENGINEERED WALL SEALS AND INSULATION PROTECTION

A. Pipe Penetration Wall Seal: Seals HVAC piping wall penetrations with compression gasket wall mounted rigid plastic outlet cover.
   1. Wall Outlet Size, Stucco and Masonry Applications: 7-1/2 inch wide by 10 inch high.
   2. Outlet Cover Color: Gray.
5. Air Permeance: Comply with ASTM E2178.

B. Insulation Protection System: Mechanical line insulation and PVC cover.
   1. PVC Insulation Cover Color: Black with full-length velcro fastener.
   2. Water/Vapor Permeability: Comply with ASTM E96/E96M.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Remove scale and dirt on inside and outside before assembly.
C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Install refrigeration specialties in accordance with manufacturer's instructions.
B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
C. Install piping to conserve building space and avoid interference with use of space.
D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
E. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.5.
   2. Support horizontal piping as indicated.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
F. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
G. Provide clearance for installation of insulation and access to valves and fittings.
H. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Section 08 3100.
I. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
J. Fully charge completed system with refrigerant after testing.
K. Provide electrical connection to solenoid valves. Refer to Section 26 0583.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Test refrigeration system in accordance with ASME B31.5.
C. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using halide torch. Test to no leakage.

3.04 SCHEDULES

A. Hanger Spacing for Copper Tubing.
   1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
   4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.

END OF SECTION
SECTION 23 3100
HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Metal ductwork.
B. Nonmetal ductwork.
C. Casing and plenums.
D. Duct cleaning.

1.02 RELATED REQUIREMENTS
A. Section 07 8400 - Firestopping.
B. Section 09 9113 - Exterior Painting: Weld priming, weather resistant, paint or coating.
C. Section 09 9123 - Interior Painting: Weld priming, paint or coating.
D. Section 23 0130.51 - HVAC Air-Distribution System Cleaning: Cleaning ducts after completion of installation.
E. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.
F. Section 23 0713 - Duct Insulation: External insulation and duct liner.
G. Section 23 3300 - Air Duct Accessorys.
H. Section 23 3700 - Air Outlets and Inlets.

1.03 REFERENCE STANDARDS
B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
E. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.
G. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
I. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
J. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.

1.04 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data for duct materials.
C. Manufacturer's Certificate: Certify that installation of glass fiber ductwork meet or exceed specified requirements.
D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK).
E. Manufacturer's Installation Instructions: Indicate special procedures for glass fiber ducts.
QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.

FIELD CONDITIONS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

DUCT ASSEMBLIES

A. Regulatory Requirements: Construct ductwork to comply with NFPA 90A standards.
B. Ducts: Galvanized steel, unless otherwise indicated.
C. Low Pressure Supply (Heating Systems): 1/2 inch w.g. pressure class, galvanized steel.
D. Low Pressure Supply (System with Cooling Coils): 1/2 inch w.g. pressure class, galvanized steel.
E. General Exhaust: 1/2 inch w.g. pressure class, galvanized steel.
F. Outside Air Intake: 1/2 inch w.g. pressure class, galvanized steel.
G. Emergency Generation Ventilation: 1/2 inch w.g. pressure class, galvanized steel.

MATERIALS

A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
B. PVC Coating for Steel Ducts: 4 mils polyvinyl chloride plastic on both sides.
C. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
   1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
   2. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
D. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
E. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
   3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
   5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
   6. Other Types: As required.

DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.
B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
C. Construct T’s, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.
D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
E. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).

F. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.04 MANUFACTURED DUCTWORK AND FITTINGS

A. Flat Oval Ducts: Machine made from round spiral lockseam duct.
   1. Manufacture in accordance with SMACNA (DCS).
   2. Fittings: Manufacture at least two gages heavier metal than duct.
   3. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Flexible Ducts: Two ply vinyl film supported by helically wound spring steel wire.
   1. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
   2. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
   4. Temperature Range: Minus 10 degrees F to 160 degrees F.

C. Flexible Ducts: Multiple layers of aluminum laminate supported by helically wound spring steel wire.
   1. UL labeled.
   2. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
   3. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
   5. Temperature Range: Minus 20 degrees F to 210 degrees F.

D. Transverse Duct Connection System: SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).

2.05 CASINGS

A. Fabricate casings in accordance with SMACNA (DCS) and construct for operating pressures indicated.

B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18 gage, 0.0478 inch expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.

C. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. Install in accordance with manufacturer's instructions.

C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

D. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.

E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

F. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use flexible duct to change direction.

G. Connect diffusers or light troffer boots to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.

H. At exterior wall louvers, seal duct to louver frame and install blank-out panels.
3.02 CLEANING

A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment that could be harmed by excessive dirt with temporary filters, or bypass during cleaning.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Air turning devices/extractors.
B. Backdraft dampers - metal.
C. Backdraft dampers - fabric.
D. Combination fire and smoke dampers.
E. Duct access doors.
F. Duct test holes.
G. Fire dampers.
H. Flexible duct connections.
I. Smoke dampers.
J. Volume control dampers.

1.02 RELATED REQUIREMENTS
A. Section 07 8400 - Firestopping.
B. Section 23 0548 - Vibration and Seismic Controls for HVAC.
C. Section 23 3100 - HVAC Ducts and Casings.
D. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS
C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
D. UL 33 - Safety Heat Responsive Links for Fire-Protection Service.
E. UL 555 - Standard for Fire Dampers.
F. UL 555C - Standard for Safety Ceiling Dampers.

1.04 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
C. Manufacturer's Installation Instructions: Provide instructions for fire dampers.
D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Extra Fusible Links: One of each type and size.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
1.06 DELIVERY, STORAGE, AND HANDLING
A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS
A. Manufacturers:
1. Carlisle HVAC Products; Dynair Hollow Vane and Rail (Double Wall Vane): www.carlislehvacom/#sle.
2. Elgen Manufacturing, Inc; ______: www.elgenmfg.com/#sle.
5. Titus HVAC, a brand of Johnson Controls; ______: www.titus-hvac.com/#sle.
7. Substitutions: See Section 01 6000 - Product Requirements.
B. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.02 BACKDRAFT DAMPERS - METAL
A. Manufacturers:
1. Louvers & Dampers, Inc, a brand of Mestek, Inc; ______: www.louvers-dampers.com/#sle.
4. Substitutions: See Section 01 6000 - Product Requirements.
B. Gravity Backdraft Dampers, Size 18 by 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.
C. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.03 BACKDRAFT DAMPERS - FABRIC
A. Fabric Backdraft Dampers: Factory-fabricated.
2. Birdscreen: 1/2 inch nominal mesh of galvanized steel or aluminum.
3. Maximum Velocity: 1000 fpm (5 mps) face velocity.

2.04 COMBINATION FIRE AND SMOKE DAMPERS

2.05 DUCT ACCESS DOORS
A. Manufacturers:
1. Acudor Products Inc, a Division of Nelson Industrial Inc; ______: www.acudor.com/#sle.
2. Elgen Manufacturing, Inc; ______: www.elgenmfg.com/#sle.
5. Ruskin Company; ______: www.ruskin.com/#sle.
6. SEMCO LLC; ______: www.semcohvac.com/#sle.
8. Substitutions: See Section 01 6000 - Product Requirements.
B. Fabricate in accordance with SMACNA (DCS) and as indicated.
C. Access doors with sheet metal screw fasteners are not acceptable.
2.06 DUCT TEST HOLES

A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.
   1. Manufacturers:
      a. Carlisle HVAC Products; Dynair Test Port with Red Cap with O-Ring Seal: www.carlislehvac.com/#sle.
      b. Substitutions: See Section 01 6000 - Product Requirements.

2.07 FIRE DAMPERS

A. Manufacturers:
   1. Lloyd Industries, Inc; _____: www.firedamper.com/#sle.
   4. NCA, a brand of Metal Industries Inc; _____: www.ncamfg.com/#sle.
   5. Pottorff; _____: www.pottorff.com/#sle.
   8. Substitutions: See Section 01 6000 - Product Requirements.

B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

C. Ceiling (Radiation) Dampers: Galvanized steel, 22 gage, 0.0299 inch frame and 16 gage, 0.0598 inch flap, two layers 0.125 inch ceramic fiber on top side and one layer on bottom side for round flaps, with locking clip.
   1. Rated for three hour service in compliance with UL 555C.

D. Horizontal Dampers: Galvanized steel, 22 gage, 0.0299 inch frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.

E. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1.0 inch pressure class ducts up to 12 inches in height.

F. Multiple Blade Dampers: 16 gage, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

G. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.08 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers:
   2. Elgen Manufacturing, Inc; _____: www.elgenmfg.com/#sle.
   3. Substitutions: See Section 01 6000 - Product Requirements.

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Flexible Duct Connections: Fabric crimped into metal edging strip.

D. Maximum Installed Length: 14 inch.

2.09 SMOKE DAMPERS

2.10 VOLUME CONTROL DAMPERS

A. Manufacturers:
3. NCA, a brand of Metal Industries Inc; _____: www.ncamfg.com/#sle.
5. Substitutions: See Section 01 6000 - Product Requirements.

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Splitter Dampers:
   1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
   2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.

D. Single Blade Dampers:
   1. Fabricate for duct sizes up to 6 by 30 inch.
   2. Blade: 24 gage, 0.0239 inch, minimum.

E. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.

PART 3 EXECUTION

3.01 PREPARATION
   A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION
   A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 23 3100 for duct construction and pressure class.
   B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
   C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide minimum 8 by 8 inch size for hand access, size for shoulder access, and as indicated. Provide 4 by 4 inch for balancing dampers only. Review locations prior to fabrication.
   D. Provide duct test holes where indicated and required for testing and balancing purposes.
   E. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
   F. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
   G. Demonstrate re-setting of fire dampers to Owner's representative.
   H. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
   I. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
   J. Use splitter dampers only where indicated.
   K. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, unless dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Cabinet exhaust fans.
   B. Ceiling exhaust fans.
   C. Inline centrifugal fans.

1.02 RELATED REQUIREMENTS
   A. Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
   B. Section 23 3300 - Air Duct Accessories: Backdraft dampers.

1.03 REFERENCE STANDARDS
   A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program.
   C. AMCA 204 - Balance Quality and Vibration Levels for Fans.
   E. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
   F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

1.04 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
   C. Manufacturer's Instructions: Indicate installation instructions.
   D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.05 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 FIELD CONDITIONS
   A. Permanent ventilators may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Carnes, a division of Carnes Company Inc; ______: www.carnes.com/#sle.
   B. Greenheck Fan Corporation; ______: www.greenheck.com/#sle.
   C. Loren Cook Company; ______: www.lorencook.com/#sle.
   D. PennBarry, Division of Air System Components; ______: www.pennbarry.com/#sle.
   E. Twin City Fan & Blower; ______: www.tcf.com/#sle.
F. Panasonic.
G. Substitutions: See Section 01 6000 - Product Requirements.

2.02 POWER VENTILATORS - GENERAL
A. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.
B. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
C. Sound Ratings: AMCA 301, tested to AMCA 300 and bearing AMCA Certified Sound Rating Seal.
D. Fabrication: Comply with AMCA 99.
E. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.03 CABINET EXHAUST FANS
A. Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.
B. Disconnect Switch: Cord and plug in housing for thermal overload protected motor and wall mounted switch.
C. Grille: Molded white plastic.
D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.04 INLINE CENTRIFUGAL FANS
A. Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.
B. Disconnect Switch: Cord and plug in housing for thermal overload protected motor and wall mounted switch.
C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Hung Cabinet Fans:
   1. Install flexible connections specified in Section 23 3300 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
C. Provide sheaves required for final air balance.
D. Provide backdraft dampers on outlet from cabinet and ceiling exhauster fans and as indicated.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Diffusers.
   B. Registers/grilles.
   C. Louvers.
   D. Goosenecks.

1.02 REFERENCE STANDARDS
   A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating.
   B. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Inlets.
   D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

1.03 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements for submittal procedures.
   B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

1.04 QUALITY ASSURANCE
   A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
   B. Test and rate louver performance in accordance with AMCA 500-L.
   C. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. American Louver Company; ALC Grilles and Registers: www.americanlouver.com/#sle.
   B. Carnes, a division of Carnes Company Inc; _____: www.carnes.com/#sle.
   E. Titus, a brand of Air Distribution Technologies; _____: www.titus-hvac.com/#sle.
   F. Tuttle and Bailey; _____: www.tuttleandbailey.com/#sle.
   G. Shoemaker.
   H. Metalaire
   I. Ruskine
   J. Substitutions: See Section 01 6000 - Product Requirements.
2.02 CEILING SUPPLY REGISTERS/GRILLES
A. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, two-way deflection.
B. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
C. Construction: Made of aluminum extrusions with factory enamel finish.
D. Color: As selected by Architect from manufacturer's standard range.
E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.03 CEILING EXHAUST AND RETURN REGISTERS/GRILLES
A. Type: Streamlined blades, 3/4 inch minimum depth, 1/2 inch maximum spacing, with blades set at 45 degrees, horizontal face.
B. Frame: 1-1/4 inch margin with countersunk screw mounting.
C. Fabrication: Steel with 20 gage, 0.0359 inch minimum frames and 22 gage, 0.0299 inch minimum blades, steel and aluminum with 20 gage, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.
D. Color: To be selected by Architect from manufacturer's standard range.
E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.

2.04 WALL EXHAUST AND RETURN REGISTERS/GRILLES
A. Type: Streamlined blades, 3/4 inch minimum depth, 1/2 inch maximum spacing, with spring or other device to set blades, horizontal face.
B. Frame: 1-1/4 inch margin with countersunk screw mounting.
C. Fabrication: Steel frames and blades, with factory baked enamel finish.
D. Color: To be selected by Architect from manufacturer's standard range.
E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.05 LOUVERS
A. Type: 6 inch deep with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch square mesh screen over exhaust and 1/2 inch square mesh screen over intake.
B. Fabrication: 16 gage, 0.0598 inch thick galvanized steel welded assembly, with factory prime coat finish.
C. Color: To be selected by Architect from manufacturer's standard range.
D. Color: To be selected by Architect from manufacturer's standard range.
E. Mounting: Furnish with interior flat flange for installation.

2.06 GOOSENECKS
A. Fabricate in accordance with SMACNA (DCS) of minimum 18 gage, 0.0598 inch galvanized steel.
B. Mount on minimum 12 inch high curb base where size exceeds 9 by 9 inch.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.
C. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

D. Install diffusers to ductwork with air tight connection.

E. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, unless dampers are specified as part of the diffuser, or grille and register assembly.

END OF SECTION
SECTION 23 5216
CONDENSING BOILERS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Manufactured units.
B. Boiler construction.
C. Boiler trim.
D. Fuel burning system.
E. Factory installed controls.

1.02 RELATED REQUIREMENTS
A. Section 23 0913 - Instrumentation and Control Devices for HVAC.
B. Section 23 2500 - HVAC Water Treatment.
C. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS
D. ASHRAE Std 103 - Methods of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers.
F. NBBI Manufacturer and Repair Directory - The National Board of Boiler and Pressure Vessel Inspectors (NBBI).

1.04 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittals procedures.
B. Product Data: Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.
C. Manufacturer's Installation Instructions: Indicate assembly, support details, connection requirements, and include start up instructions.
D. Manufacturer's Factory Inspection Report: Submit boiler inspection prior to shipment.
E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.
F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
1.06 WARRANTY
   A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
   B. Provide a five year warranty to include coverage for heat exchanger.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Natural Gas, Propane, or Combination Natural Gas/Propane for Indoor Applications:
      1. Noritz.

2.02 MANUFACTURED UNITS
   A. Factory assembled, factory fire-tested, self-contained, readily transported unit ready for automatic operation except for connection of water, fuel, electrical, and vent services.
   B. Unit: Metal membrane wall, water or fire tube, condensing boiler on integral structural steel frame base with integral fuel burning system, firing controls, boiler trim, insulation, and removable jacket, suitable for indoor application.
   C. Annual Fuel Utilization Efficiency (AFUE) in accordance with ASHRAE Std 103: 0.82.

2.03 BOILER CONSTRUCTION
   A. Comply with the minimum requirements of ASME BPVC-IV and ANSI Z21.13 for construction of boilers.
   B. Assembly to bear the ASME "H" stamp and comply with the efficiency requirements of the latest edition of ASHRAE Std 90.1 I-P.
   C. Required Directory Listings:
      2. NBBI Manufacturer and Repair Directory - The National Board of Boiler and Pressure Vessel Inspectors (NBBI); current edition at www.nationalboard.org.
   D. Heat Exchanger: Construct with materials that are impervious to corrosion where subject to contact with corrosive condensables.
   E. Provide adequate tappings, observation ports, removable panels, and access doors for entry, cleaning, and inspection.
   F. Insulate casing with insulation material, protected and covered by heavy-gage metal jacket.
   G. Factory apply boiler base and other components, that are subject to corrosion, with durable, acrylic, powder coated, painted, weather-proofed, or ___________ finish.

2.04 BOILER TRIM
   A. ASME rated pressure relief valve.
   B. Flow switch.
   C. Electronic Low Water Cut-off: Complete with test light and manual reset button to automatically prevent firing operation whenever boiler water falls below safe level.
   D. Temperature and pressure gauge.
   E. Pressure Switches:
      1. High gas pressure.
      2. Low gas pressure.
      3. Air pressure.
   F. Manual reset high limit.
   G. Boiler Pump (where required by boiler design):
1. Primary pump, factory supplied and sized for field installation to ensure minimum, continuous
circulation through boiler.
2. Where pump is not provided by boiler manufacturer, provide pump in accordance with boiler
manufacturer's recommendations.
3. Pump time delay.

2.05 FUEL BURNING SYSTEM

A. Provide forced draft automatic burner, pulse combustion, or __________, integral to boiler, designed to
burn natural gas, propane, No. 2 fuel oil, and __________, and maintain fuel-air ratios automatically.
1. Blower Design: Statically and dynamically balanced to supply combustion air; direct connected to
motor.
2. Forced Draft Design: Mixes combustion air and gas to achieve 90 percent combustion efficiency.

B. Gas Train: Plug valve, safety gas valve, gas-air ratio control valve, and pressure regulator controls air and
gas mixture.

C. Emission of Oxides of Nitrogen Requirements: Comply with SCAQMD 1146.1 for natural gas fired system,
as applicable.

D. Intakes: Combustion air intake capable of accepting free mechanical room air or direct outside air through
a sealed intake pipe.

2.06 FACTORY INSTALLED CONTROLS

A. Option for internal or external (0-10) VDC control.

B. Temperature Controls:
   1. Automatic reset type to control fuel burning system on-off, firing rate, and _______ to maintain
      temperature.
   2. Manual reset type to control fuel burning system to prevent boiler water temperature from exceeding
      safe system water temperature.
   3. Low-fire start time delay relay.

C. Electronic PI setpoint/modulation control system.

D. Microprocessor-based, fuel/air mixing controls.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install boiler and provide connection of natural gas service in accordance with requirements of NFPA 54
and applicable codes.

C. Coordinate factory installed controls with Section 23 0913.

D. Coordinate provisions for water treatment in accordance with Section 23 2500.

E. Pipe relief valves to nearest floor drain.

F. Pipe cooled condensate produced by the combustion process from the boiler condensate connection and/or
flue stack with suitable piping material to neutralizer prior to discharging into nearest floor drain.

G. Provide piping connection and accessories in accordance with Section 23 2114.

H. Provide for connection to electrical service in accordance with Section 26 0583.

I. Vent combustion fumes in accordance with manufacturer's recommendations. Refer to Section 23 5100.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Packaged roof top unit.
   B. Unit controls.
   C. Remote panel.
   D. Roof mounting curb and base.
   E. Maintenance service.

1.02 RELATED REQUIREMENTS
   A. Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
   B. Section 23 0548 - Vibration and Seismic Controls for HVAC.
   C. Section 23 0913 - Instrumentation and Control Devices for HVAC: Control components, time clocks.
   D. Section 23 0913 - Instrumentation and Control Devices for HVAC: Installation of thermostats and other controls components.
   E. Section 23 4000 - HVAC Air Cleaning Devices.

1.03 REFERENCE STANDARDS
   B. AHRI 270 - Sound Performance Rating of Outdoor Unitary Equipment.

1.04 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.

1.05 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Protect units from physical damage by storing off site until roof mounting curbs are in place, ready for immediate installation of units.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Carrier, a part of UTC Building and Industrial Systems, a unit of United Technologies Corp; _______: www.carrier.com/#sle.
   B. Substitutions: See Section 01 6000 - Product Requirements.
2.02 PERFORMANCE REQUIREMENTS: SEE DRAWINGS FOR ADDITIONAL REQUIREMENTS

2.03 MANUFACTURED UNITS
   A. General: Roof mounted units having gas burner and electric refrigeration.
   B. Description: Self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, return fan, heat exchanger and burner, heat recovery coil, controls, air filters, refrigerant cooling coil and compressor, condenser coil and condenser fan.

2.04 FABRICATION
   A. Cabinet: Steel with baked enamel finish, including access panels with screwdriver operated flush cam type fasteners. Structural members shall be minimum 18 gage, 0.0478 inch, with access doors or panels of minimum 20 gage, 0.0359 inch.
   B. Heat Exchangers: Aluminized steel, of welded construction.
   C. Supply and Return Fan: Forward curved centrifugal type, resiliently mounted with V-belt drive, adjustable variable pitch motor pulley, and rubber isolated hinge mounted high efficiency motor or direct drive as indicated. Refer to Section 22 0548.
   D. Air Filters:
      1. 2 inch thick glass fiber disposable media in metal frames.
   E. Roof Mounting Curb: 24 inches high galvanized steel, channel frame with gaskets, nailer strips.

2.05 BURNER
   A. Gas Burner: Atmospheric type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame sensing device, and automatic 100 percent shut-off pilot.
   B. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after air flow proven and slight delay, allow gas valve to open.

2.06 EVAPORATOR COIL
   A. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.
   B. Provide capillary tubes or thermostatic expansion valves for units of 6 tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.

2.07 COMPRESSOR
   A. Provide hermetic compressors, 3600 rpm maximum, resiliently mounted with positive lubrication, crankcase heater, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports, and filter drier.

2.08 CONDENSER COIL
   A. Provide copper tube aluminum fin coil assembly with subcooling rows and coil guard.
   B. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Provide high efficiency fan motors.

2.09 OPERATING CONTROLS
   A. Provide terminal strip on unit for connection of operating controls to remote panel by others. Control shall allow for two stages of heating and two stages cooling.

2.10 OPERATING CONTROLS - VARIABLE VOLUME UNITS
   A. Temperature transmitter located in supply air shall signal electronic logic panel to control mixing dampers and cooling in sequence. Mixing section shall operate as first stage of cooling and revert to minimum outside air above approximately 75 degrees F as determined by enthalpy of return and outdoor air.
B. Control cooling by cycling compressors, cylinder unloading, and hot gas bypass.

2.11 HEAT RECOVERY COIL
   A. Provide copper tube aluminum fin coil assembly with multiple circuits arranged to provide heat recovery.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.
   B. Verify that proper power supply is available.

3.02 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Mount units on factory built roof mounting curb providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.

END OF SECTION
SECTION 23 8126.13
SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Air cooled condensing units.
   B. Indoor air handler (fan & coil) units for duct connection.
   C. Indoor ductless fan & coil units.
   D. Controls.

1.02 RELATED REQUIREMENTS
   A. Section 23 0913 - Instrumentation and Control Devices for HVAC: Thermostats, humidistats, time clocks.
   B. Section 23 1123 - Facility Natural-Gas Piping.
   C. Section 23 3100 - HVAC Ducts and Casings.
   D. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections and installation and wiring of thermostats and other controls components.

1.03 REFERENCE STANDARDS
   B. AHRI 270 - Sound Performance Rating of Outdoor Unitary Equipment.
   C. AHRI 520 - Performance Rating of Positive Displacement Condensing Units.
   E. ASHRAE Std 23.1 - Methods of Testing for Rating the Performance of Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Temperatures of the Refrigerant.
   F. NEMA MG 1 - Motors and Generators.
   I. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical.

1.04 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
   C. Design Data: Indicate refrigerant pipe sizing.
   D. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
   E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
   F. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
   G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      1. See Section 01 6000 - Product Requirements, for additional provisions.
1.05 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this
      section, with minimum three years of documented experience.

1.06 WARRANTY
   A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
   B. Provide three year manufacturers warranty for solid state ignition modules.
   C. Provide five year manufacturers warranty for heat exchangers.
   D. Provide five year manufacturers warranty for electronic air cleaners.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   B. Trane Inc: www.trane.com/#sle.
   D. First CO..
   E. Substitutions: See Section 01 6000 - Product Requirements.

2.02 SYSTEM DESIGN
   A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and
      assembled, pre-wired indoor and outdoor units; UL listed.
      2. Cooling: Outdoor electric condensing unit with evaporator coil in central ducted indoor unit.
      3. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried,
         pressurized and sealed, with insulated suction line.
   B. Performance Requirements: See Drawings for additional requirements.
   C. Electrical Characteristics:
      1. ____ kW.
      2. ____ volts, single phase, 60 Hz.
      3. ____ amperes maximum fuse size.
      4. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 26
         0583.

2.03 INDOOR UNITS FOR DUCTED SYSTEMS
   A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan,
      heating and cooling element(s), controls, and accessories; wired for single power connection with control
      transformer.
      2. Cabinet: Steel with baked enamel finish, easily removed and secured access doors with safety
         interlock switches, glass fiber insulation with reflective liner.
   B. Supply Fan: Centrifugal type rubber mounted with direct or belt drive with adjustable variable pitch motor
      pulley.
      1. Motor: NEMA MG 1; 1750 rpm single speed, permanently lubricated, hinge mounted.
      2. Motor Electrical Characteristics:
   C. Air Filters: 1 inch thick urethane, washable type arranged for easy replacement.
   D. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all
      directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic
      expansion valve.
1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.

2.04 OUTDOOR UNITS

A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
   1. Comply with AHRI 210/240.
   2. Refrigerant: R-410A.
   3. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
   4. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23.1 and UL 207.
   5. Sound Rating: 69 dBA, when measured in accordance with AHRI 270.

B. Compressor: Hermetic, two speed 1800 and 3600 rpm, AHRI 520 resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling and rapid speed changes.

C. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.

D. Coil: Air-cooled, aluminum fins bonded to copper tubes.

E. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).
   1. Provide thermostatic expansion valves.

F. Operating Controls:
   1. Control by room thermostat to maintain room temperature setting.

G. Mounting Pad: manufacturer provided, minimum 8 inches square; minimum of two located under cabinet feet.

2.05 ACCESSORY EQUIPMENT

A. Room Thermostat: Wall-mounted, electric solid state microcomputer based room thermostat with remote sensor to maintain temperature setting; low-voltage; with following features:
   1. Automatic switching from heating to cooling.
   2. Preferential rate control to minimize overshoot and deviation from setpoint.
   3. Battery replacement without program loss.
   4. Thermostat Display:
      a. Time of day.
      b. Actual room temperature.
      c. Programmed temperature.
      d. Programmed time.
      e. Day of week.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.

B. Verify that proper power supply is available and in correct location.

3.02 INSTALLATION

A. Install in accordance with NFPA 90A and NFPA 90B.
B. Install refrigeration systems in accordance with ASHRAE Std 15.

END OF SECTION
SECTION 23 8200
CONVECTION HEATING AND COOLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fan-coil units.
B. Electric unit heaters.
C. Electric cabinet unit heaters.
D. Air coils.

1.02 RELATED REQUIREMENTS

A. Section 23 2300 - Refrigerant Piping.
B. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections. Installation of room thermostats. Electrical supply to units.

1.03 REFERENCE STANDARDS

C. AHRI 440 - Performance Rating of Room Fan-Coil Units.
D. NFPA 70 - National Electrical Code.
F. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide typical catalog of information including arrangements.
C. Shop Drawings:
   1. Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
   2. Indicate air coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
   3. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
   4. Indicate mechanical and electrical service locations and requirements.
D. Certificates: Certify that coils are tested and rated in accordance with AHRI 410.
E. Manufacturer's Instructions: Indicate installation instructions and recommendations.
F. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.
G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
H. Warranty: Submit manufacturer’s warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide 5 year manufacturer’s warranty for equipment.

PART 2 PRODUCTS

2.01 FAN-COIL UNITS

A. Manufacturers:
   1. Vertical Cabinet, Horizontal Exposed, or Horizontal Recessed:
      a. Carrier, a part of UTC Building and Industrial Systems, a unit of United Technologies Corp: www.commercial.carrier.com/#sle.
      c. Trane, a brand of Ingersoll Rand: www.trane.com/#sle.
      d. Airmark.
      e. Substitutions: See Section 01 6000 - Product Requirements.

B. Performance Data and Safety Requirements:
   1. Unit capacities certified in accordance with AHRI 440.
   2. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to Authority Having Jurisdiction as suitable for the purpose indicated.
   3. Insulation to comply with NFPA 90A requirements for flame spread and smoke generation.
   4. Equipment wiring to comply with requirements of NFPA 70.


D. Coils:
   1. Evenly spaced aluminum fins mechanically bonded to copper tubes.
   2. Electric-Resistance Heating Coil:
      a. Open-wire type located in pre-heat position.
      b. Nickel chromium element.
      c. Interlock with fan motor switch.
      d. Factory installed step-down transformer.
      e. Unit mounted magnetic relays.
      f. High temperature cutout with automatic reset to de-energize the electric heat in the event of malfunction.
   3. Provide drain pan under cooling coil easily removable for cleaning.

E. Vertical Cabinet and Horizontal Exposed Units: Minimum 18 gage, 0.0478 inch thick sheet steel with exposed corners and edges rounded, easily removed panels, glass fiber insulation, integral air outlet, and inlet grilles.

F. Horizontal Recessed Units:
   1. Provide with a galvanized steel cabinet, easily removed panels, glass fiber insulation, integral air outlet, and inlet grilles with minimum 18 gage, 0.0478 inch thick sheet steel bottom panel.
   2. Ducted Units: Provide with air inlet and outlet duct collars.
G. Finish: Factory applied baked primer coat on visible surfaces of enclosure or cabinet.

H. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.

I. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted.

J. Controls:
   1. Provide units with control valves furnished by the fan coil unit manufacturer.
   2. Fan Coil Unit Manufacturer's Controls:
      a. Fan speed switch for unit mounting.
      b. Disconnect switch.
      c. Thermostats and controllers.
   3. Controls Interface:
      a. Relay board.
      b. 24-volt transformer.
      c. Contactors for electric heat units.
      d. Inverting relays for use with standard thermostats and normally open valves.

K. Filter: Easily removed 1 inch thick glass fiber throw-away type, located to filter air before coil.

L. Fresh Air Dampers: Where indicated, automatic type, set to allow maximum of 30 percent fresh air to enter space.

M. Electrical Characteristics:

2.02 ELECTRIC UNIT HEATERS

A. Manufacturers:
   3. Trane, a brand of Ingersoll Rand: www.trane.com/#sle.
   4. Reznor.
   5. Substitutions: See Section 01 6000 - Product Requirements.

B. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to Authority Having Jurisdiction as suitable for the purpose indicated.

C. Assembly: Suitable for mounting from ceiling or structure above with built-in controls, thermal safety cut-out, and electric terminal box.

D. Acceptable Heating Element Assemblies:
   1. Horizontal Projection Units:
      a. Steel fins copper brazed to steel sheath and epoxy sealed for moisture resistance.
      b. Nickel chromium resistance wire surrounded with magnesium oxide and sheathed in steel, spiral-finned tubes.
      c. High-mass, all steel tubular type, copper brazed, centrally located and installed in fixed element banks.
   2. Vertical Projection Units:
      a. Finned tubular.
      b. Nickel chromium resistance wire surrounded with magnesium oxide and sheathed in steel, spiral-finned tubes.
      c. High-mass, all steel tubular type, copper brazed, centrally located and installed in fixed element banks.

E. Housing:
   1. Horizontal Projection Units:
      a. Construction materials to consist of heavy gage steel with galvanized, polyester powder coat, high gloss baked enamel, or __________ finish.
      b. Provide with threaded holes for threaded rod suspension or __________.
      c. Provisions for access to internal components for maintenance, adjustments, and repair.
   2. Vertical Projection Units:
      a. Construction materials to consist of heavy gage steel with polyester powder coat, high gloss baked enamel, or __________.
b. Provide with mounting support brackets or provisions for mounting from ceiling or structure above.
c. Provisions for access to internal components for maintenance, adjustments, and repair.

F. Air Inlets and Outlets:
1. Inlets: Provide stamped louvers, protective grilles with fan blade guard, or ___________.
2. Outlets: Provide diffuser cones, directional louvers, radial diffusers, or ___________.

G. Fan: Factory balanced, direct drive, axial type with fan guard.

H. Motor: Totally enclosed, thermally protected, and provided with permanently lubricated bearings.

I. Controls:
1. Disconnect.
2. 24-volt relay.
3. Fan speed switch.
5. Summer-winter switch.

J. Electrical Characteristics:
1. Disconnect Switch: Factory mount disconnect switch.

2.03 AIR COILS

A. Refrigerant Coils:
1. Coils rated and tested in accordance with AHRI 410.
2. Tubes: Material to consist of seamless copper, brass, or ____________, mechanically expanded, tension wound, or ____________ to fins; appropriate tube joining methods based on tube material.
3. Fins: Material to consist of aluminum or copper, continuous plate type with full fin collars, individual helical finned tube type wound under tension, or ____________.
4. Casing: Heavy gage, galvanized steel with mounting holes, including intermediate tube supports if required by coil design and length.
5. Suction Header: Construct of nonferrous material with tube connection appropriate to header material provided.
6. Liquid distributor: Brass or copper venture type with seamless copper distribution tubes; maximum 12, 18, or __ circuits per distributor.
7. Configuration: Down feed with bottom suction to prevent oil trapping.
8. Acceptable Factory Testing Methods:
   a. Proof test at 1.5 times the maximum operating pressure and leak test at the maximum operating temperature.
   b. Leak test at minimum 300 psig air pressure under water.
   c. Perform hydrostatic testing for coils with removable headers in accordance with approved shop drawings and normally accepted means and methods.

B. Electric Coils:
1. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to Authority Having Jurisdiction as suitable for the purpose indicated.
2. Assembly: Terminal control box with hinged, screwed, or ______ access cover, heating element, casing, and controls.
3. Frame: Heavy gage galvanized, corrosion resistant, or ____________ steel.
4. Standard Built-In Components:
   a. Interlock disconnect switch.
   b. Contactors.
   c. Fused transformers.
   d. Airflow switch.
   e. Circuit fuses.
   f. Load and control terminal blocks.
5. Over-Temperature Protection: Provide thermal cutouts for primary and secondary over-temperature protection.
6. Electrical Characteristics:
PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that surfaces are suitable for installation.
B. Verify that field measurements are as indicated on drawings.

3.02 INSTALLATION
A. Install in accordance with manufacturer's recommendations.
B. Do not damage equipment or finishes.
C. Unit Heaters:
   1. Hang from building structure, with pipe hangers anchored to building, not from piping or electrical conduit.
   2. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
D. Fan-Coil Units:
   1. Install as indicated.
   2. Coordinate to ensure correct recess size for recessed units.
E. Units with Cooling Coils: Connect drain pan to condensate drain.
F. Units with Electric Heating Elements:
   1. Install as indicated including electrical devices furnished by manufacturer but not factory installed.
   2. Install wiring in accordance with the manufacturer's wiring diagram submittal and Section 26 0583.
G. Air Coils:
   1. Coil Safeguards:
      a. Protect coils to prevent damage to flanges and fins.
      b. Comb out damaged fins.
   2. Refrigerant Coils:
      a. Provide sight glass in liquid line within 12 inches of coil.
      b. Refer to Section 23 2300.

3.03 FIELD QUALITY CONTROL
A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Provide manufacturer's field representative to test, inspect, instruct, observe, and ________.

3.04 CLEANING
A. After construction and painting is completed, clean exposed surfaces of units.
B. Vacuum clean coils and inside of units.
C. Touch-up marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.
D. Install new filters.

3.05 PROTECTION
A. Provide finished cabinet units with protective covers during the balance of construction.

END OF SECTION
SECTION 26 0526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Grounding and bonding requirements.
B. Conductors for grounding and bonding.
C. Connectors for grounding and bonding.
D. Ground bars.
E. Ground rod electrodes.

1.02 REFERENCE STANDARDS

B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings.
D. NFPA 70 - National Electrical Code.
E. NFPA 780 - Standard for the Installation of Lightning Protection Systems.
F. UL 467 - Grounding and Bonding Equipment.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify exact locations of underground metal water service pipe entrances to building.
   2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.

B. Sequencing:
   1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittals procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
C. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

D. Grounding System Resistance:
1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using “fall-of-potential” method.

E. Grounding Electrode System:
1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
   a. Provide continuous grounding electrode conductors without splice or joint.
   b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
2. Metal Underground Water Pipe(s):
   a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
   b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
   c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
3. Metal In-Ground Support Structure:
   a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
4. Concrete-Encased Electrode:
   a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
5. Ground Rod Electrode(s):
   a. Provide two electrodes unless otherwise indicated or required.
   b. Space electrodes not less than 6 feet from each other and any other ground electrode.
   c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
7. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
   a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
   b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
   c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.

F. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
3. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
4. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.

5. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.

G. Communications Systems Grounding and Bonding:
   1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
   2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
      a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
      b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
      c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.

H. Lightning Protection Systems, in Addition to Requirements of Section 26 4113:
   1. Do not use grounding electrode dedicated for lightning protection system for component of building grounding electrode system provided under this section.
   2. Provide bonding of building grounding electrode system provided under this section and lightning protection grounding electrode system in accordance with NFPA 70 and NFPA 780.

2.02 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
   1. Provide products listed, classified, and labeled as suitable for the purpose intended.
   2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 0526:
   1. Use insulated copper conductors unless otherwise indicated.
      a. Exceptions:
         1) Use bare copper conductors where installed underground in direct contact with earth.
         2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:
   1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
   2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
   3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

D. Ground Bars:
   1. Description: Copper rectangular ground bars with mounting brackets and insulators.
   2. Size: As indicated.
   3. Holes for Connections: As indicated or as required for connections to be made.

E. Ground Rod Electrodes:
   1. Comply with NEMA GR 1.
   3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that field measurements are as indicated.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).
C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
   1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
   2. Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.

D. Make grounding and bonding connections using specified connectors.
   1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
   2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
   3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer’s recommendations.
   4. Mechanical Connectors: Secure connections according to manufacturer’s recommended torque settings.
   5. Compression Connectors: Secure connections using manufacturer’s recommended tools and dies.

E. Identify grounding and bonding system components in accordance with Section 26 0553.

END OF SECTION
SECTION 26 0529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
B. Section 26 0533.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
C. Section 26 0533.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.

1.03 REFERENCE STANDARDS

D. MFMA-4 - Metal Framing Standards Publication.
E. NECA 1 - Standard for Good Workmanship in Electrical Construction.
F. NFPA 70 - National Electrical Code.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 3000.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.
C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

1.06 QUALITY ASSURANCE

A. Comply with NFPA 70.
B. Comply with applicable building code.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
   2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
   3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
   4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
   5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
      a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
      c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
   1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
   2. Conduit Clamps: Bolted type unless otherwise indicated.

C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.

D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.

E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.

F. Anchors and Fasteners:
   1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

G. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

H. Secure fasteners according to manufacturer's recommended torque settings.

I. Remove temporary supports.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES
   A.  Galvanized steel rigid metal conduit (RMC).
   B.  Intermediate metal conduit (IMC).
   C.  PVC-coated galvanized steel rigid metal conduit (RMC).
   D.  Flexible metal conduit (FMC).
   E.  Liquidtight flexible metal conduit (LFMC).
   F.  Electrical metallic tubing (EMT).
   G.  Rigid polyvinyl chloride (PVC) conduit.
   H.  Conduit fittings.

1.02  REFERENCE STANDARDS
   A.  ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC).
   B.  ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S).
   C.  ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC).
   D.  NECA 1 - Standard for Good Workmanship in Electrical Construction.
   E.  NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT).
   F.  NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC).
   G.  NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
   H.  NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   I.  NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit.
   J.  NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
   K.  NFPA 70 - National Electrical Code.
   L.  UL 1 - Flexible Metal Conduit.
   M.  UL 6 - Electrical Rigid Metal Conduit-Steel.
   N.  UL 360 - Liquid-Tight Flexible Steel Conduit.
   O.  UL 514B - Conduit, Tubing, and Cable Fittings.
   P.  UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
   Q.  UL 797 - Electrical Metallic Tubing-Steel.
   R.  UL 1242 - Electrical Intermediate Metal Conduit-Steel.

1.03  ADMINISTRATIVE REQUIREMENTS
   A.  Coordination:
      1.  Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
      2.  Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.04 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements for submittals procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

1.05 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS
2.01 CONDUIT APPLICATIONS
A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
C. Underground:
   1. Under Slab on Grade: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
   2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, intermediate metallic conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
   3. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
   4. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
   5. Where steel conduit is installed in direct contact with earth where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape to provide supplementary corrosion protection or use PVC-coated galvanized steel rigid metal conduit.

2.02 CONDUIT REQUIREMENTS
A. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
B. Provide products listed, classified, and labeled as suitable for the purpose intended.
C. Minimum Conduit Size, Unless Otherwise Indicated:
   1. Branch Circuits: 1/2 inch (16 mm) trade size.
2. Branch Circuit Home Runs: 3/4 inch (21 mm) trade size.
4. Underground, Exterior: 1 inch (27 mm) trade size.

D. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

B. Fittings:
   1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.
   3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 INTERMEDIATE METAL CONDUIT (IMC)

A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

B. Fittings:
   1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.
   3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.05 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.

B. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.

C. PVC-Coated Fittings:
   1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
   2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
   3. Material: Use steel or malleable iron.
   4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.

D. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

2.06 FLEXIBLE METAL CONDUIT (FMC)

A. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.

2.07 LIQUID TIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.
2.08 ELECTRICAL METALLIC TUBING (EMT)
A. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.
   3. Connectors and Couplings: Use compression (gland) or set-screw type.
      a. Do not use indenter type connectors and couplings.

2.09 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT
A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
B. Fittings:
   1. Manufacturer: Same as manufacturer of conduit to be connected.
   2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install products in accordance with manufacturer's instructions.
B. Perform work in accordance with NECA 1 (general workmanship).
C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
D. Install intermediate metal conduit (IMC) in accordance with NECA 101.
E. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.
F. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
G. Conduit Routing:
   1. Unless dimensioned, conduit routing indicated is diagrammatic.
   2. When conduit destination is indicated without specific routing, determine exact routing required.
   3. Conceal all conduits unless specifically indicated to be exposed.
   4. Conduits in the following areas may be exposed, unless otherwise indicated:
      a. Electrical rooms.
      b. Mechanical equipment rooms.
      c. Within joists in areas with no ceiling.
   5. Unless otherwise approved, do not route conduits exposed:
      a. Across floors.
      b. Across roofs.
      c. Across building exterior surfaces.
   6. Arrange conduit to maintain adequate headroom, clearances, and access.
   7. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
   8. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
   9. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
      10. Group parallel conduits in the same area together on a common rack.
H. Conduit Support:
   1. Secure and support conduits in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
   2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.

I. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

J. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roof system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

K. Underground Installation:
1. Minimum Cover, Unless Otherwise Indicated or Required:

L. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
3. Where conduits are subject to earth movement by settlement or frost.

M. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
1. Where conduits pass from outdoors into conditioned interior spaces.
2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

N. Provide grounding and bonding in accordance with Section 26 0526.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
C. Boxes and enclosures for integrated power, data, and audio/video.

1.02 RELATED REQUIREMENTS
A. Section 08 3100 - Access Doors and Panels: Panels for maintaining access to concealed boxes.
B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
C. Section 26 0529 - Hangers and Supports for Electrical Systems.
D. Section 26 0533.13 - Conduit for Electrical Systems:
   1. Conduit bodies and other fittings.
E. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
F. Section 26 2726 - Wiring Devices:
   1. Wall plates.

1.03 REFERENCE STANDARDS
A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
F. NFPA 70 - National Electrical Code.
G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
I. UL 508A - Industrial Control Panels.
J. UL 514A - Metallic Outlet Boxes.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
   4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
   5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
   6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 BOXES
A. General Requirements:
1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use suitable concrete type boxes where flush-mounted in concrete.
4. Use suitable masonry type boxes where flush-mounted in masonry walls.
5. Use raised covers suitable for the type of wall construction and device configuration where required.
6. Use shallow boxes where required by the type of wall construction.
7. Do not use "through-wall" boxes designed for access from both sides of wall.
8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
12. Wall Plates: Comply with Section 26 2726.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
3. Junction and Pull Boxes Larger Than 100 cubic inches:
   a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that field measurements are as indicated.
B. Verify that mounting surfaces are ready to receive boxes.
C. Verify that conditions are satisfactory for installation prior to starting work.
3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Box Locations:
   1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 3100 as required where approved by the Architect.
   2. Unless dimensioned, box locations indicated are approximate.
   3. Locate boxes so that wall plates do not span different building finishes.

E. Box Supports:
   1. Secure and support boxes in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
   2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.

F. Install boxes plumb and level.

G. Flush-Mounted Boxes:
   1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
   2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
   3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

H. Install boxes as required to preserve insulation integrity.

I. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

J. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

K. Close unused box openings.

L. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

M. Provide grounding and bonding in accordance with Section 26 0526.

END OF SECTION
PART 1  GENERAL

1.01  REFERENCE STANDARDS
   C. NFPA 70 - National Electrical Code.
   D. UL 969 - Marking and Labeling Systems.

1.02  ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
   B. Sequencing:
      1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
      2. Do not install identification products until final surface finishes and painting are complete.

1.03  QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.

PART 2  PRODUCTS

2.01  IDENTIFICATION REQUIREMENTS
   A. Identification for Equipment:
      1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
         a. Switchboards:
            1) Identify ampere rating.
            2) Identify voltage and phase.
            3) Identify power source and circuit number. Include location when not within sight of equipment.
            4) Use identification nameplate to identify main overcurrent protective device.
            5) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
         b. Panelboards:
            1) Identify ampere rating.
            2) Identify voltage and phase.
            3) Identify power source and circuit number. Include location when not within sight of equipment.
            4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
            5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
            6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
         c. Enclosed switches, circuit breakers, and motor controllers:
            1) Identify voltage and phase.
            2) Identify power source and circuit number. Include location when not within sight of equipment.
            3) Identify load(s) served. Include location when not within sight of equipment.
         d. Transfer Switches:
            1) Identify voltage and phase.
2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.

3) Identify load(s) served. Include location when not within sight of equipment.

4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.

e. Electricity Meters:
   1) Identify load(s) metered.

2. Service Equipment:
   a. Use identification nameplate to identify each service disconnecting means.

3. Emergency System Equipment:
   a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
   b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
   c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.

4. Use voltage marker to identify highest voltage present for each piece of electrical equipment.

5. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.

6. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".

7. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70, including but not limited to the following.
   a. Service equipment.
   b. Industrial control panels.
   c. Motor control centers.
   d. Elevator control panels.
   e. Industrial machinery.

8. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.

B. Identification for Conductors and Cables:
   1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 0519.
   2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.

C. Identification for Raceways:

D. Identification for Boxes:
   1. Use voltage markers to identify highest voltage present.

E. Identification for Devices:

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
   1. Materials:
   2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
   3. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:
   1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
   2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
C. Format for Equipment Identification:
   1. Minimum Size: 1 inch by 2.5 inches.
   2. Legend:
      a. System designation where applicable:
         1) Emergency Power System: Identify with text "EMERGENCY".
         b. Equipment designation or other approved description.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height:
      a. System Designation: 1 inch.
      b. Equipment Designation: 1/2 inch.
   5. Color:

D. Format for General Information and Operating Instructions:
   1. Minimum Size: 1 inch by 2.5 inches.
   2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
   3. Text: All capitalized unless otherwise indicated.
   5. Color: Black text on white background unless otherwise indicated.

E. Format for Caution and Warning Messages:
   1. Minimum Size: 2 inches by 4 inches.
   2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height: 1/2 inch.
   5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Receptacle Identification:
   1. Minimum Size: 3/8 inch by 1.5 inches.
   2. Legend: Power source and circuit number or other designation indicated.
   3. Text: All capitalized unless otherwise indicated.
   5. Color: Black text on clear background.

2.03 WIRE AND CABLE MARKERS

A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

B. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

C. Legend: Power source and circuit number or other designation indicated.

D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

E. Minimum Text Height: 1/8 inch.

F. Color: Black text on white background unless otherwise indicated.

2.04 VOLTAGE MARKERS

A. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.

B. Minimum Size:
   1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
   2. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.

C. Legend:
1. Markers for Voltage Identification: Highest voltage present.

D. Color: Black text on orange background unless otherwise indicated.

2.05 UNDERGROUND WARNING TAPE

A. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

B. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.

C. Legend: Type of service, continuously repeated over full length of tape.

D. Color:

2.06 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:
   1. Materials:
   2. Minimum Size: 7 by 10 inches unless otherwise indicated.

C. Warning Labels:
   1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
   3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
   3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
   4. Elevated Equipment: Legible from the floor or working platform.
   5. Branch Devices: Adjacent to device.
   6. Interior Components: Legible from the point of access.
   7. Conduits: Legible from the floor.
   8. Boxes: Outside face of cover.
   9. Conductors and Cables: Legible from the point of access.
   10. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.

G. Mark all handwritten text, where permitted, to be neat and legible.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES

A. Short-circuit study.
B. Protective device coordination study.
C. Arc flash and shock risk assessment.
   1. Includes arc flash hazard warning labels.
D. Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

1.02  RELATED REQUIREMENTS

A. Section 26 0553 - Identification for Electrical Systems: Additional requirements for arc flash hazard warning labels.
B. Section 26 2413 - Switchboards.
C. Section 26 2416 - Panelboards.

1.03  REFERENCE STANDARDS

C. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
F. IEEE 1584 - IEEE Guide for Performing Arc Flash Hazard Calculations - Includes 1584, 1584A and 1584B.
G. NEMA MG 1 - Motors and Generators.
I. NFPA 70 - National Electrical Code.
J. NFPA 70E - Standard for Electrical Safety in the Workplace.

1.04  ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
   2. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Submit study reports prior to or concurrent with product submittals.
   2. Do not order equipment until matching study reports and product submittals have both been evaluated by Architect.

1.05  SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Study reports, stamped or sealed and signed by study preparer.
C. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.
1. Include characteristic time-current trip curves for protective devices.
2. Include impedance data for engine generators.
3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
4. Include documentation of listed series ratings upon request.
5. Identify modifications made in accordance with studies that:
   a. Can be made at no additional cost to Owner.
   b. As submitted will involve a change to the contract sum.

D. Arc Flash Hazard Warning Label Samples: One of each type and legend specified.

1.06 POWER SYSTEM STUDIES

A. Scope of Studies:
1. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).
2. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.

B. General Study Requirements:
1. Comply with NFPA 70.
2. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.

C. Data Collection:
1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.
   a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.
      1) Obtain up-to-date information from Utility Company.
   b. Generators: Include manufacturer/model, kW and voltage ratings, and impedance.
   c. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 1 code letter designation.
   d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.
   e. Protective Devices:
      1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
      2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).
   f. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
   g. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.

D. Short-Circuit Study:
2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:
   a. Maximum utility fault currents.
   b. Maximum motor contribution.
   c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.

E. Protective Device Coordination Study:
1. Comply with applicable portions of IEEE 242 and IEEE 399.
2. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
3. Analyze protective devices and associated settings for suitable margins between time-current curves to achieve full selective coordination while providing adequate protection for equipment and conductors.

F. Arc Flash and Shock Risk Assessment:
1. Comply with NFPA 70E.
2. Perform incident energy and arc flash boundary calculations in accordance with IEEE 1584 (as referenced in NFPA 70E Annex D), where applicable.
3. Analyze alternate scenarios considering conditions that may result in maximum incident energy, including but not limited to:
   a. Maximum and minimum utility fault currents.
   b. Maximum and minimum motor contribution.
   c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

G. Study Reports:
1. General Requirements:
   a. Identify date of study and study preparer.
   b. Identify study methodology and software product(s) used.
   c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.
   d. Identify base used for per unit values.
   e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.
   f. Include conclusions and recommendations.
2. Short-Circuit Study:
   a. For each scenario, identify at each bus location:
      1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).
      2) Fault point X/R ratio.
      3) Associated equipment short circuit current ratings.
   b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.
3. Protective Device Coordination Study:
   a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.
   b. For each graph include (where applicable):
      1) Partial single-line diagram identifying the portion of the system illustrated.
      2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.
      3) Conductors: Damage curves.
      4) Transformers: Inrush points and damage curves.
      5) Generators: Full load current, overload curves, decrement curves, and short circuit withstand points.
      6) Motors: Full load current, starting curves, and damage curves.
      7) Capacitors: Full load current and damage curves.
   c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.
      1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
      2) Include ground fault pickup and delay.
      3) Include fuse ratings.
      4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.
d. Identify cases where either full selective coordination or adequate protection is not achieved, along with recommendations.

4. Arc Flash and Shock Risk Assessment:
   a. For each scenario, identify at each bus location:
      1) Calculated incident energy and associated working distance.
      2) Calculated arc flash boundary.
      3) Bolted fault current.
      4) Arcing fault current.
      5) Clearing time.
      6) Arc gap distance.
   b. For purposes of producing arc flash hazard warning labels, summarize the maximum incident energy and associated data reflecting the worst case condition of all scenarios at each bus location.
   c. Identify locations where the calculated maximum incident energy exceeds 40 calories per sq cm.

1.07 QUALITY ASSURANCE
   A. Study Preparer Qualifications: Professional electrical engineer licensed in Colorado and with minimum five years experience in the preparation of studies of similar type and complexity using specified computer software.
   B. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.

PART 2 PRODUCTS
2.01 ARC FLASH HAZARD WARNING LABELS
   A. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.
      1. Materials: Comply with Section 26 0553.
      2. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.
         a. Include the following information:
            1) Arc flash boundary.
            2) Available incident energy and corresponding working distance.
            3) Nominal system voltage.

PART 3 EXECUTION
3.01 FIELD QUALITY CONTROL
   A. See Section 01 4000 - Quality Requirements, for additional requirements.
   B. Inspect and test in accordance with NETA ATS, except Section 4.
   C. Adjust equipment and protective devices for compliance with studies and recommended settings.
   D. Notify Architect of any conflicts with or deviations from studies. Obtain direction before proceeding.

3.02 CLOSEOUT ACTIVITIES
   A. Training: Include as part of the base bid training for Owner's personnel on electrical safety pertaining to arc flash and shock hazards.
      1. Use site-specific arc flash and shock risk assessment report as training reference, supplemented with additional training materials as required.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES

A. Low-voltage (600 V and less) standard (non-arc-resistant) metal-enclosed drawout switchgear and accessories for service and distribution applications.

1.02  REFERENCE STANDARDS

C. NECA 1 - Standard for Good Workmanship in Electrical Construction.
D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
F. NFPA 70 - National Electrical Code.
H. UL 1066 - Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.
I. UL 1558 - Switchgear.

1.03  ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
   5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Service Entrance Switchgear:
   1. Coordinate with Utility Company to provide switchgear with suitable provisions for electrical service and utility metering, where applicable.
   2. Coordinate with Owner to arrange for Utility Company required access to equipment for installation and maintenance.
   3. Obtain Utility Company approval of switchgear prior to fabrication.
   4. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.04  SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchgear, enclosures, overcurrent protective devices, and other installed components and accessories.
C. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, short-time current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include dimensioned plan and elevation views of switchgear and adjacent equipment with all required clearances indicated.
2. Include documentation demonstrating selective coordination upon request.

D. Service Entrance Switchgear: Include documentation of Utility Company approval of switchgear.

### QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

### PART 2 PRODUCTS

#### 2.01 MANUFACTURERS

#### 2.02 LOW-VOLTAGE SWITCHGEAR

A. Provide switchgear assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Dead-front standard (non-arc-resistant) type metal-enclosed drawout switchgear complying with IEEE C37.20.1 and ANSI C37.51; listed and labeled as complying with UL 1558; ratings, configurations and features as indicated on the drawings.

D. Service Entrance Switchgear:
   1. Listed and labeled as suitable for use as service equipment according to UL 869A.
   2. For solidly-grounded wye systems, provide factory-installed main bonding jumper between neutral and ground busses, and removable neutral disconnecting link for testing purposes.

E. Service Conditions:
   1. Provide switchgear and associated components suitable for operation under the following service conditions without derating:
      a. Altitude: Less than 6,600 feet.
      b. Ambient Temperature: Between -22 degrees F and 104 degrees F.
   2. Provide switchgear and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

F. Short Circuit Current Rating:
   1. Provide switchgear with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

G. Short-Time Current (30-Cycle Withstand) Rating: Equivalent to specified short circuit current rating.

H. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.

I. Bussing: Sized in accordance with UL 1558 temperature rise requirements.
   1. Main bus (horizontal cross bus) to be fully rated through full length of switchgear.
   2. Provide solidly bonded equipment ground bus through full length of switchgear, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
   3. Phase and Neutral Bus Material: Copper.

J. Conductor Terminations: Suitable for use with the conductors to be installed.
   1. Line Conductor Terminations:
      a. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
      b. Main and Neutral Lug Type: Mechanical.
   2. Load Conductor Terminations:
      a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
      b. Lug Type:

K. Enclosures:
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
2. Finish: Manufacturer's standard unless otherwise indicated.

L. Future Provisions:
1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

M. Instrument Transformers:
2. Select suitable ratio, burden, and accuracy as required for connected devices.

2.03 LOW-VOLTAGE POWER CIRCUIT BREAKERS

A. Description: Quick-make, quick-break, trip-free low-voltage power circuit breakers with two-step stored energy closing mechanism; 100 percent rated; complying with IEEE C37.13, IEEE C37.16, IEEE C37.17, and ANSI C37.50; listed and labeled as complying with UL 1066; ratings, configurations, and features as indicated on the drawings.

B. Interrupting Capacity: Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated.

C. Construction: Drawout.
1. Allows withdrawal of circuit breaker into test and disconnected positions, with racking position indication (connected, test, disconnected, withdrawn).
2. Provide safety interlock to prevent racking of circuit breaker while in the ON position.

D. Trip Units: Solid state, microprocessor-based, true rms sensing.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the switchgear and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive switchgear.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install switchgear in accordance with NECA 1 (general workmanship) and IEEE C37.20.1.

C. Arrange equipment to provide required clearances and maintenance access, including accommodations for drawout circuit breakers.

D. Provide required support and attachment in accordance with Section 26 0529.

E. Install switchgear plumb and level.

F. Unless otherwise indicated, mount switchgear on properly sized 4 inch high concrete pad constructed in accordance with Section 03 3000.

G. Provide grounding and bonding in accordance with Section 26 0526.

H. Install all field-installed devices, components, and accessories.

I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's reports with submittals.

C. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Before energizing switchgear, perform preoperation checks in accordance with IEEE C37.20.1.

E. Inspect and test in accordance with NETA ATS, except Section 4.

F. Perform inspections and tests listed in NETA ATS, Section 7.1.

G. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10. The dielectric withstand tests on primary windings with secondary windings connected to ground listed as optional are not required.

H. Correct deficiencies and replace damaged or defective switchgear assemblies or associated components.

3.04 PROTECTION

A. Protect installed switchgear assemblies from subsequent construction operations.
SECTION 26 2416
PANELBOARDS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS
   A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
   B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
   C. Section 26 0529 - Hangers and Supports for Electrical Systems.
   D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
   E. Section 26 4300 - Surge Protective Devices.

1.02 REFERENCE STANDARDS
   A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
   B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
   C. NECA 407 - Standard for Installing and Maintaining Panelboards.
   D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
   E. NEMA PB 1 - Panelboards.
   F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
   H. NFPA 70 - National Electrical Code.
   I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
   J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
   K. UL 67 - Panelboards.
   L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
   M. UL 1699 - Arc-Fault Circuit-Interrupters.

1.03 ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
      2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
      3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
      4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
      5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
   2. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.

D. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation; _____: www.eaton.com/#sle.

B. Schneider Electric; Square D Products; _____: www.schneider-electric.us/#sle.


2.02 PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature:
      a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

C. Short Circuit Current Rating:
   1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
   1. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.

G. Conductor Terminations: Suitable for use with the conductors to be installed.

H. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      2. Boxes: Galvanized steel unless otherwise indicated.
         a. Provide wiring gutters sized to accommodate the conductors to be installed.
      3. Fronts:
         a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
         b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
      4. Lockable Doors: All locks keyed alike unless otherwise indicated.

I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

J. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 4300, list and label panelboards as a complete assembly including surge protective device.
K. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

2.03 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
   1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   2. Main and Neutral Lug Type: Mechanical.

C. Bussing:

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:
   1. Provide surface-mounted or flush-mounted enclosures as indicated.
   2. Provide clear plastic circuit directory holder mounted on inside of door.

2.04 LOAD CENTERS

A. Description: Circuit breaker type load centers listed and labeled as complying with UL 67; ratings, configurations, and features as indicated on the drawings.

B. Bussing:
   2. Bus Material: Aluminum or copper.

C. Circuit Breakers: Thermal magnetic plug-in type.

D. Enclosures:
   1. Provide flush-mounted enclosures unless otherwise indicated.
   2. Provide circuit directory label on inside of door or individual circuit labels adjacent to circuit breakers.

2.05 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:
   1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
   2. Interrupting Capacity:
      a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
      b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
   3. Conductor Terminations:
      a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
   5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive panelboards.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer’s instructions.
C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
D. Arrange equipment to provide minimum clearances in accordance with manufacturer’s instructions and NFPA 70.
E. Provide required support and attachment in accordance with Section 26 0529.
F. Install panelboards plumb.
G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
I. Mount floor-mounted power distribution panelboards on properly sized 3 inch high concrete pad constructed in accordance with Section 03 3000.
J. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
K. Provide grounding and bonding in accordance with Section 26 0526.
L. Install all field-installed branch devices, components, and accessories.
M. Provide filler plates to cover unused spaces in panelboards.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Inspect and test in accordance with NETA ATS, except Section 4.
C. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than _____ amperes. Tests listed as optional are not required.
D. Test GFCI circuit breakers to verify proper operation.
E. Test AFCI circuit breakers to verify proper operation.
F. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer’s recommended torque settings.
B. Adjust alignment of panelboard fronts.
C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION
SECTION 26 2726
WIRING DEVICES - LUTRON

PART 1 GENERAL

1.01    SECTION INCLUDES

A. Mechanical wall switches.
B. Wall dimmers and electronic switches.
C. Receptacles.
D. Accessory low voltage devices.
E. Wall plates.

1.02    RELATED REQUIREMENTS

A. Section 26 0533.16 - Boxes for Electrical Systems.
B. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03    REFERENCE STANDARDS

B. ASTM E308 - Standard Practice for Computing the Colors of Objects by Using the CIE System.
D. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits.
E. NECA 1 - Standard for Good Workmanship in Electrical Construction.
F. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
G. NEMA WD 1 - General Color Requirements for Wiring Devices.
H. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
I. UL 20 - General-Use Snap Switches.
J. UL 498 - Attachment Plugs and Receptacles.
K. UL 508 - Industrial Control Equipment.
L. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
M. UL 943 - Ground-Fault Circuit-Interrupters.
N. UL 1310 - Class 2 Power Units.
O. UL 1472 - Solid-State Dimming Controls.

1.04    ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of wiring devices with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
   3. Coordinate the placement of wall controls with actual installed door swings.
   4. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.
B. Sequencing:
   1. Do not install wiring devices until final surface finishes and painting are complete.

1.05 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
   1. Wall Dimmers: Include derating information for ganged multiple devices.

PART 2 PRODUCTS
2.01 MANUFACTURERS

2.02 WIRING DEVICES - GENERAL REQUIREMENTS
A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
B. Provide wiring devices suitable for intended use and with ratings adequate for load served.
C. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, programming, etc. as necessary for a complete operating system that provides the control intent indicated.
D. Design lighting control equipment for 10 year operational life while operating continually at any temperature in an ambient temperature range of 32 degrees F to 104 degrees F and 90 percent non-condensing relative humidity.
E. Electrostatic Discharge Tolerance: Design and test equipment to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2.
F. Power Failure Recovery: When power is interrupted for periods up to 10 years and subsequently restored, lights to automatically return to same levels (dimmed setting, full on, or full off) as prior to power interruption.
G. Device Finishes:
   1. Standard Colors: Comply with NEMA WD 1 where applicable.
   2. Color Variation in Same Product Family: Maximum delta E of 1, CIE L*a*b color units per ASTM E308.
   3. Visible Parts: Exhibit ultraviolet color stability when tested with multiple actinic light sources as defined in ASTM D4674. Provide proof of testing upon request.

2.03 MECHANICAL WALL SWITCHES
A. Comply with NEMA WD 6, where applicable, and list as complying with UL 20.
B. Paddle Type Mechanical Wall Switches; Lutron Claro Series (Designer Style):
   1. Switch Control: Paddle type rocker switch for on/off operation.

2.04 WALL DIMMERS AND ELECTRONIC SWITCHES
A. General Requirements:
   1. Utilize air gap off, activated when user selects "off" to disconnect the load from line supply.
   2. Provide air gap service switch accessible without removing faceplate.
   3. Operates at the rated capacity across the full ambient temperature range including modified capacities for ganged configurations which require removal of fins.
   4. Provide radio frequency interference suppression.
   5. Surge Tolerance: Designed and tested to withstand surges of 6,000 V, 200 amps according to IEEE C62.41.2 without impairment to performance.
   6. Dimmers: Provide full range, continuously variable control of light intensity.
   7. Dimmers for Electronic Low Voltage (ELV) Transformers:
      a. Provide circuitry designed to control the input of electronic (solid-state) low voltage (ELV) transformers. Do not use dimmers that utilize standard phase control.
b. Provide resettable overload protection that provides automatic shut-off when dimmer capacity is exceeded. Do not use protection methods that are non-resettable or require device to be removed from outlet box.

c. Designed to withstand a short, per UL 1472, between load hot and either neutral or ground without damage to dimmer.

8. Dimmers for Magnetic Low Voltage (MLV) Transformers:
   a. Provide circuitry designed to control and provide a symmetrical AC waveform to input of magnetic low voltage transformers per UL 1472.
   b. Magnetic low voltage transformers to operate below rated current or temperature.

9. Fluorescent Dimmers:
   a. Provides direct control of fluorescent dimming ballasts up to the ballast manufacturer's specified rating.

10. Electronic Switches:
    a. Listed as complying with UL 20, UL 508, and UL 1472.

2.05 RECEPTACLES
   A. Comply with NEMA WD 6, and list as complying with UL 498.
   B. NEMA configurations specified are according to NEMA WD 6.
   C. GFCI Receptacles: Provide with feed-through protection, light to indicate ground fault tripped condition and loss of protection, and with test and reset buttons of same color as device; list as complying with UL 943, class A.
   D. USB Receptacles: Dual output USB ports with 3.8 A total output; list as complying with UL 1310.

2.06 ACCESSORY LOW VOLTAGE DEVICES
   A. Manufacturer: Same as manufacturer of lighting controls, to provide aesthetically compatible devices.

2.07 WALL PLATES
   A. Manufacturer: Same as manufacturer of devices, for aesthetically compatible installation.
   B. Provide screwless wall plates with concealed mounting hardware and alignment adapter plate, suitable for the quantity and types of devices to be installed.
   C. List as complying with UL 514C.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as shown on the drawings.
   B. Verify that ratings and configurations of devices are consistent with the indicated requirements.
   C. Verify that mounting surfaces are ready to receive devices.
   D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION
   A. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION
   A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, except for mounting heights specified in those standards.
   B. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of devices provided under this section.
   C. Where multiple devices are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
   D. Install products in accordance with manufacturer's instructions.
E. Install permanent barrier between ganged devices when voltage between adjacent devices exceeds 300 V.
F. For isolated ground receptacles, connect grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.
G. Install wall dimmers to achieve full rating specified after derating for ganging as instructed by manufacturer.
H. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings.
I. Identify devices in accordance with Section 26 0553.

3.04 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Test each receptacle to verify operation and proper polarity.
C. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
D. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

3.05 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Packaged engine generator system and associated components and accessories:
   1. Engine and engine accessory equipment.
   2. Alternator (generator).
   3. Generator set control system.

1.02 REFERENCE STANDARDS

B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
C. NECA/EGSA 404 - Standard for Installing Generator Sets.
D. NEMA MG 1 - Motors and Generators.
E. NFPA 30 - Flammable and Combustible Liquids Code.
F. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
G. NFPA 70 - National Electrical Code.
J. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids.
K. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries.
L. UL 2085 - Protected Aboveground Tanks for Flammable and Combustible Liquids.
M. UL 2200 - Stationary Engine Generator Assemblies.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.
      a. Transfer Switches: See Section 26 3600.
   2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for engine generator system.
   3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
   5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.
   1. Include generator set sound level test data.
2. Include characteristic trip curves for overcurrent protective devices upon request.
3. Include alternator thermal damage curve upon request.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.
   1. Identify mounting conditions required for equipment seismic qualification.

D. Manufacturer's equipment seismic qualification certification.

E. Derating Calculations: Indicate ratings adjusted for applicable service conditions.

F. Fuel Storage Tank Calculations: Indicate maximum running time for generator set configuration provided.

G. Evidence of qualifications for installer.

H. Evidence of qualifications for maintenance contractor (if different entity from installer).

I. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

J. Manufacturer's factory emissions certification.

K. Source quality control test reports.

L. Provide NFPA 110 required documentation from manufacturer where requested by authorities having jurisdiction, including but not limited to:
   1. Certified prototype tests.
   2. Torsional vibration compatibility certification.
   3. NFPA 110 compliance certification.
   4. Certified rated load test at rated power factor.

M. Manufacturer's detailed field testing procedures.

N. Field quality control test reports.

O. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
   1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

P. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

Q. Maintenance contracts.

R. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

1.05 QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70 (National Electrical Code).
   2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for Level 1 system.
   3. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
   4. NFPA 30 (Flammable and Combustible Liquids Code).

B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.
B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Maintain field conditions within manufacturer’s required service conditions during and after installation.

1.08 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Packaged Engine Generator Set - Basis of Design: GENERAC.

B. Packaged Engine Generator Set - Other Acceptable Manufacturers:

C. Substitutions: See Section 01 6000 - Product Requirements.

D. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

E. Source Limitations: Furnish engine generator sets and associated components and accessories produced by a single manufacturer and obtained from a single supplier.

2.02 PACKAGED ENGINE GENERATOR SYSTEM

A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. System Description:
3. Total System Power Rating: 60 kW, standby, including applicable derating adjustments.

D. Packaged Engine Generator Set:
1. Type: Diesel (compression ignition).
2. Power Rating: 60 kW, standby, including applicable derating adjustments.
3. Voltage: As indicated on drawings.

E. Generator Set General Requirements:
1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
2. Factory-assembled, with components mounted on suitable base.
3. List and label engine generator assembly as complying with UL 2200.
4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.

F. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.
G. Starting and Load Acceptance Requirements:
1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.
2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).
4. Maximum Load Step: Supports 100 percent of rated load in one step.

H. Exhaust Emissions Requirements:
1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.
2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

I. Sound Level Requirements:
1. Comply with applicable noise level regulations.

2.03 ENGINE AND ENGINE ACCESSORY EQUIPMENT

A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.

B. Engine Fuel System - Diesel (Compression Ignition):
1. Fuel Source: Diesel, ASTM D975 No. 2-D or approved cold weather diesel blends.
5. Sub-Base Fuel Tank:
   a. Provide sub-base mounted, double-wall fuel tank with secondary containment; listed and labeled as complying with UL 142.
   b. Tank Capacity: Size for minimum of 24 hours of continuous engine generator operation at 100 percent rated load, but not larger than permissible by applicable codes.
   c. Features:
      1) Direct reading fuel level gauge.
      2) Normal atmospheric vent.
      3) Emergency pressure relief vent.
      4) Fuel fill opening with lockable cap.
      5) Dedicated electrical conduit stub-up area.

C. Engine Starting System:
1. System Type: Electric, with DC solenoid-activated starting motor(s).
2. Battery(s):
   a. Battery Type: Lead-acid.
   b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.
   c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.
4. Battery Charger:
   a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
   b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.
   c. Recognized as complying with UL 1236.
d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.

e. Provide integral DC output ammeter and voltmeter with five percent accuracy.

f. Provide alarm output contacts as necessary for alarm indications.

5. Battery Heater: Provide thermostatically controlled battery heater to improve starting under cold ambient conditions.

D. Engine Speed Control System (Governor):
   2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.

E. Engine Lubrication System:
   1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.

F. Engine Cooling System:
   1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
   2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.
   3. Coolant Heater: Provide thermostatically controlled coolant heater to improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.

G. Engine Air Intake and Exhaust System:
   1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
   2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.
   3. Exhaust Silencer: Provide critical grade or better exhaust silencer with sound attenuation not less than basis of design; select according to manufacturer's recommendations to meet sound performance requirements, where specified.

2.04 ALTERNATOR (GENERATOR)

A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.

B. Exciter:
   1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
   2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
   3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.

C. Temperature Rise: Comply with UL 2200.

D. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.

E. Enclosure: NEMA MG 1, drip-proof.

F. Total Harmonic Distortion: Not greater than five percent.

2.05 GENERATOR SET CONTROL SYSTEM

A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.

B. Control Panel:
   1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
   2. Generator Set Control Functions:
a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.

3. Generator Set Status Indications:
   a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
   b. Current (Amps): For each phase.
   c. Frequency (Hz).
   d. Real power (W/kW).
   e. Reactive power (VAR/kVAR).
   f. Apparent power (VA/kVA).
   g. Duty factor.
   h. Duty Level: Actual load as percentage of rated power.
      i. Engine speed (RPM).
      j. Battery voltage (Volts DC).
      k. Engine oil pressure.
     l. Engine coolant temperature.
     m. Engine run time.
   n. Generator powering load (position signal from transfer switch).

4. Generator Set Protection and Warning/Shutdown Indications:
   a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:
      1) Overcrank (shutdown).
      2) Low coolant temperature (warning).
      3) High coolant temperature (warning).
      4) High coolant temperature (shutdown).
      5) Low oil pressure (shutdown).
      6) Overspeed (shutdown).
      7) Low fuel level (warning).
      8) Low coolant level (warning/shutdown).
      9) Generator control not in automatic mode (warning).
      10) High battery voltage (warning).
      11) Low cranking voltage (warning).
      12) Low battery voltage (warning).
      13) Battery charger failure (warning).
   b. In addition to NFPA 110 requirements, provide the following protections/indications:
      1) High AC voltage (shutdown).
      2) Low AC voltage (shutdown).
      3) High frequency (shutdown).
      4) Low frequency (shutdown).
      5) Overcurrent (shutdown).
   c. Provide contacts for local and remote common alarm.
   d. Provide lamp test function that illuminates all indicator lamps.

5. Other Control Panel Features:
   a. Event log.

C. Remote Annunciator:
   1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
   2. Generator Set Status Indications:
      a. Generator powering load (via position signal from transfer switch).
      b. Communication functional.
   3. Generator Set Warning/Shutdown Indications:
      a. Comply with NFPA 110 for Level 1 systems including but not limited to the following indications:
         1) Overcrank (shutdown).
2) Low coolant temperature (warning).
3) High coolant temperature (warning).
4) High coolant temperature (shutdown).
5) Low oil pressure (shutdown).
6) Overspeed (shutdown).
7) Low fuel level (warning).
8) Low coolant level (warning/shutdown).
9) Generator control not in automatic mode (warning).
10) High battery voltage (warning).
11) Low cranking voltage (warning).
12) Low battery voltage (warning).
13) Battery charger failure (warning).

b. Provide audible alarm with silence function.
c. Provide lamp test function that illuminates all indicator lamps.

D. Remote Emergency Stop: Provide approved red, mushroom style remote emergency stop button where indicated or required by authorities having jurisdiction.

2.06 SOURCE QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.
C. Generator Set production testing to include, at a minimum:
   1. Operation at rated load and rated power factor.
   2. Single step load pick-up.
   3. Transient and steady state voltage and frequency performance.
   4. Operation of safety shutdowns.
D. Diesel Fuel Storage Tanks: Perform pressurized leak test prior to shipment.

PART 3 EXECUTION

3.01 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer's instructions.
C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.
D. Arrange equipment to provide minimum clearances and required maintenance access.
E. Unless otherwise indicated, mount generator set on properly sized, minimum 6 inch high concrete pad constructed in accordance with Section 03 3000.
F. Provide required support and attachment in accordance with Section 26 0529.
G. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.
H. Provide diesel fuel piping and venting in accordance with Section 23 1113, where not factory installed.
I. Provide engine exhaust piping in accordance with Section 23 5100, where not factory installed.
   1. Include piping expansion joints, piping insulation, thimble, condensation trap/drain, rain cap, hangers/supports, etc. as indicated or as required.
   2. Do not exceed manufacturer's maximum back pressure requirements.
J. Install exhaust silencer in accordance with Section 23 5100, where not factory installed.
K. Provide grounding and bonding in accordance with Section 26 0526.
L. Identify system wiring and components in accordance with Section 26 0553.
3.02 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Notify Owner and Architect at least two weeks prior to scheduled inspections and tests.
C. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
D. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.
E. Preliminary inspection and testing to include, at a minimum:
   1. Inspect each system component for damage and defects.
   2. Verify tightness of mechanical and electrical connections are according to manufacturer’s recommended torque settings.
   3. Check for proper oil and coolant levels.
F. Prepare and start system in accordance with manufacturer's instructions.
G. Perform acceptance test in accordance with NFPA 110.
H. Inspection and testing to include, at a minimum:
   1. Verify compliance with starting and load acceptance requirements.
   2. Verify voltage and frequency; make required adjustments as necessary.
   3. Verify phase sequence.
   4. Verify control system operation, including safety shutdowns.
   5. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).
I. Provide field emissions testing where necessary for certification.
J. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.03 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.
B. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of four hours of training.
   3. Instructor: Manufacturer's authorized representative.
   4. Location: At project site.
C. After successful acceptance test and just prior to Substantial Completion, replace air, oil, and fuel filters and fill fuel storage tank.

3.04 PROTECTION

A. Protect installed engine generator system from subsequent construction operations.

3.05 MAINTENANCE

A. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of engine generator system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

END OF SECTION
SECTION 26 3600
TRANSFER SWITCHES

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Transfer switches for low-voltage (600 V and less) applications and associated accessories:
   1. Automatic transfer switches.
   2. Remote annunciators.

1.02  RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
B. Section 14 2100 - Electric Traction Elevators: For interface with transfer switch.
C. Section 14 2400 - Hydraulic Elevators: For interface with transfer switch.
D. Section 26 0526 - Grounding and Bonding for Electrical Systems.
E. Section 26 0529 - Hangers and Supports for Electrical Systems.
F. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
G. Section 26 3213 - Engine Generators: For interface with transfer switches.
   1. Includes code requirements applicable to work of this section.

1.03  REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
E. NFPA 70 - National Electrical Code.
G. UL 1008 - Transfer Switch Equipment.

1.04  ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate compatibility of transfer switches to be installed with work provided under other sections or by others.
   2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Coordinate the work with placement of supports, anchors, etc. required for mounting.
   5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.05  SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.
   1. Clearly indicate whether proposed short circuit current ratings are based on testing with specific overcurrent protective devices or time durations; indicate short-time ratings where applicable.
   2. Identify mounting conditions required for equipment seismic qualification.

D. Manufacturer's equipment seismic qualification certification.

E. Evidence of qualifications for installer.

F. Evidence of qualifications for maintenance contractor (if different entity from installer).

G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

H. Manufacturer's detailed field testing procedures.

I. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
   1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

J. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

K. Maintenance contracts.

L. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

1.06 QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70 (National Electrical Code).
   2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for system Level specified in Section 26 3213.

B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 WARRANTY

A. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 TRANSFER SWITCHES

A. Provide complete power transfer system consisting of all required equipment, conduit, boxes, wiring, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Applications:
   1. Utilize open transition transfer unless otherwise indicated or required.
   2. For transfer of highly inductive loads (e.g. large motors and transformers), utilize open transition transfer with in-phase monitor or delayed transition transfer.
D. Construction Type: Either "contactor type" (open contact) or "breaker type" (enclosed contact) transfer switches complying with specified requirements are acceptable.

E. Automatic Transfer Switch:
   1. Transfer Switch Type: As indicated on the drawings.
   2. Transition Configuration: As indicated on the drawings.
   3. Voltage: As indicated on the drawings.
   4. Ampere Rating: As indicated on the drawings.
   5. Neutral Configuration: Solid neutral (unswitched), except as indicated.
   6. Load Served: As indicated on the drawings.
   7. Primary Source: As indicated on the drawings.
   8. Alternate Source: As indicated on the drawings.

F. Comply with NEMA ICS 10 Part 1, and list and label as complying with UL 1008 for the classification of the intended application (e.g. emergency, optional standby).

G. Do not use double throw safety switches or other equipment not specifically designed for power transfer applications and listed as transfer switch equipment.

H. Load Classification: Classified for total system load (any combination of motor, electric discharge lamp, resistive, and tungsten lamp loads with tungsten lamp loads not exceeding 30 percent of the continuous current rating) unless otherwise indicated or required.

I. Switching Methods:
   1. Open Transition: a. Provide break-before-make transfer without a neutral position that is not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.
      b. Where in-phase transfer is indicated, utilize in-phase monitor to initiate transfer when phase angle difference between sources is near zero to limit in-rush currents.
   2. Delayed Transition:
      a. Provide break-before-make transfer with programmable time delay in a neutral position not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.
   3. Obtain control power for transfer operation from line side of source to which the load is to be transferred.

J. Service Conditions: Provide transfer switches suitable for continuous operation at indicated ratings under the service conditions at the installed location.

K. Enclosures:
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   2. Finish: Manufacturer's standard unless otherwise indicated.

L. Short Circuit Current Rating:

M. Automatic Transfer Switches:
   1. Description: Transfer switches with automatically initiated transfer between sources; electrically operated and mechanically held.
   2. Control Functions:
      a. Automatic mode.
      b. Test Mode: Simulates failure of primary/normal source.
      c. Voltage and Frequency Sensing:
         1) Undervoltage sensing for each phase of primary/normal source; adjustable dropout/pickup settings.
         2) Undervoltage sensing for alternate/emergency source; adjustable dropout/pickup settings.
         3) Underfrequency sensing for alternate/emergency source; adjustable dropout/pickup settings.
      d. Outputs:
         1) Contacts for engine start/shutdown (except where direct generator communication interface is provided).
         2) Auxiliary contacts; one set(s) for each switch position.
      e. Adjustable Time Delays:
1) Engine generator start time delay; delays engine start signal to override momentary primary/normal source failures.
2) Transfer to alternate/emergency source time delay.
3) Retransfer to primary/normal source time delay.
4) Engine generator cooldown time delay; delays engine shutdown following retransfer to primary/normal source to permit generator to run unloaded for cooldown period.

f. In-Phase Monitor (Open Transition Transfer Switches): Monitors phase angle difference between sources for initiating in-phase transfer.
g. Engine Exerciser: Provides programmable scheduled exercising of engine generator selectable with or without transfer to load; provides memory retention during power outage.

3. Status Indications:
   a. Connected to alternate/emergency source.
   b. Connected to primary/normal source.
   c. Alternate/emergency source available.

4. Automatic Sequence of Operations:
   a. Upon failure of primary/normal source for a programmable time period (engine generator start time delay), initiate starting of engine generator where applicable.
   b. When alternate/emergency source is available, transfer load to alternate/emergency source after programmable time delay.
   c. When primary/normal source has been restored, retransfer to primary/normal source after a programmable time delay. Bypass time delay if alternate/emergency source fails and primary/normal source is available.
   d. Where applicable, initiate shutdown of engine generator after programmable engine cooldown time delay.

N. Remote Annunciators:
   1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
   2. Transfer Switch Status Indications:
      a. Connected to alternate/emergency source.
      b. Connected to primary/normal source.
      c. Alternate/emergency source available.

O. Interface with Other Work:
   1. Interface with engine generators as specified in Section 26 3213.
   2. Interface with elevators as specified in Section 14 2100 and 14 2400.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify that the ratings and configurations of transfer switches are consistent with the indicated requirements.
   C. Verify that rough-ins for field connections are in the proper locations.
   D. Verify that mounting surfaces are ready to receive transfer switches.
   E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
   A. Perform work in accordance with NECA 1 (general workmanship).
   B. Install products in accordance with manufacturer's instructions.
   C. Arrange equipment to provide minimum clearances and required maintenance access.
   D. Provide required support and attachment in accordance with Section 26 0529.
   E. Install transfer switches plumb and level.
   F. Unless otherwise indicated, mount floor-mounted transfer switches on properly sized 3 inch high concrete pad constructed in accordance with Section 03 3000.
G. Provide grounding and bonding in accordance with Section 26 0526.
H. Identify transfer switches and associated system wiring in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL
A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.
C. Prepare and start system in accordance with manufacturer's instructions.
D. Automatic Transfer Switches:
   1. Inspect and test in accordance with NETA ATS, except Section 4.
   2. Perform inspections and tests listed in NETA ATS, Section 7.22.3. The insulation-resistance tests listed as optional are not required.
E. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.04 CLEANING
A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 PROTECTION
A. Protect installed transfer switches from subsequent construction operations.

3.06 MAINTENANCE
A. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of transfer switches for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Strike (air) terminals and interconnecting conductors.
   B. Grounding and bonding for lightning protection.

1.02 REFERENCE STANDARDS
   A. NFPA 780 - Standard for the Installation of Lightning Protection Systems.
   B. UL 96 - Lightning Protection Components.

1.03 ADMINISTRATIVE REQUIREMENTS
   A. Preinstallation Meeting: Convene a meeting at least at least two weeks prior to commencement of any work affected by lightning protection system requirements to discuss prerequisites and coordination required by other installers; require attendance by representatives of installers whose work will be affected.
   B. Provide ADD ALTERNATE line item pricing for Lightning Protection System as a delegated design/build system. Provide complete turn-key pricing to Owner for review and consideration.

1.04 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   B. Shop Drawings: Indicate location and layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details.
      1. Where conductors or grounds are to be embedded or concealed in other construction, submit shop drawings at least 30 days prior to start of construction.
      2. If concrete-encased grounds are to be used and are not shown in Contract Documents, provide sufficient data to determine concrete encasement dimensions and location.
      3. Include data on actual ground resistance determined by field measurement in accordance with NFPA 780.
      4. Include engineering analysis of equalization of potential to metal bodies within the structure.
   C. Product Data: Provide dimensions and materials of each component, indication of testing agency listing, and installation instructions.
   D. Installation Certification: Submit copy of certification agency's approval.
   E. Operation and Maintenance Data: Provide recommended inspection and testing plan, including recommended intervals, to achieve periodic maintenance as recommended in NFPA 780; provide customized plan reflecting actual installation configuration with specific installed components identified.
   F. Project Record Documents: Record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors in project record documents.

1.05 QUALITY ASSURANCE
   A. Maintain one copy of each referenced system design standard on site.
   B. Manufacturer Qualifications: Company specializing in lightning protection equipment with minimum three years documented experience.
   C. Designer Qualifications: Person or entity, employed by installer, who specializes in lightning protection system design with minimum three years documented experience.
   D. Installer Qualifications: Capable of providing the specified certification of the installed system.
PART 2 PRODUCTS

2.01 LIGHTNING PROTECTION SYSTEM

A. Lightning Protection System: Provide complete system complying with NFPA 780, including air terminals, bonding, interconnecting conductors and grounding electrodes.
   1. Provide system that protects:
      a. The entire structure.
      b. Open air areas within 100 feet of exterior walls at grade level.
      c. Open air areas within building footprint.
   2. Coordinate with other grounding and bonding systems specified.
   3. Determine ground resistance by field measurement.
   4. Provide copper, bronze, or stainless steel components, except where aluminum is allowed by NFPA 780.
   5. Provide system certified by Underwriters Laboratories or the Lightning Protection Institute.

2.02 COMPONENTS

A. All Components: Complying with applicable requirements of UL 96.
B. Strike (Air) Terminals: Copper, solid, with adhesive bases for single-ply roof installations.
C. Grounding Rods: Solid copper.
D. Ground Plate: Copper.
E. Conductors: Copper cable.
F. Connectors and Splicers: Bronze.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with referenced system standards and as required for specified certification.
B. Connect conductors using mechanical connectors or exothermic welding process; protect adjacent construction elements and finishes from damage.

3.02 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Perform visual inspection as specified in NFPA 780 as if this were a periodic follow-up inspection.
C. Perform continuity testing as specified in NFPA 780 as if this were testing for periodic maintenance.
D. Obtain the services of the specified certification agency to provide inspection and certification of the lightning protection system, including performance of any other testing required by that agency.

END OF SECTION
SECTION 26 4300
SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Surge protective devices for branch panelboard locations.

1.02 REFERENCE STANDARDS
A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
C. NFPA 70 - National Electrical Code.
D. UL 1449 - Standard for Surge Protective Devices.

1.03 ADMINISTRATIVE REQUIREMENTS
A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to ordering equipment.

1.04 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
C. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.
D. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
E. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Field-installed, Externally Mounted Surge Protective Devices:
B. Source Limitations: Furnish surge protective devices produced by a single manufacturer and obtained from a single supplier.

2.02 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS
A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.
B. Unless otherwise indicated, provide field-installed, externally-mounted or factory-installed, internally-mounted SPDs.
C. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.
D. Protected Modes:

E. UL 1449 Voltage Protection Ratings (VPRs):
   1. 208Y/120V System Voltage: Not more than 1,000 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.

F. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

G. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

2.03 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.
   C. Verify system grounding and bonding is in accordance with Section 26 0526, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.
   D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
   A. Perform work in accordance with NECA 1 (general workmanship).
   B. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
   C. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 0526 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

3.03 FIELD QUALITY CONTROL
   A. See Section 01 4000 - Quality Requirements, for additional requirements.
   B. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Interior luminaires.
   B. Emergency lighting units.

1.02 REFERENCE STANDARDS
   C. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems.
   E. NFPA 70 - National Electrical Code.
   G. UL 924 - Emergency Lighting and Power Equipment.
   H. UL 1598 - Luminaires.

1.03 ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
      2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
      3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
      4. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.04 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
      1. LED Luminaires:
         a. Include estimated useful life, calculated based on IES LM-80 test data.
         b. Include IES LM-79 test report upon request.
   C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
   D. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
   E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      1. See Section 01 6000 - Product Requirements, for additional provisions.
2. Extra Lenses and Louvers: Two percent of total quantity installed for each type, but not less than one of each type.

F. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.05 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.

1.06 DELIVERY, STORAGE, AND PROTECTION
A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.07 FIELD CONDITIONS
A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.08 WARRANTY
A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Provide three year manufacturer warranty for LED luminaires, including drivers.

PART 2 PRODUCTS

2.01 LUMINAIRES
A. Provide products that comply with requirements of NFPA 70.
B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
C. Provide products listed, classified, and labeled as suitable for the purpose intended.
D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

2.02 EMERGENCY LIGHTING UNITS
A. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
B. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
C. Battery:
   1. Size battery to supply all connected lamps, including emergency remote heads where indicated.
D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
E. Provide low-voltage disconnect to prevent battery damage from deep discharge.

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SECTION 31 0010
APPLICATION OF WATER

PART 1  GENERAL
1.01  SECTION INCLUDES
A. Work to provide and apply water to control dust created by traveling public and Contractor in performing other necessary work within project boundary as indicated in the Contract Documents, or directed by Engineer.

1.02  PAYMENT
A. All application of water work outlined in the Contract Documents shall be included in the LUMP SUM contract price.

1.03  REFERENCE STANDARDS
A. CDOT Specification Section 209 - Watering and Dust Palliatives

PART 2  PRODUCTS
2.01  MATERIALS
A. Water: To be reasonably clean

PART 3  EXECUTION
3.01  APPLICATION OF WATER
A. Secure own source of water.
B. Contact Owner to determine whether water is available for use and associated cost.
C. Water supply and equipment shall be capable of applying quantity of water required to abate dust and avoid unwarranted loss of water through evaporation, absorption, or drainage.

END OF SECTION
SELECTIVE DEMOLITION FOR SITE WORK

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Work to provide all labor, materials, tools, and equipment necessary or incidental to removal and disposal of those site work obstructions indicated in the Contract Documents including salvaging of designated materials, abandonment and removal of existing utilities and utility structures, and filling of resulting trenches, holes, and depressions.

1.02 PAYMENT
A. All site demolition work as outlined in the Contract Documents shall be included in the LUMP SUM contract price.

1.03 REFERENCE STANDARDS
A. 29 CFR 1926 - U.S. Occupational Safety and Health Standards.
B. CDOT Specification Section 202 - Removal of Structures and Obstructions.

1.04 DEFINITIONS
A. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.
B. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.
C. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.
D. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.
E. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.
F. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.
G. Return: To give back reusable items or unused products to vendors for credit.
H. Reuse: To reuse a construction waste material in some manner on the project site.
I. Salvage: To remove a material from the project site in acceptable condition for reuse.
J. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.
K. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.05 SUBMITTALS
A. Disposal Plan:
   1. Provide Engineer with information and documentation substantiating proper disposal arrangements and operations.

1.06 REGULATORY REQUIREMENTS
A. Comply with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.
B. Comply with applicable codes and regulations for safety of adjacent structures and the public.
C. Obtain required permits.
D. Coordinate haul routes.
E. Use of explosives is not permitted.
PART 2  PRODUCTS

2.01  MATERIALS
   A.  Fill Material: As specified in Section 31 2316 - Excavation.

PART 3  EXECUTION

3.01  SCOPE
   A.  Work covered under this section includes, but is not limited to:
      1.  Sawing of bituminous pavement.
      2.  Sawing of concrete pavement.
      3.  Removal and disposal of pavement surfacing.
      4.  Removal and disposal of sidewalk.
      5.  Removal and disposal of manholes and manhole covers, curb inlets and catch basins.
      6.  Removal and disposal of existing culvert and storm sewer piping.
      7.  Removal and disposal of existing fences and gates.
      8.  Removal of all other site work obstructions indicated for salvage, relocation, or recycling in the Contract Documents.
      9.  Removal, salvage, and reinstallation of existing obstructions not indicated in the Contract Documents, but required by the Work. Obstruction items include, but are not limited to signage, mailboxes, fences, and drainage piping. Restore or replace items to condition equal to or better than existing unless noted otherwise.
     10. Protection of items adjacent to obstructions indicated for salvage, relocation, or recycling in the Contract Documents.
     11. Filling and compacting trenches, holes, and depressions generated as result of demolition work as specified in Section 31 2316 - Excavation.

3.02  CONSTRUCTION REQUIREMENTS
   A.  Coordinate Work with utility companies; notify before starting work and comply with requirements; obtain required permits.
   B.  Protect existing utilities to remain from damage.
   C.  Do not disrupt public utilities without permit from authority having jurisdiction.
   D.  Protect existing structures and other elements that are not to be removed.
   E.  Do not begin demolition work until receipt of notification to proceed from Owner.
   F.  Do not begin demolition work until built items to be salvaged or relocated have been removed.
   G.  Do not begin demolition work until vegetation to be relocated has been removed and specified measures have been taken to protect vegetation to remain.
   H.  Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
      1.  Verify that construction and utility arrangements are as shown.
      2.  Report discrepancies to Engineer before disturbing existing installation.
      3.  Commencement of demolition work constitutes acceptance of existing conditions.
   I.  Provide, erect, and maintain temporary barriers and security devices.
   J.  Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
   K.  Conduct operations to minimize effects on and interference with adjacent structures and occupants.
   L.  Do not close or obstruct roadways or sidewalks without permit.
   M.  Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.
N. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon or limit access to their property.

O. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.

P. Stockpile items designated for salvage at location approved by Engineer. Remove, dismantle, and clean materials as required by the Contract Documents prior to stockpiling.

Q. Protect existing structures and other items not to be removed.
   1. Provide bracing and shoring.
   2. Prevent movement or settlement of adjacent structures.
   3. Perform cutting to accomplish removals neatly and as specified for cutting new work.
   4. Stop work immediately if adjacent structures appear to be in danger.
   5. Patch as specified for patching new work.

R. Saw cut bituminous and concrete surfaces as shown on the Drawings and as directed by the Engineer prior to starting demolition work to establish a neat line for extending the new work.

S. Remove existing items as indicated and as required to accomplish new work.
   1. Remove rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction specified.
   2. Remove items indicated on Drawings.

T. Remove and Abandon Utility Piping:
   1. Existing watermain, sanitary sewer, and storm sewer pipe being replaced with new materials are generally considered as debris to be removed as shown on the Drawings.
   2. In certain instances, existing pipes may be abandoned in place as designated on the Drawings, or directed by Engineer.
   3. Pipe abandonment includes the following:
      a. Disconnect line to be abandoned from live system as indicated on Drawings or directed by Engineer.
      b. Fill line to be abandoned by pumping or blowing fine granular material capable of filling pipe cavity to be abandoned as approved by Engineer.
      c. Cap open pipe ends with fittings appropriate to piping or bulkhead with non-shrink concrete grout at a thickness of not less than one pipe diameter to provide watertight seal.
      d. Document pipe abandonment locations on Project record documents.

U. Partial Removal of Structure:
   1. Protect existing structure to remain for use during removal operations.
   2. Ensure a length of at least 40 bar diameters from the face of the cut for existing reinforcement bars for concrete structures to be left in place.

V. Partial Removal of Paving and Curbs:
   1. Neatly saw cut full depth at right angle to surface as shown on the plans or as directed by Engineer in the field.
   2. Removal of paving and curbs shall be made to nearest joint to limits indicated on the Drawings when reasonable, unless otherwise approved by Engineer.

W. Concrete and masonry structures:
   1. Remove to excavation limits as shown on the Drawings.
   2. Provide a by-pass and maintain service to live sewers during removal operations.
   3. Rebuild and reconnect live sewers following removal of related manholes, catch basins, and drop inlets.
   4. Plug abandoned pipes draining into basements, manholes, or similar structures with concrete, masonry plugs, or other methods as approved by Engineer.

X. Replace existing items damaged by Contractor during prosecution of the Work with new materials or equipment of equal or better quality prior to Substantial Completion. Engineer will make final decision on acceptability of replacement materials and equipment.
Y. Remove from site items designated for salvage that are determined by Engineer following removal to be in a condition not worth salvaging. This is only applicable to removed items not damaged due to negligence of Contractor.

Z. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

AA. Generate least amount of trash and waste as possible. Perform demolition in a manner that maximizes salvage and recycling of materials.
   1. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.

AB. Stop work and notify Engineer and Owner if hazardous materials are discovered during removal operations. Hazardous materials include, but are not limited to regulated asbestos containing materials, lead, PCB's, mercury, and petroleum based fuel products.

3.03 CLEAN UP

A. Remove debris, junk, and trash from site.

B. Remove from site all materials not to be reused on site.

C. Unacceptable methods of trash/waste disposal include:
   1. Burning on the project site.
   2. Burying on the project site.
   3. Other illegal dumping or burying.

D. Leave site in clean condition, ready for subsequent work.

E. Clean up spillage and wind-blown debris from public and private lands.

F. Assume full responsibility for acceptable disposition of removal materials and for damages resulting from disposal operations.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Work to provide all labor, materials, tools, and equipment necessary or incidental to grade, excavate, fill, and compact Site as indicated in Contract Documents.

1.02 PRICE AND PAYMENT PROCEDURES
A. All removal and disposal required; sheeting, shoring and bracing; source quality control testing and other Work required under this Section shall be considered incidental to Project and no claim for compensation or extra work will be accepted.

B. No claim for additional payment will be accepted for excavation and fill required for removal of unsuitable material of up to 6-in. below bottom of subgrade, 12-in. below bottom of foundation, 12-in. below bottom of structural fill, or 12-in. below minimum excavation limit indicated on Drawings, whichever results in greater excavation and fill.

C. Excavation and fill required for removal of unsuitable material deeper than above limits will be paid for as Extra Work.

1.03 DEFINITIONS
A. Structure: Existing and new man-made features including, but not limited to buildings foundations, slabs, pump stations, manholes, catch basins, drop inlets, retaining walls, and other structural elements and systems.

B. Topsoil: Organic soil material, typically found at top of soil horizon and black in color.

C. Common Excavation: Excavated material not classified as Rock Excavation, but including stripped topsoil material.

D. Rock Excavation: Material including hard, solid rock in ledge formation, bedded deposits and unstratified masses; all natural conglomerate deposits so firmly cemented as to present all characteristics of solid rock; and any boulder stone, masonry or concrete fragments exceeding 1 cu.yd. in volume that requires drilling, or ripping before excavation. Material such as shale, hard pan, soft or disintegrated rock which can be dislodged with a hand pick or removed with a power operated excavator are not classified as Rock Excavation.

E. Suitable Subsoil Material: Excavated material that will provide for indicated soil bearing capacity, soil densities, material requirements and that, in opinion of soil testing laboratory, will not be subject to future decomposition, settlement, subsidence, expansion, and are otherwise of required soil type.

F. Unsuitable Subsoil Material: Excavated material that will not provide for indicated soil bearing capacity and soil densities and that in opinion of soil testing laboratory will be subject to future decomposition, settlement, subsidence, expansion, and are otherwise not of required soil type, as well as material that exceeds 1-cu.yd. in volume, cannot be re-used within project limits, and in opinion of Engineer requires special means for handling and disposal including but are not limited to organic soils, rubble, wood debris, boulder stone, masonry, concrete fragments, and metals.

1.04 REFERENCE STANDARDS
A. CDOT Specification Section 203 - Excavation and Embankment.
B. CDOT Specification Section 306 - Reconditioning.
C. CDOT Specification Section 212 - Seeding, Fertilizer, Soil Conditioner, and Sodding.
D. CDOT Specification Section 703 - Aggregates.

1.05 SUBMITTALS
A. Manufacturer's Certification: Certificate of compliance for all materials, supplies, and equipment provided.
B. Lab Test Reports: As specified; include source of each material tested and date sampled.
   1. Gradation

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Stockpiles:
      1. Place material on Site at location approved by Owner until required for incorporation into Work.
      2. Locate to limit additional loading or soil pressure on Site excavations and structures.
      3. Place, grade, and shape for proper drainage.
      4. Limit depth not to exceed 8-ft.
      5. Separate differing materials with dividers or stockpile separately to prevent intermixing.
      6. Prevent material contamination.
      7. Protect from erosion and deterioration of materials.

1.07 WARRANTY
   A. Correct defective Work within correction period after Date of Substantial Completion.
      1. Assume full responsibility and expense for all settlement, and refill and restore Work as directed to maintain an acceptable surface condition regardless of location.
      2. Settlement of pavement areas in excess of 1-in., as measured by a 10-ft. straight edge shall be considered failure of mechanical compaction.

PART 2 PRODUCTS

2.01 MATERIALS
   A. Per CDOT Specification Section 203 - Excavation and Embankment

2.02 SOURCE QUALITY CONTROL
   A. Coordinate and pay for independent testing agency to perform Source Quality Control tests, and submit test reports to Engineer and Contractor per the following.
      1. Obtain samples for testing from material in stock at locations and by methods approved by Engineer.
      2. Provide 1 gradation test of select granular borrow used as fill.
      3. Perform tests no more than 90 calendar days before Notice of Award.
   B. Coordinate and pay to re-test material failing a test, or provide alternate acceptable material as necessary to satisfy Engineer that requirements are met.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Determine to own satisfaction of location and nature of surface and subsurface obstacles and soil and water conditions that will be encountered during Work.
      1. Test borings and other exploratory operations may be made by Contractor at own expense to make such determinations.
      2. Make arrangements for soil investigations with Owner when applicable.
      3. Claims for additional payment due of nature of subsurface in which Work of this Section is performed, or for repairs made to subgrade related to weather will not be permitted.
   B. Verify that survey bench marks and intended elevations for Work are as indicated.
   C. Verify that structural installations have been inspected prior to filling Work.

3.02 PREPARATION
   A. Identify required lines, levels, contours, and datum.
   B. Stake and flag locations of known utilities.
   C. Locate, identify, and protect from damage above and below-grade utilities to remain.
   D. Notify utility company to remove and relocate utilities if necessary.
E. Prevent interruption of existing utilities serving facilities occupied and used by Owner or others, except when allowed by utility owner and then only after acceptable temporary utility services have been provided.
   1. Provide temporary services, complying with Federal, State, and local laws and regulations, and as acceptable to Owner, during any interruptions.

F. Protect Site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs, from lateral movement, settlement, undermining, washout, and other undesirable conditions created by Work.

G. Maintain full access to project exits and entrances, fire hydrants, street crossings, sidewalks, and other points as designated by Owner to prevent significant interruption of accessibility.

H. Maintain existing site drainage ways or provide new paths of drainage as required to perform Work.

I. Protect trees, plants, lawns, and other features to remain as a portion of final landscaping by providing substantial fencing around area. Place fencing for trees at outer drip line of branches; no grading is to be performed inside drip line.

J. Protect critical areas of Site from compaction as necessary including, but not limited to, infiltration areas, wetland soil edges, certain utilities, Areas of Environmental Sensitivity, and those other areas as indicated on Drawings. Assume full responsibility for restoration Work to decompact such areas including subsoiling Work per CDOT 212 - Seeding, Fertilizer, Soil Conditioner, and Sodding, and soil density testing to verify restoration to condition as good or better than existing as determined by Engineer.

3.03 SOIL REMOVAL AND STOCKPILING
   A. Stockpile excavated topsoil for re-used on Site; remove excess from Site.
   B. Stockpile excavated suitable subsoil material for re-used on Site; remove excess from Site.
   C. Remove excavated unsuitable subsoil material from Site.

3.04 EXCAVATING
   A. Remove topsoil from excavation area, without mixing with foreign materials.
   B. Do not remove topsoil when wet.
   C. Remove subsoil from excavation area.
   D. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.
   E. Reserve and segregate all suitable subsoil material, granular material, and topsoil from other materials and stockpile to extent practicable during excavation operations to permit best use of available materials at time of filling. Handle material as described incidental to Project with no additional compensation provided unless otherwise specified in Contract Documents.
   F. Areas of soil correction greater than 1-foot in depth shall be completed within the first 4 weeks of project initiation. Contractor shall verify the extents of these soil corrections with Engineer prior to initiating excavation. No additional compensation will be provided without Engineer's approval.
   G. Handle surplus material following filling as specified above.
   H. When excavating through roots, perform Work to limit root disturbance and cut exposed roots clean with sharp tool.
   I. Slope sides of excavations as required to provide stability and to comply with Federal, State, and local laws and regulations. Shore and brace excavation when required by Project conditions.
   J. Utilize cofferdams, steel sheet piling, shoring, underpinning, and other systems required to prevent damage to existing structures, settlement, slope stability problems, and undermining.
K. Remove construction related protection systems after use is complete, in manner that will not loosen or damage soils, create slope stability problems, and otherwise damage existing or new structures.

L. Leave construction related protection systems in place subject to approval of Engineer, when removal would create potential for damage to soil conditions or structures.

M. Excavate to required elevations and dimensions within specified tolerances and extending a sufficient distance as required to provide for Work, completion of structures, observation, and testing.

N. Do not disturb soil materials at and below excavation limits when excavating for structure foundations. Excavate by hand when necessary to prevent damage to subsoil material to remain.

O. Trim structure bottoms to required lines and grades to leave solid dense base of required bearing capacity.

P. Do not interfere with 2:1 (H:V) bearing splay of structural foundations, unless otherwise approved by Engineer.

Q. Excavation of unsuitable subsoil material encountered when establishing grade elevations shall be to depth recommended by Engineer or soils testing laboratory beneath structures to obtain design bearing capacity. Material to be considered Common Excavation.

R. Removal of materials beyond required subgrade elevations or dimensions without specific approval of Engineer or soils testing laboratory as well as filling, compaction, and remedial work recommended at over excavated area shall be at own expense.

S. Fill unauthorized excavation under structures and their components utilizing one of the following systems, and as acceptable to Engineer.
   1. Extend indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation.
   2. Install lean concrete fill to bring elevations to required position.
   3. Fill and compact unauthorized excavations with soil materials and to density required by Engineer.

T. Elsewhere, fill and compact unauthorized excavations as indicated for authorized excavations of same classification.

U. Use of explosives for rock excavation, when applicable, is not permitted.

V. Rock excavation for construction of structural elements, when applicable, shall be to depth required to allow for proper construction of structure. All rock excavated shall be considered unsuitable subsoil material and removed from Site.

W. Dewater excavations as necessary for Performance of Work according to Section 31 2319 - Dewatering.

X. Grade top perimeter of excavation to prevent surface water from draining into excavation.

Y. Protect excavation bottoms from freezing. Remove frozen materials and provide unfrozen compacted materials acceptable to Engineer prior to placement of materials on them.

Z. Notify Engineer immediately of unexpected subsurface conditions and discontinue affected Work in area. Allow reasonable amount of time for Engineer to make assessment of conditions and determine alternate means of construction if necessary. As a minimum, Engineer shall be allowed one Working Day from time of notification to make assessment and determination of alternate Work without Contractor submittal of Change Proposal for adjustment in Contract Price or Contract Times.

3.05 FILLING AND COMPACTING

A. Remove all topsoil and unsuitable subsoil material to satisfaction of Engineer prior to placing fill under structures and pavement areas.

B. Do not proceed with filling of excavations until completion of the following:
1. Acceptance by Engineer for construction of structures below finish grade.
2. Observation, testing, approval, and recording of locations of underground utilities.
4. Removal of shoring, bracing, other protection systems, and backfilling and compaction of voids left by their removals.
5. Removal of unsuitable subsoil materials, construction related debris, and excess materials.

C. Employ placement methods that do not disturb or damage other Work.
D. Fill to subgrade elevation within specified tolerances unless otherwise indicated.
E. Do not place fill on muddy surfaces, frozen ground, or on materials containing frost or ice.
F. Do not place fill on or in water.
G. Verify ability of structures to support loads imposed by fill.
H. Provide fill for specific locations and compact as specified:
   1. Use select granular borrow unless otherwise specified or indicated.
I. Place fill materials in compacted layers of thickness required to obtain specified soil densities.
J. Limit fill layer thickness to 8-in. in loose depth for material compacted by heavy compaction equipment, and 4-in. in loose depth for material compacted by hand operated tampers unless soil density tests substantiate specified densities will be obtained when material is placed in thicker lifts.
K. Place fill material in lifts uniformly to same approximate elevation, not exceeding final grade height, in manner required to prevent creation of unbalanced soil lateral pressures, wedging action of materials, soil pressures that exceed design lateral soil conditions, and damage to structures.
L. Scarify, mix, and compact upper 6-in. of pavement subgrade following grading, filling, and/or trenching Work.
M. Determine moisture content during compaction using test methods approved by Engineer.
N. Apply water or aerate each fill layer to extent required to obtain optimum moisture content required for indicated compaction density.
O. Maintain moisture content of pavement subgrade during compaction between 65% and 102% of optimum moisture content.
P. Prevent free water from appearing on surface during or subsequent to compaction operations.
Q. Remove and replace with acceptable fill material, or scarify and air dry otherwise acceptable subsoil material that is too wet to obtain specified soil density.
R. Assist drying by disking, harrowing, or pulverizing, until moisture content is reduced to value required for compaction.
S. Compact structural grading and fill Work to required density specified for each area classification.
T. Compact nonstructural grading and fill Work per CDOT 203 - Excavation and Embankment.
U. Hand tamp or utilize hand operated vibratory equipment when required to compact fill material placed immediately adjacent to structures.
V. Do not place additional fill layers until density of each layer in place complies with compaction requirements.

3.06 GRADING
   A. Prepare subgrade and topsoil per CDOT 207 and 212 prior to turf establishment Work.
   B. Rough grade areas adjacent to structures to drain away from structures and prevent ponding or increase in soil lateral pressure on structure.
   C. Uniformly grade areas of Project including adjacent transition areas to approximate contours of finished surface, and smooth surface within specified tolerances with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades.
D. Slope grade away from buildings at slope not less than 5% for minimum distance of 10-ft. in turf establishment areas, unless otherwise indicated on Drawings. Blend slope into level areas.

E. Positively drain all turf establishment areas to designated surface water collection points, streets, and/or waterways.

F. Verify subgrade has been contoured and compacted prior to finish grading.

G. Remove all construction debris prior to topsoil placement.

H. Perform subsoiling of subgrade to minimum depth of 6-in per CDOT 306 for turf establishment areas where subgrade has become compacted prior to topsoil placement, including the following locations:
   1. Where equipment has been operated in performance of Work including haul roads.
   2. Equipment and material staging and stockpiling areas.
   3. Infiltration areas.

I. Place stockpiled topsoil from Site, or import and place topsoil borrow type specified as necessary in turf establishment areas to minimum thickness of 6-in., unless otherwise indicated on Drawings.

J. Place topsoil during dry weather.

K. Spread topsoil by hand near plants and trees to prevent damage.

L. Prepare topsoil surface for turf establishment using cultivating equipment such as disks, harrows, field diggers, or tillers capable of loosening soil to minimum depth of 3-in. on all areas except for slopes steeper than 2:1 (H:V) to provide a smooth, moist, and evenly textured foundation.

M. Perform soil tracking of topsoil on slopes 2:1 (H:V) and steeper prior to turf establishment per CDOT 208.05(r).

N. Following soil loosening operations, work turf establishment areas to be seeded or sodded to provide surface free of lumps, and tillage ridges exceeding 1.5-in. Work turf establishment areas to be hydro seeded to provide surface free of lumps, and tillage ridges exceeding 3/4-in. Multiple passes of equipment may be necessary to meet these specifications.

O. Remove all rocks and debris from topsoil surface exceeding 1-in., except that lawn areas shall be raked free of rocks, clods, and debris exceeding 3/4-in.

3.07 TOLERANCES
   A. Top Surface of pavement subgrade: Plus 0.05-ft. to minus 0.10-ft. from Drawing elevation.
   B. Top Surface of turfed area subgrade: Plus or minus 0.10-ft. from Drawing elevation.
   C. Top Surface of turfed area finish grade: Plus or minus 0.10-ft. from Drawing elevation.
   D. Top Surface of concession stand subgrade: Plus or minus 6 inches of final grade as determined on the Drawings.

3.08 FIELD QUALITY CONTROL
   A. Coordinate for Owner's independent testing agency to perform visual inspection of load-bearing excavated surfaces before placement of structural foundations.
   B. Coordinate for Owner's independent testing agency to perform density testing per the following:
      1. Obtain samples for testing from material in place at locations and by methods approved by Engineer.
      2. Perform soil density tests per ASTM D698 (standard Proctor test) at not less than the following frequencies for indicated areas unless field conditions substantiate that frequency can be modified, and modification is approved by Engineer.
      3. Include in test reports project identification name and number, date of test, name of Contractor, name of testing laboratory, location of test including elevation, soil type, density obtained, and moisture content.
      4. Report verbal test results to Engineer and Contractor on same day tests are made.
5. Submit test reports to Engineer and Contractor as soon as available.
6. Soil density shall meet or exceed values specified above for fill at specific locations.

C. Coordinate for Engineer (or Owner's independent testing agency) to observe Contractor roll testing per the following:
   1. Provide tandem truck with maximum front axle tire width of 17-in., maximum rear axle tire width of 11-in., minimum tire pressure of 80-psi, minimum legal capacity of 52,000-lb., and minimum front axle capacity of 20,000-lb. Load truck such that front axle load is minimum of 16,000-lb., and total weight of truck and load is minimum of 50,000-lb. Weigh test roller at independent certified scale facility, and provide documentation to Engineer.
   2. Provide deflection measurement device approved by Engineer. Mount device over center of front axle and offset 12-in. from outside edge of each tire.
   3. Construct subgrade surface for test to within 4-in. of design cross section and profile, and free of marks, tracks, ruts, or ridges.
   4. Protect structures from damage caused by test roller.
   5. Test roll entire length and width of pavement subgrade in presence of Engineer at operating speed from 2.5-mph to 3.5-mph. Roll first pass with outside wheel at edge of test area, and offset subsequent passes with one wheel centered between wheel path of previous pass, until surface is covered at approximately 4-ft. interval between center of each pass.
   6. Engineer shall observe testing from behind roller, measure deflection using device on truck from top of unrolled surface to bottom of rut at time of rolling, and mark and record failing areas immediately.
   7. Subgrade deflection shall not exceed 0.6-in.

D. Perform corrective work on failing areas when test results indicate specified values where not attained.
E. Coordinate and pay for re-testing following corrective work. All subsequent Work placed before corrective work and passing retest constitutes Unauthorized Work.

### 3.09 CLEANING AND PROTECTION

A. Dispose of waste and excess soil material offsite and under conditions that are in accordance with Federal, State, and local laws and regulations at own cost.
B. Barricade open excavations occurring as part of this Work and post warning lights. Operate warning lights during hours of dusk to dawn each day and as otherwise required.
C. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.
D. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.
E. Repair disturbed areas and compact to required density prior to subsequent Work.
F. Protect areas that have been finish graded from subsequent construction operations, traffic, and erosion.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Work to provide all labor, materials, tools, and equipment necessary or incidental to shape, mix, and compact top of roadway and parking lot subgrade before placing base or surfacing layers as indicated in the Contract Documents excluding excavation or embankment Work necessary to obtain planned grades.

1.02 PAYMENT
A. All subgrade preparation Work outlined in the Contract Documents shall be included in the LUMP SUM contract price.

1.03 REFERENCE STANDARDS
A. CDOT Specification Section 306 - Reconditioning

1.04 DEFINITIONS
A. Soil Testing Laboratory: Refers to a professional geotechnical engineering firm with soil sampling and testing services that is independent from, but hired by Contractor. Soil testing laboratory's engineer shall be licensed in the State of Colorado.

1.05 SUBMITTALS
A. Field Test Reports:
   1. Soil Density Test Reports

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 EXAMINATION
A. Determine to own satisfaction of location and nature of surface and subsurface obstacles and the soil and water conditions that will be encountered during the Work.
B. Test borings and other exploratory operations may be made by Contractor at Contractor's expense. Make arrangements for soil investigation with Owner.
C. Make no claim for additional payments because of nature of the subsurface in which work of this Section is performed.
D. Make no claim for additional payments for repairs made to subgrade due to weather-related issues.

3.02 CONSTRUCTION REQUIREMENTS
A. Scarify, shape, and recompact upper 6 inches of subgrade following excavation and/or backfill work, to minimum 100 percent of standard maximum dry unit weight per ASTM D698 (standard Proctor test).
B. Maintain moisture content during compaction between 65 percent and 102 percent of optimum moisture content using test methods approved by Engineer.
C. Tolerance Top Surface of Subgrade: Plus 0.05-feet to minus 0.10-feet from Drawing elevations.
D. The building pad subgrade for the concession stand should be compacted and prepared to within 6 inches of final grade as part of this Contract.

END OF SECTION
SECTION 31 2316
EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Work to provide all labor, materials, tools, and equipment necessary or incidental to excavate, backfill, fill, grade, and compact the site as indicated in the Contract Documents.

1.02 PAYMENT
A. All excavation, backfill, and compaction Work outlined in the Contract Documents shall be included in the LUMP SUM contract price.
1. All earth, rock, peat, muck and all other excavation, removal and disposal required; sheeting, shoring and bracing; fill and backfill; placement, compaction, grading, source quality control testing and all other Work required under this Section shall be considered incidental to the Project and no claim for compensation or extra work will be accepted.
2. No claim for additional payment will be accepted for excavation and fill required for removal of unsuitable material of up to 1-foot below bottom of foundation, 1-foot below bottom of structural fill, or 1-foot below minimum excavation limit as noted on Drawings, whichever results in the greater excavation and fill.
3. Excavation and fill required for removal of unsuitable material deeper than the above limits will be paid for as Extra Work.

1.03 REFERENCE STANDARDS
A. CDOT Specification Section 203 - Excavation and Embankment.
B. CDOT Specification Section 212 - Seeding, Fertilizer, Soil Conditioner, and Sodding.
C. CDOT Specification Section 703 - Aggregates.

1.04 DEFINITIONS
A. Structures: Existing and new construction including slabs, buildings, pump stations, manholes, retaining walls, and structural elements and systems.
B. Soil Testing Laboratory: Refers to a professional geotechnical engineering firm with soil sampling and testing services that is independent from, but hired by Contractor. Soil testing laboratory's engineer shall be licensed in the State of Colorado.
C. Topsoil: Organic soil material, typically found at the top of soil horizon and black in color.

1.05 SUBMITTALS
A. Manufacturer's Certification: Certificate of compliance for all materials, supplies, and equipment provided.
B. Product Data: Information on manufactured products indicating compliance with requirements of this Section.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Stockpile delivered and excavated material at location approved by Owner until required for backfill or fill. Place, grade, and shape stockpile for drainage.
B. Store materials in manner that will not impose additional loading and soil pressure on excavation limits or structures.

PART 2 PRODUCTS

2.01 MATERIALS
A. Excavated materials will be classified for reuse as being either Suitable or Unsuitable for backfill or other specified use, subject to selective controls.
1. Suitable Materials: Material that will provide for indicated soil bearing capacity, soil densities, material requirements and that, in the opinion of soil testing laboratory, will not be subject to future decomposition, settlement, subsidence, expansion, and are otherwise of the required soil type.
2. Unsuitable Material: Material that will not provide for indicated soil bearing capacity and soil densities and that in the opinion of the soil testing laboratory will be subject to future decomposition, settlement, subsidence, expansion, and are otherwise not of the required soil type, as well as material that exceeds 1 cubic yard in volume, cannot be re-used within the project limits, and in the opinion of Engineer requires special means for handling and disposal including but are not limited to organic soils, rubble, wood debris, boulder stone, masonry, concrete fragments, and metals.

3. Excavated material will be classified for payment only when specifically provided in the Contract Documents according to the following classifications:
   a. Common Excavation: Material not classified as rock excavation, but excluding stripped topsoil material.
   b. Rock Excavation: Material that requires drilling, or ripping before excavation. This includes boulders and other detached rock larger than 1 cu. yd.

4. All suitable materials shall be reserved for backfill and grading work to extent needed, and any surplus remaining shall be utilized for other construction on the project as may be specified or ordered by Engineer.

B. Utility Excavation:
   1. Granular material furnished for foundation, bedding, encasement, backfill, or other utility construction purposes as may be specified shall consist of any natural or synthetic mineral aggregate such as sand, gravel, crushed rock, crushed stone, or slag that shall be so graded as to meet gradation requirements specified herein for each particular use by material manufacturer or as indicated in the Contract Documents.

   2. Foundation:
      a. Material placed 6 inches or greater below bottom of pipe grade as recommended by Engineer or soils testing laboratory as replacement for unsuitable or unstable soils, to achieve improved foundation support.
      b. Shall have 100% by weight passing 1-1/2" sieve and a maximum of 10% by weight passing No. 4 sieve. Not less than 50% of material by weight that is retained on the No. 4 sieve shall have 1 or more crushed faces. Hard, durable crushed carbonate quarry rock may be used.

   3. Bedding:
      a. Material placed below pipe springline, prior to pipe installation, to facilitate proper shaping and to achieve uniform pipe support. For flexible pipe installation, placed below pipe springline to a point six inches below bottom of pipe or twenty five percent of diameter below pipe, whichever is greater.
      b. Shall meet the requirements of CDOT Specification 703, Aggregates, except that 100% by weight shall pass the 1-inch sieve.

   4. Encasement:
      a. Material placed from an elevation one foot above top of pipe to pipe springline, after pipe installation, for protection of pipe and to assure proper filling of voids or thorough consolidation of backfill.
      b. Shall meet requirements of CDOT Specification 703, Aggregates, except that 100% by weight shall pass 1-inch sieve.

   5. Backfill:
      a. Material placed below pavement base course, or below topsoil in areas to receive turf, to an elevation one foot above top of pipe at top of encasement material, as the second stage of backfill, to minimize trench settlement and provide support for surface improvements.
      b. Shall consist of suitable existing trench materials, except as otherwise specified in the Special Provisions. Suitable material shall include mineral soil free of foreign materials (rubbish, organics, and debris), frozen clumps, oversize stone, rock, concrete or bituminous chunks, and other unsuitable material that may damage pipe, prevent thorough compaction, or increase risk of settlement.

   6. Coarse Filter Aggregate:
a. Material placed from an elevation one foot above top of pipe to six inches below bottom of pipe for pipe support and protection, and to help facilitate proper subsoil drainage.
b. Shall meet requirements of CDOT Specification 703, Aggregates.

C. Site Grading and Structural Fill:
   1. Per CDOT Specification Section 203 - Excavation and Embankment.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Determine to own satisfaction of location and nature of surface and subsurface obstacles and the soil and water conditions that will be encountered during the Work.
   B. Test borings and other exploratory operations may be made by Contractor at Contractor's expense. Make arrangements for soil investigation with Owner.
   C. Make no claim for additional payments because of nature of the subsurface in which work of this Section is performed.
   D. Make no claim for additional payments for repairs made to subgrade due to weather-related issues.

3.02 PREPARATION
   A. Ensure all proper permits are acquired prior to excavation; particular attention shall be paid to any work in areas designated as wetlands.
   B. Verify that survey bench marks and intended elevations for the Work are as indicated.
   C. Identify required lines, levels, contours, and datum.
   D. Stake and flag locations of known utilities.
   E. Locate, identify, and protect from damage above- and below-grade utilities to remain.
   F. Notify utility company to remove and relocate utilities if necessary.
   G. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, except when allowed by utility owner and then only after acceptable temporary utility services have been provided.
      1. Provide temporary services, complying with Federal, State, and local laws and regulations, and as acceptable to Owner, during any interruptions.
   H. Protect site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs, from lateral movement, settlement, undermining, washout, and other undesirable conditions created by the Work.
   I. Maintain full access to project exits and entrances, fire hydrants, street crossings, sidewalks, and other points as designated by Owner to prevent significant interruption of accessibility.
   J. Maintain existing site drainage ways or provide new paths of drainage as required to perform earthwork.
   K. Protect trees to remain by providing substantial fencing around entire tree at outer tips of its branches; no grading is to be performed inside this line.
   L. Protect plants, lawns, and other features to remain as a portion of final landscaping.

3.03 SOIL REMOVAL AND SALVAGE FOR EXCAVATION AND GRADING
   A. Stockpile topsoil to be re-used on site; excess shall be removed from site.
   B. Stockpile subsoil to be re-used on site; excess shall be removed from site.
   C. Remove unsuitable material from site.
   D. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.
3.04 EXCAVATION

A. Segregate suitable material, granular material, and topsoil from other materials and stockpile to extent practicable during excavation operations so as to permit best use of available materials at time of backfilling.

B. Unless otherwise specified in the Contract Documents, material handling as described above shall be considered incidental with no additional compensation provided.

C. Slope sides of excavations as required to provide stability and to comply with Federal, State, and local laws and regulations. Shore and brace excavation when required by project conditions.

D. Utilize cofferdams, steel sheet piling, shoring, underpinning, and other systems required to prevent damage to existing structures, settlement, slope stability problems, and undermining.

E. Remove construction related protection systems after their need is complete, in a manner that will not loosen or damage soils, create slope stability problems, and otherwise damage existing or new structures.

F. Leave construction related protection systems in place subject to approval of Engineer, when removal would create potential for damage to soil conditions or structures.

G. Excavate to required elevations and dimensions within a tolerance of plus or minus 0.10-ft. and extending a sufficient distance as required to provide for the Work, completion of the structures, observation, and testing.

H. When excavating for utility and structure foundations, do not disturb soil materials at and below excavation limits. Excavate by hand when necessary to prevent damage to soil materials that will remain.

I. Trim utility and structure bottoms to required lines and grades to leave solid dense base of required bearing capacity.

J. Use of explosives for rock excavation is not permitted.

K. Rock excavation for utility construction shall be to a depth of 6-inches below required invert elevation of pipe to allow for placement of specified bedding materials. All rock excavated shall be removed from site.

L. Excavation of unsuitable material encountered when establishing grade elevations shall be to depth recommended by Engineer or soils testing laboratory beneath utilities and structures to obtain design bearing capacity. Material to be considered Common Excavation.

M. Removal of materials beyond required subgrade elevations or dimensions without specific approval of Engineer or soils testing laboratory as well as backfilling, compaction, and remedial work recommended at over excavated area shall be at Contractor's expense.

N. Fill unauthorized excavation under structures and their components utilizing one of the following systems, and as acceptable to Engineer.
   1. Extend indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation.
   2. Install lean concrete fill to bring elevations to required position.
   3. Fill and compact unauthorized excavations with soil materials and to density required by Engineer.

O. Elsewhere, backfill and compact unauthorized excavations as indicated for authorized excavations of the same classification.

P. Dewater excavations for observation of excavation limits by soils testing laboratory.

Q. Grade top perimeter of excavation to prevent surface water from draining into excavation.

R. Protect excavation bottoms from freezing. Remove frozen materials and provide unfrozen compacted materials acceptable to Engineer prior to placement of materials on them.
3.05 FILLING, BACKFILLING, AND COMPACTING

A. Remove all topsoil and organic material to satisfaction of Engineer prior to placing fill or embankment under structures and paved areas.
B. Do not place fill required below structures until soil conditions encountered have been approved by Engineer.
C. Do not place material on muddy surfaces, frozen ground, or on materials containing frost or ice.
D. Do not place material on or in water.
E. Do not proceed with backfilling of excavations until completion of the following:
   1. Acceptance by Engineer for construction of structures below finish grade.
   2. Observation, testing, approval, and recording of locations of underground utilities.
   4. Removal of shoring, bracing, other protection systems, and backfilling and compaction of voids left by their removals.
   5. Removal of unsuitable materials, construction related debris, and excess materials.
F. When existing in-place soil materials are of density less than that specified, but the soil material is acceptable to Engineer, perform removal, filling, diskng of ground surface, moisture-conditioning to the optimum moisture content, and compact to provide specified density and bearing capacity as recommended by soils testing laboratory and acceptable to Engineer.
G. Placement and Compaction:
   1. Place materials in compacted layers of thickness required to obtain specified soil densities.
   2. Layers shall not exceed 8-inches in loose depth for material compacted by heavy compaction equipment and not more than 4-inches in loose depth for material compacted by hand operated tampers unless soil density tests substantiate specified densities will be obtained when material is placed in thicker lifts.
   3. Place material in lifts uniformly to the same approximate elevation, not exceeding final grade height, in manner required to prevent creation of unbalanced soil lateral pressures, wedging action of materials and soil pressures that exceed the design lateral soil conditions and to prevent damage to the structure.
   4. Moisture or aerate each layer to the extent required to obtain optimum moisture content required for indicated compaction density.
H. Prevent free water from appearing on surface during or subsequent to compaction operations.
I. Remove and replace with acceptable material, or scarify and air dry otherwise acceptable soil materials that is too wet to obtain specified soil density.
J. Assist drying by diskng, harrowing, or pulverizing, until moisture content is reduced to value required for compaction.
K. Compact each layer to required density specified for each area classification.
L. Hand tamp or utilize hand operated vibratory equipment when required to compact material placed immediately adjacent to structures.
M. Do not place additional fill layers until density of each layer in place complies with compaction requirements.

3.06 GRADING

A. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas to approximate contour of the finished surface. Smooth finished surface within specified tolerances with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.
B. Tolerance Top Surface of General Grading: Plus or minus 0.1 feet from plan elevations.
C. Tolerance Top Surface of Grading Under Building Slabs and Under Paved Areas: Plus or minus 0.05 feet from plan elevations.
D. Rough grade areas adjacent to structures to drain away from structures and to prevent ponding or increase in soil lateral pressure on the structure.

E. The subgrade shall be loosened with a disc or harrow to a depth of six inches prior to application of topsoil.

F. All construction debris shall be removed prior to topsoil placement.

G. Topsoil shall be imported as necessary to provide a minimum thickness of 6-inches, or more as detailed on Drawings.

3.07 TOPSOIL PREPARATION

A. Prepare topsoil surface for turf establishment by using cultivating equipment such as disks, harrows, field diggers, or tillers capable of loosening soil to a depth of at least 3-inches on all areas except for slopes steeper than 2:1 (H:V) to provide a smooth, moist, and evenly textured foundation.

B. Following soil loosening operations, work turf establishment areas to provide a surface free of soil clods, lumps, and tillage ridges. Multiple passes of equipment may be necessary to meet these specifications.

C. Remove all rocks and debris from topsoil surface exceeding 1-inch, except that lawn areas shall be raked free of rocks, clods, and debris exceeding 3/4-inch.

3.08 FILL AT SPECIFIC LOCATIONS

A. Use select granular borrow unless otherwise specified or indicated.

B. Footing, Foundation, and Slab Fill:
   1. Use Fill Type Select Granular Borrow.
   2. Fill to subgrade elevation.
   3. Compact to minimum 98 percent of the standard maximum dry unit weight per ASTM D698 (standard Proctor test).

C. Exterior Foundation Wall Fill:
   1. Use Fill Type Select Granular Borrow.
   2. Fill to 1 foot below subgrade elevation and cap with 1 foot layer of compacted clay sloped to provide positive surface drainage away from structure.
   3. Compact to minimum 95 percent of the standard maximum dry unit weight per ASTM D698 (standard Proctor test).
   4. Do not backfill against unsupported foundation walls.
   5. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.

D. Subsurface Drainage Piping Fill at Foundation Perimeter, Under Slabs, and under Pavements:
   1. Use Fill Type Coarse Filter Aggregate.
   2. Cover with Fill Type Select Granular Borrow.
   3. Fill to subgrade elevation.
   4. Compact to minimum 95 percent of the standard maximum dry unit weight per ASTM D698 (standard Proctor test).

E. Buried Utility Piping Fill in Trenches:
   1. Bedding: Use Fill Type Bedding.
   2. Encasement: Use Fill Type Encasement.
   3. Cover with Fill Type Backfill.
   4. Fill to subgrade elevation.
   5. Compact to minimum 95 percent of the standard maximum dry unit weight per ASTM D698 (standard Proctor test).

F. Site Grading Fill and Embankment:
   1. Use Fill Type Common Borrow as is available on site, otherwise use Fill Type Select Granular Borrow.
   2. Fill to subgrade elevation.
3. Under structures compact to minimum 100 percent of standard maximum dry unit weight per ASTM D698 (standard Proctor test).
4. In upper 3-feet under pavement subgrade compact to minimum 100 percent of standard maximum dry unit weight per ASTM D698 (standard Proctor test).
5. In areas not indicated above compact to minimum 95 percent of standard maximum dry unit weight per ASTM D698 (standard Proctor test).

G. Turf Establishment Areas:
1. Use Fill Type Topsoil (unless specified on the plans).
2. Fill up to finished elevation.
3. Compact loosely to facilitate turf establishment.

3.09 SOURCE QUALITY CONTROL
A. Soil testing laboratory shall perform indicated Source Quality Control tests indicated, and submit test reports to Engineer and Contractor per the following:
1. Provide one (1) gradation test per 10,000 cubic yards (CV) of select granular borrow used as site grading and structural fill.
2. Provide one (1) gradation test per source of each aggregate material used as utility foundation, bedding, or encasement.

B. Obtain samples for testing from material in stock at locations and by methods approved by Engineer.
C. Arrange for re-testing of material failing a test, or provide alternate acceptable material as necessary to satisfy Engineer that requirements are met.

3.10 FIELD QUALITY CONTROL
A. Perform general grading and nonstructural embankment Work in accordance with CDOT Specification Section 203 - Excavation and Embankment.
B. Arrange for visual inspection of load-bearing excavated surfaces by soil testing laboratory before placement of foundations.
C. Soil testing laboratory shall perform indicated Field Quality Control tests in the indicated locations per ASTM D698 (standard Proctor test), and submit test reports to Engineer and Contractor per the following:
1. Inspect and approve excavation limits, subgrades, and filled and compacted layers before further Work is performed thereon.
2. Report verbal test results to Engineer and Contractor on same day soil density tests are made.
3. Report written test results to Engineer and Contractor within 24-hrs from when soil density tests are made.
4. Include in reports of soil density tests project identification name and number, date of test, name of Contractor, name of testing laboratory, location of test including elevation, soil type, and density obtained.
D. Obtain samples for testing from material in place at locations and by methods approved by Engineer.
E. Soil testing laboratory shall perform additional tests when test results indicate required density has not been obtained. Perform corrective work as required to obtain required density.
1. Cost associated with corrective work and required retesting at failed test locations shall be at Contractor's expense.
F. Do not place additional layers until required density in each layer has been obtained. If tests indicate work does not meet specified requirements, remove work, replace and retest.

3.11 PROTECTION AND CLEANING
A. Barricade open excavations occurring as part of this work and post warning lights. Operate warning lights during hours of dusk to dawn each day and as otherwise required.
B. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.
C. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.
D. Protect areas that have been finish graded from subsequent construction operations, traffic, and erosion.
E. Protect infiltration areas and rain gardens from compaction, subsequent construction operations, traffic, and erosion.
F. Protect infiltration areas and rain gardens from compaction, subsequent construction operations, traffic, and erosion.
G. Dispose of waste and excess soil material offsite and under conditions that are in accordance with Federal, State, and local laws and regulations at no additional cost to Owner.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES

A. Work to provide all labor, materials, tools, and equipment necessary or incidental to trench, backfill, and compact Site for underground utilities as indicated in Contract Documents.

1.02  PRICE AND PAYMENT PROCEDURES

A. All removal and disposal required; sheeting, shoring and bracing; source quality control testing and other Work required under this Section shall be considered incidental to Project and no claim for compensation or extra work will be accepted.

B. No claim for additional payment will be accepted for excavation and fill required for removal of unsuitable material of up to 12-in. below bottom of foundation, 12-in. below bottom of structural fill, or 12-in. below minimum excavation limit indicated on Drawings, whichever results in greater excavation and fill.

C. Excavation and fill required for removal of unsuitable material deeper than above limits will be paid for as Extra Work.

1.03  DEFINITIONS

A. Structure: Existing and new man-made features including, but not limited to buildings foundations, slabs, pump stations, manholes, catch basins, drop inlets, retaining walls, and other structural elements and systems.

B. Topsoil: Organic soil material, typically found at top of soil horizon and black in color.

C. Rock Excavation: Material including hard, solid rock in ledge formation, bedded deposits and unstratified masses; all natural conglomerate deposits so firmly cemented as to present all characteristics of solid rock; and any boulder stone, masonry or concrete fragments exceeding 1-cu.yd. in volume that requires drilling, or ripping before excavation. Material such as shale, hard pan, soft or disintegrated rock which can be dislodged with a hand pick or removed with a power operated excavator are not classified as Rock Excavation.

D. Suitable Subsoil Material: Excavated material that will provide for indicated soil bearing capacity, soil densities, material requirements and that, in opinion of soil testing laboratory, will not be subject to future decomposition, settlement, subsidence, expansion, and are otherwise of required soil type.

E. Unsuitable Subsoil Material: Excavated material that will not provide for indicated soil bearing capacity and soil densities and that in opinion of soil testing laboratory will be subject to future decomposition, settlement, subsidence, expansion, and are otherwise not of required soil type, as well as material that exceeds 1-cu.yd. in volume, cannot be re-used within project limits, and in opinion of Engineer requires special means for handling and disposal including but are not limited to organic soils, rubble, wood debris, boulder stone, masonry, concrete fragments, and metals.

1.04  REFERENCE STANDARDS

A. CDOT Specification Section 206 - Excavation and Backfill for Structures.

1.05  SUBMITTALS

A. Manufacturer's Certification: Certificate of compliance for all materials, supplies, and equipment provided.

B. Lab Test Reports: As specified; include source of each material tested and date sampled.
   1. Gradation

1.06  DELIVERY, STORAGE, AND HANDLING

A. Stockpiles:
   1. Place material on Site at location approved by Owner until required for incorporation into Work.
2. Locate to limit additional loading or soil pressure on Site excavations and structures.
3. Place, grade, and shape for proper drainage.
4. Limit depth not to exceed 8-ft.
5. Separate differing materials with dividers or stockpile separately to prevent intermixing.
6. Prevent material contamination.
7. Protect from erosion and deterioration of materials.

1.07 WARRANTY

A. Correct defective Work within correction period after Date of Substantial Completion.
   1. Assume full responsibility and expense for all settlement, and refill and restore Work as directed to maintain an acceptable surface condition regardless of location.
   2. Settlement of pavement areas in excess of 1-in., as measured by a 10-ft. straight edge shall be considered failure of mechanical compaction.

PART 2 PRODUCTS

2.01 MATERIALS

A. Granular material for foundation, bedding, encasement, backfill, or other utility construction purposes as may be specified shall consist of any natural or synthetic mineral aggregate such as sand, gravel, crushed rock, crushed stone, or slag that shall be so graded as to meet gradation requirements specified herein for each particular use by material manufacturer or as indicated in Contract Documents.

B. Foundation:
   1. Material placed below bottom of pipe grade as recommended by Engineer or soils testing laboratory as replacement for unsuitable or unstable subsoils, to achieve improved foundation support.
   2. Shall have 100% by weight passing 1.5-in. sieve and a maximum of 10% by weight passing No. 4 sieve. Not less than 50% of material by weight that is retained on No. 4 sieve shall have 1 or more crushed faces. Hard, durable crushed carbonate quarry rock may be used.

C. Bedding:
   1. Material placed below pipe springline, prior to pipe installation, to facilitate proper shaping and to achieve uniform pipe support. For flexible pipe installation, placed below pipe springline to a point 6-in. below bottom of pipe or 25% of diameter below pipe, whichever is greater.
   2. Shall meet requirements of CDOT Specification 703, Aggregates, except that 100% by weight shall pass 1-in. sieve.

D. Encasement:
   1. Material placed from an elevation 12-in. above top of pipe to pipe springline, after pipe installation, for protection of pipe and to assure proper filling of voids or thorough consolidation of backfill.
   2. Shall meet requirements of CDOT Specification 703, Aggregates, except that 100% by weight shall pass 1-in. sieve.

E. Backfill:
   1. Material placed below pavement base course, or below topsoil in turf establishment areas, to an elevation 12-in. above top of pipe at top of encasement material, as second stage of backfill, to minimize trench settlement and provide support for surface improvements.
   2. Shall consist of suitable existing trench subsoil materials, except as otherwise specified in Contract Documents. Suitable subsoil material shall include mineral soil free of foreign materials (rubbish, organics, and debris), frozen clumps, oversize stone, rock, concrete or bituminous chunks, and other unsuitable material that may damage pipe, prevent thorough compaction, or increase risk of settlement.

F. Coarse Fill Aggregate:
   1. Material placed from an elevation 12-in. above top of pipe to 6-in. below bottom of pipe for pipe support and protection, and to help facilitate proper subsoil drainage.
2. Shall meet requirements of CDOT Specification 703, Aggregates.

2.02 SOURCE QUALITY CONTROL
A. Coordinate and pay for independent testing agency to perform Source Quality Control tests, and submit test reports to Engineer and Contractor per the following.
   1. Obtain samples for testing from material in stock at locations and by methods approved by Engineer.
   2. Provide 1 gradation test of each aggregate material used as utility foundation, bedding, or encasement.
   3. Perform tests no more than 90 calendar days before Notice of Award.
B. Coordinate and pay to re-test material failing a test, or provide alternate acceptable material as necessary to satisfy Engineer that requirements are met.

PART 3 EXECUTION
3.01 EXAMINATION
A. Determine to own satisfaction of location and nature of surface and subsurface obstacles and soil and water conditions that will be encountered during Work.
   1. Test borings and other exploratory operations may be made by Contractor at own expense to make such determinations.
   2. Make arrangements for soil investigations with Owner when applicable.
   3. Claims for additional payment due of nature of subsurface in which Work of this Section is performed, or for repairs made to subgrade related to weather will not be permitted.
B. Verify that survey bench marks and intended elevations for Work are as indicated.

3.02 PREPARATION
A. Refer to Section 31 2200 - Grading for additional requirements pertaining to excavating, filling, and grading Work.
B. Identify required lines, levels, contours, and datum.
C. Stake and flag locations of known utilities.
D. Locate, identify, and protect from damage above- and below-grade utilities to remain.
E. Notify utility company to remove and relocate utilities if necessary.
F. Prevent interruption of existing utilities serving facilities occupied and used by Owner or others, except when allowed by utility owner and then only after acceptable temporary utility services have been provided.
   1. Provide temporary services, complying with Federal, State, and local laws and regulations, and as acceptable to Owner, during any interruptions.
G. Protect site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs, from lateral movement, settlement, undermining, washout, and other undesirable conditions created by Work.
H. Maintain full access to project exits and entrances, fire hydrants, street crossings, sidewalks, and other points as designated by Owner to prevent significant interruption of accessibility.
I. Maintain existing site drainage ways or provide new paths of drainage as required to perform Work.
J. Protect trees, plants, lawns, and other features to remain as a portion of final landscaping by providing substantial fencing around area. Place fencing for trees at outer drip line of branches; no grading is to be performed inside drip line.

3.03 SOIL REMOVAL AND STOCKPILING
A. Stockpile excavated topsoil for re-used on Site; remove excess from Site.
B. Stockpile excavated suitable subsoil material for re-used on Site; remove excess from Site.
C. Remove excavated unsuitable subsoil material from Site.
3.04 TRENCHING

A. Remove topsoil from utility trench area, without mixing with foreign materials.
B. Do not remove topsoil when wet.
C. Remove subsoil from utility trench area.
D. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.
E. Reserve and segregate all suitable subsoil material, granular material, and topsoil from other materials and stockpile to extent practicable during excavation operations to permit best use of available materials at time of filling. Handle material as described incidental to Project with no additional compensation provided unless otherwise specified in Contract Documents.
F. Handle surplus material following filling as specified above.
G. When trenching through roots, perform Work to limit root disturbance and cut exposed roots clean with sharp tool.
H. Slope sides of trenches as required to provide stability and to comply with Federal, State, and local laws and regulations. Shore and brace trenches when required by Project conditions.
I. Utilize cofferdams, steel sheet piling, shoring, underpinning, and other systems required to prevent damage to existing utilities and structures, settlement, slope stability problems, and undermining.
J. Remove construction related protection systems after use is complete, in manner that will not loosen or damage soils, create slope stability problems, and otherwise damage existing or new utilities and structures.
K. Leave construction related protection systems in place subject to approval of Engineer, when removal would create potential for damage to soil conditions, utilities, or structures.
L. Cut trench meeting the following requirements for locations where cover over top of utility pipe will exceed 15-ft.:
   1. For portion of trench below point 12-in. above top of pipe, provide nearly vertical side slopes.
   2. Excavate trench bottom width sufficient to allow for inspection of installation, and proper compaction of encasement material.
   3. Excavate trench bottom for utility pipes of diameter less than 42-in. to maximum width of outside utility pipe diameter plus 24-in.
   4. Excavate trench bottom for utility pipes of diameter from 42-in. to 54-in. to maximum width of 1.5 times outside diameter of utility pipe.
   5. Excavate trench bottom for utility pipes of diameter greater than 54-in. to maximum width of outside utility pipe diameter plus 36-in.
M. Provide higher class of bedding, higher strength pipe, or both as directed by Engineer at own expense if maximum trench widths above are exceeded.
N. Do not disturb soil materials at or below utility bedding limits. Trench by hand when necessary to prevent damage to subsoil material to remain.
O. Do not interfere with 2:1 (H:V) bearing splay of structural foundations, unless otherwise approved by Engineer.
P. Trim utility bottoms to required lines and grades to leave solid dense base of required bearing capacity.
Q. Trenching of unsuitable subsoil material encountered when establishing grade elevations shall be to depth recommended by Engineer or soils testing laboratory beneath utilities to obtain design bearing capacity. Material excavation and handling to be considered incidental to foundation.
R. Removal of materials beyond required subgrade elevations or dimensions without specific approval of Engineer or soils testing laboratory as well as filling, compaction, and remedial work recommended at over excavated area shall be at own expense.

S. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.

T. Use of explosives for rock excavation, when applicable, is not permitted.

U. Rock excavation for construction of utilities, when applicable, shall be to depth 6-in. below required invert elevation of utility to allow for placement of specified bedding materials. All rock excavated shall be considered unsuitable subsoil material and removed from Site.

V. Dewater trenches as necessary for Performance of Work according to Section 31 2319 - Dewatering.

W. Grade top perimeter of trenches to prevent surface water from draining into trench.

X. Notify Engineer immediately of unexpected subsurface conditions and discontinue affected Work in area. Allow reasonable amount of time for Engineer to make assessment of conditions and determine alternate means of construction if necessary. As a minimum, Engineer shall be allowed one Working Day from time of notification to make assessment and determination of alternate Work without submitting a Change Proposal for adjustment in Contract Price or Contract Times.

Y. Maintain trenches and prevent loose soil from falling into trench until ready to backfill.

3.05 BACKFILLING AND COMPACTING

A. Do not proceed with backfilling of trenches until completion of the following:
   1. Observation, testing, approval, and recording of locations of underground utilities.
   2. Removal of shoring, bracing, other protection systems, and backfilling and compaction of voids left by their removals.

B. Employ placement methods that do not disturb or damage other Work.

C. Backfill to subgrade elevation within specified tolerances unless otherwise indicated.

D. Do not place backfill on muddy surfaces, frozen ground, or on materials containing frost or ice.

E. Do not place backfill on or in water.

F. Verify ability of structures to support loads imposed by backfill.

G. Backfill all trenches by end of Working Day unless another method of protecting trench while Work is not being performed is approved by Engineer.

H. Placement and Compaction:
   1. Place backfill materials in compacted layers of thickness required to obtain specified soil densities.
   2. Limit backfill layer thickness to 8-in. in loose depth for material compacted by heavy compaction equipment, and 4-in. in loose depth for material compacted by hand operated tampers unless soil density tests substantiate specified densities will be obtained when material is placed in thicker lifts.
   3. Place backfill material in lifts uniformly to same approximate elevation, not exceeding final grade height, in manner required to prevent creation of unbalanced soil lateral pressures, wedging action of materials, soil pressures that exceed design lateral soil conditions, and damage to structures.
   4. Apply water or aerate each backfill layer to extent required to obtain optimum moisture content required for indicated compaction density.

I. Prevent free water from appearing on surface during or subsequent to compaction operations.

J. Maintain optimum moisture content of backfill materials to attain required compaction density.

K. Compact each backfill layer to required density specified for each area classification.
L. Hand tamp or utilize hand operated vibratory equipment when required to compact backfill material placed immediately adjacent to structures.

M. Do not place additional fill layers until density of each layer in place complies with compaction requirements.

N. Compact backfill to minimum 100% of maximum dry unit weight per ASTM D698 (standard Proctor test) in upper 3-ft. under pavement subgrade.

O. Compact backfill to minimum 95% of maximum dry unit weight per ASTM D698 (standard Proctor test) in areas not indicated above.

3.06 TOLERANCES
A. Top Surface of pavement subgrade: Plus 0.05-ft. to minus 0.10-ft. from Drawing elevation.
B. Top Surface of building slab subgrade: Plus or minus 0.05-ft. from Drawing elevation.
C. Top Surface of turfed area subgrade: Plus or minus 0.10-ft. from Drawing elevation.
D. Top Surface of turfed area finish grade: Plus or minus 0.10-ft. from Drawing elevation.

3.07 FIELD QUALITY CONTROL
A. Coordinate for Owner's independent testing agency to perform density testing per the following:
   1. Obtain samples for testing from material in place at locations and by methods approved by Engineer.
   2. Perform soil density tests per ASTM D698 (standard Proctor test) at not less than the following frequencies for indicated areas unless field conditions substantiate that frequency can be modified, and modification is approved by Engineer.
   3. Include in test reports project identification name and number, date of test, name of Contractor, name of testing laboratory, location of test including elevation, soil type, density obtained, and moisture content.
   4. Report verbal test results to Engineer and Contractor on same day tests are made.
   5. Submit test reports to Engineer and Contractor as soon as available.
   6. Soil density shall meet or exceed values specified above for backfill at specific locations.
B. Perform corrective work on failing areas when test results indicate specified values where not attained.
C. Coordinate and pay for re-testing following corrective work. All subsequent Work placed before corrective work and passing retest constitutes Unauthorized Work.

3.08 CLEANING AND PROTECTION
A. Dispose of waste and excess soil material offsite and under conditions that are in accordance with Federal, State, and local laws and regulations at own cost.
B. Barricade open trenches occurring as part of this Work and post warning lights. Operate warning lights during hours of dusk to dawn each day and as otherwise required.
C. Prevent displacement of banks and keep loose soil from falling into trenches; maintain soil stability.
D. Protect bottom of trenches from freezing.
E. Repair disturbed areas and compact to required density prior to subsequent Work.

END OF SECTION
SECTION 31 2319
DEWATERING

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Work to provide all labor, materials, tools, and equipment necessary or incidental to dewatering systems as necessary and indicated in the Contract Documents.

1.02  PAYMENT
A. All dewatering Work outlined in the Contract Documents shall be included in the LUMP SUM contract price.

1.03  PERFORMANCE REQUIREMENTS
A. Conduct excavation work in accordance with requirements of applicable governing authority having jurisdiction and Section 31 2316 - Excavation.
B. Secure all required permits for dewatering operations and additional hazard insurance as required. Cost of obtaining such permits and insurance shall be at Contractor's own expense.

PART 2  PRODUCTS - NOT USED

PART 3  EXECUTION

3.01  SCOPE
A. Design Requirements:
   1. Design dewatering system subject to requirements of this Section.
B. Performance Requirements:
   1. Dewatering systems shall provide for the following:
      a. Prevent flotation, uplift pressures, increased water pressures, and hydrostatic soil pressures, heaving, settlements, shifting, and related damage of existing or new structures, utilities, site items, and property.
      b. Maintain excavations free of water to the extent required for the Work and observations of these areas by the Engineer and soil testing laboratory.
      c. Prevent loss of soil material, boils, movement of fines, slope stability problems, undermining, and other disturbances to the existing soils and rock formations.
      d. Prevent surface water and dewatering discharge related damages.
      e. Coordinate with surface water control systems.
      f. Conform to applicable government regulations and accepted engineering and construction practice.

3.02  EXAMINATION
A. Examine Project site and conditions under which dewatering work is to be performed.

3.03  PREPARATION
A. Locate existing underground utilities in area of work. When utilities are to remain in place, provide adequate means of protection during dewatering operations.
B. Prevent interruption of existing utilities serving facilities occupied and used by Owner or others, except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided.
C. Consult Engineer immediately for direction as to procedure if uncharted or incorrectly charted piping or other utilities are encountered during dewatering operations. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities equal to the condition existing prior to the damage and as approved by utility owner.
D. Maintain full access to structure exits and entrances, fire hydrants, street crossings, sidewalks, and other points designated by Owner to prevent unacceptable interruption of accessibility.
3.04 PROTECTION
   A. Protect against damages caused by dewatering operations and damages caused by inadequate dewatering or water removal.
   B. Damages to new and existing work within the Project or on adjacent property caused by dewatering operations, flooding, groundwater, subsurface water, surface water and other damage caused by dewatering operations or failure to protect against damages shall be repaired at no additional cost to Owner.

3.05 APPLICATION
   A. Conduct dewatering operations so as to prevent groundwater, subsurface water, flooding, and surface water from flowing into excavations, backfill zones, and surrounding areas until excavation, backfilling, and compaction work is complete and until finished work and adjacent structures are safe from damage.
   B. Conduct dewatering operations continuously, without interruption, and take measures necessary including, but not limited to, providing standby equipment and constant monitoring to assure system remains operational and effective throughout dewatering period.
   C. Continue dewatering operations until each structure on project site is safe from damage, buoyancy, uplift, and increased hydraulic pressures or soil hydrostatic pressures which may develop as a result of the dewatering operations or when dewatering operations are reduced, interrupted, or stopped and until the following:
      1. Structures, structural elements, soils, equipment, and other systems that will be resisting buoyancy, uplift, soil hydrostatic pressures, and water pressures are complete, in place, and structural materials have achieved their specified design and 28-day compressive strengths.
   D. Shut off dewatering system at such rate to prevent quick upsurge of water, which may weaken underlying sub grade or surrounding soil.
   E. Maintain drainage where drainage ways are obstructed by dewatering operations.
   F. Prevent water accumulation in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades, foundations, and adjacent existing structures.
      1. Maintain pumps, well points, sumps, suction and discharge lines, temporary drainage ditches outside excavation limits, sheeting, and other dewatering systems and diversions necessary to convey water away from excavations, utilities, and adjacent structures.
   G. Do not use trench excavations as temporary drainage ditches.
   H. Provide detention, water quality, and discharge facilities for water from excavations and dewatering operations as required by Federal, State, and local laws and regulations before discharging.

END OF SECTION
SECTION 31 2500
EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work to provide all labor, materials, tools, and equipment necessary or incidental as indicated in the Contract Documents to:
   1. Prevent, control, minimize, or abate pollution of air, land and water.
   2. Prevent erosion.
   3. Prevent sedimentation of waterways, open drainage ways, and sewers.
   4. Manage storm water runoff and Project related discharges to prevent sediment pollution.
   5. Manage discharges associated with dewatering and basin draining activities.
   6. Restore areas eroded due to insufficient BMPs.
   7. Implement SWMP in compliance with the Contract Documents and the CDOT SWMP.
   8. Compensate Owner for fines levied by authorities having jurisdiction due to non-compliance by Contractor.

1.02 PAYMENT

A. All temporary storm water management and erosion and sediment control Work as outlined in the Contract Documents shall be included in the LUMP SUM contract price.

B. The furnishing and installing of specific items and/or the performance of work under certain circumstances shall not be individually paid. The costs shall be included in the lump sum bid for the project. Such items of Work include but are not limited to:
   1. Complying with CDOT SWMP, when applicable.
   2. Sweeping adjacent streets clean of excess soil.
   3. Cleaning out and maintaining installed BMPs and devices.
   4. Respraying deposited sediment from the cleaning of installed BMPs and devices.
   5. Removing and disposing of installed BMPs and devices when required.

1.03 REFERENCE STANDARDS

A. CDOT Specification Section 208 - Erosion Control.
B. CDOT SWMP
C. Urban Drainage and Flood Control District, Urban Storm Drainage Criteria Manual, Volume 3

1.04 DEFINITIONS

A. AES: Areas of Environmental Sensitivity.
C. NPDES: National Pollutant Discharge Elimination System.
E. UDFCD: Urban Drainage and Flood Control District.

1.05 PERFORMANCE REQUIREMENTS

A. Comply with all requirements of CDOT SWMP when operations disturb 1 acre or more of land area.
B. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until CDOT SWMP has been obtained when applicable; furnish Owner documentation required to obtain permit.
C. Owner shall:
   1. Develop a SWMP
2. Cosign CDOT SWMP as "Owner".
3. Comply with "owner" requirements of CDOT SWMP.
4. Withhold payment to Contractor equivalent to all fines resulting from non-compliance with applicable regulations.

D. Contractor shall:
1. Prepare and submit on-line CDOT SWMP application form as "operator" with appropriate fee paid by the Contractor and included in the bid.
2. Comply with "operator" requirements of CDOT SWMP.
3. Postpone all land disturbance Work on Site until 7 calendar days after Owner's on-line CDOT SWMP application form submittal.
4. Conduct inspections and maintain inspections/maintenance logs.
5. Maintain SWMP on site at all times (See CDOT website for more information: www.codot.gov).
6. Make SWMP and inspection records available to federal, state, and local officials within 72 hours upon request for duration of permit and for 3 years following NOT.
7. Submit NOT within 30 days of final stabilization.

E. Conduct operations to prevent, control and abate the pollution of air, land and water in accordance with adopted and established federal, state, and local rules, regulations and standards of the following as a minimum:
   1. Colorado Department of Transportation
   2. Urban Drainage and Flood Control District.
   3. City of Englewood

F. Comply with regulatory agencies for fertilizer and herbicide composition.

1.06 SUBMITTALS

A. Product Data: Provide manufacturer's data on BMPs and accessories.
B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
C. Preliminary Erosion and Sedimentation Control Plan:
   1. Submit not less than 2 weeks prior to anticipated start of clearing, grading, or other work involving disturbance of ground surface cover.
   2. Include:
      a. Site plan identifying soils and vegetation, existing erosion problems, and areas vulnerable to erosion due to topography, soils, vegetation, or drainage.
      b. Site plan showing grading; new improvements; temporary roads, traffic accesses, and other temporary construction; and proposed BMPs.
      c. Where extensive areas of soil will be disturbed, include storm water flow and volume calculations, soil loss predictions, and proposed BMPs.
      d. Preliminary schedule of BMPs, in relation to ground disturbing activities.
      e. Other information required by law.
      f. Format required by law is acceptable, provided any additional information specified is also included.
   3. Obtain approval of Plan by authorities having jurisdiction and Owner.
D. Erosion and Sedimentation Control Schedule:
   1. Submit weekly.
   2. Include:
      a. Proposed BMPs and timing of installation.
      b. Grading operations.
      c. Maintenance or repair required on BMPs.
      d. Proposed BMPs during periods of suspension of Work.
E. Water Treatment Plan: When applicable.
F. Inspection Reports:
1. Submit report of each inspection for Project closeout or more often as requested by Engineer.
2. Include condition of BMPs and required maintenance or repair.

G. Maintenance Instructions: Provide instructions covering inspection and maintenance for BMPs to remain after Substantial Completion.

**PART 2 PRODUCTS**

**2.01 MATERIALS**

A. Silt Fence:
   1. Per CDOT 208.02(b)
   2. Type Machine Sliced (MS) consisting of a woven geotextile fabric installed by machine and supported by steel posts.
      b. Posts: Metal "studded tee" T-post, 66 inch minimum length, minimum 0.95 inch wall thickness.
      c. Fasteners: Plastic zip ties with tensile strength of at least 50 lb.
   3. Type Pre-Assembled (PA) consisting of a woven geotextile fabric supported by wood posts pre-attached to the fabric.
      a. Fabric: CDOT 208.02(b) Specifications.
      b. Posts: 1.5 inch by 1.5 inch wood, 42 inch minimum length, spacing of 5 feet.

B. Sediment Control Log: CDOT 208.02(h).

C. Silt Berm: CDOT 208.02(e).

D. Vehicle Tracking Pad: CDOT 208.02(k).

E. Inlet Protection: CDOT 208.02(m)

**PART 3 EXECUTION**

**3.01 EROSION CONTROL SUPERVISOR**

A. Provide Erosion Control Supervisor with valid Colorado Construction Site Management certification, authorized to represent Contractor on matters pertaining to Erosion and Stormwater Management, Work in public waters, CDOT SWMP compliance, and available to the Site within 24 hours of initial disturbance and daily when work is taking place until final stabilization.

B. Duties of Erosion Control Supervisor include the following:
   1. Amend SWMP prior to beginning the Work to identifying Contractor's Erosion Control Supervisor as responsible party for implementation of SWMP.
   2. Implement SWMP until the Work is complete, entire Site has undergone Final Stabilization, and NOT has been submitted to CDOT.
   3. Ensure proper installation, functionality, and maintenance, clean-up, and removal of all erosion prevention and sediment control BMPs.
   4. Implement erosion and sediment control schedule.
   5. Coordinate Work of subcontractors and ensure full execution of BMPs for each operation and stage of Work.
   6. Oversee Work of subcontractors and ensure subcontractors undertake BMPs at each stage of the Work.
   7. Prepare required weekly erosion control schedule and inspections with dates and times.
   8. Attend construction meetings to discuss erosion control schedule and inspections.
   9. Prepare erosion and sediment control Site Management Plans as required by the Contract Documents or as directed by Engineer.
   10. Provide for BMPs for temporary work necessary, but not shown on the Drawings.
   11. Ensure effective BMPs are in place, recommend changes to SWMP for Engineer’s approval, and amend SWMP to document changes.
12. Ensure acquisition of and compliance with applicable permits for borrow pits, dewatering, and temporary work in rivers, lakes and streams.
13. Ensure full installation of BMPs before suspension of the Work.
14. Coordinate with federal, state, and local regulatory agencies on resolution of erosion and sediment control issues resulting from the Work.
15. Ensure that proper cleanup occurs from vehicle tracking on paved surface locations where sediment leaves the Site.
16. Ensure daily compliance with environmental laws, permits, and SWMP narrative requirement.

3.02 CERTIFIED INSTALLERS
A. Provide certified installer to install or direct installations of BMPs including the following:
   1. Silt fence or other perimeter sediment control device installations
B. Provide at least one installer with a valid Colorado Inspector or Installer Certification at time of installation.
C. Failure to provide required certified installer may result in Engineer rejecting the Work as unauthorized work in accordance with the Contract Documents.

3.03 SCOPE
A. Provide access for and cooperate with representatives of Owner and/or Engineer and meet any other requirements if so directed.
B. Examine the Site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.
C. Delineate areas of the Site not to be disturbed before Work begins.
D. Install BMPs down gradient before, or in conjunction with, soil disturbing activities.
E. Schedule Work to minimize amount of time disturbed soil surfaces are left exposed in accordance with CDOT SWMP requirements or more stringent requirements of local jurisdiction.
F. Provide and maintain BMPs as required by the Contract Documents and in accordance with permits required for the Work.
G. Adjust location of BMPs as necessary to maximize effectiveness of each device or measure.
H. Schedule and phase construction in and around AES, as shown on the Drawings to minimize potential of sediment entering into these areas. Use measures such as hand clearing and grubbing, limiting bare soil exposure time, expediting construction activities, and immediately establishing final vegetation to minimize sediment loss potential.
I. Provide erosion control and velocity dissipation BMPs within and along constructed stormwater channels to provide a non-erosive flow velocity, to minimize erosion of channels and embankments, outlets, adjacent stream banks, slopes, and downstream waters during discharge conditions.
J. Stabilize the normal wetted perimeter of any temporary or permanent drainage channel that drains water from any portion of the Site, or diverts water around the Site, within 200 lineal feet from the property edge, or from point of discharge into any surface water. Stabilization of last 200 lineal feet shall be completed within 24 hours of connecting to surface water or property edge.
K. Stabilize the remaining portions of any temporary or permanent drainage channels within 14 calendar days after connecting to surface water or property edge and Work in that portion of the channel has temporarily or permanently ceased.
L. Temporary or permanent drainage channels being used as sediment containment systems with properly designed ditch checks, bio rolls, silt dikes, etc. do not need to be stabilized during the temporary period of use as sediment containment system. Area shall be stabilized within 24 hours after removal of temporary sediment containment measures.
M. Application of mulch, hydromulch, tackifier, polyacrylamide or similar erosion prevention practices is not acceptable stabilization of any temporary or permanent drainage channel.

N. Provide temporary or permanent energy dissipation BMPs at pipe outlets within 24 hours of connecting to surface waters.

O. Direct discharges from BMPs to vegetated areas of the Site (including natural buffers) to increase sediment removal and maximize stormwater infiltration unless infeasible due to lack of pervious or vegetated areas.

P. Provide a water treatment plan for pumping or dewatering of turbid or sediment laden water. Submit water treatment plan to Engineer before pumping. Do not begin work until Engineer approves water treatment plan. Contractor may include use of sediment traps, vegetative filter strips, flocculants, or other water treatments in accordance with CDOT 2505.05(c), Contaminated Groundwater Disposal, in water treatment plan.

Q. Protect discharge location of any pumping or dewatering process from erosion. Unless otherwise required by the Contract Documents, provide and install BMPs to control erosion and suspend sediment during dewatering or pumping operation.

R. Recover sediment and restore property to pre-existing conditions at no additional cost to Owner when sediment loss from Site occurs.

S. In all cases, if permanent preventive measures have been installed, temporary BMPs are not required.

T. Storm Water Runoff:
   1. Control increased storm water runoff due to disturbance of surface cover due to construction activities.
   2. Prevent runoff into sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.
   3. Anticipate runoff volume due to most extreme short term rainfall events that might occur in 25 years.

U. Erosion On Site:
   1. Minimize wind, water, and vehicular erosion of soil on Site due to construction activities.
   2. Control movement of sediment from temporary soil stockpiles.
   3. Prevent development of ruts due to equipment and vehicular traffic.
   4. Restore eroded areas at no cost to Owner if erosion occurs due to non-compliance with these requirements.

V. Erosion Off Site:
   1. Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the Site due to construction activities.
   2. Prevent windblown soil from leaving the Site.
   3. Prevent tracking of mud onto public roads outside Site.
   4. Prevent mud and sediment from flowing onto sidewalks and pavements.
   5. Restore eroded areas at no cost to Owner if erosion occurs due to non-compliance with these requirements.

W. Sedimentation of Waterways On and Off Site:
   1. Prevent sedimentation of waterways on and off Site, including rivers, streams, lakes, ponds, open drainage ways, and sewers.
   2. Unless the Project has received approval or certification for depositing fill into a surface water, remove sediment deposits within surface waters and restabilize the exposed soil area within 7 calendar days of discovery unless precluded by legal, regulatory, or physical access restraints. If precluded, perform removal and restabilization within 7 calendar days of obtaining access. Contractor is responsible for contacting all local, regional, State, and Federal authorities before working within surface waters and obtaining applicable permits.

X. Open Water: Prevent standing water that could become stagnant.
Y. Shape exposed soil and incorporate BMPs as approved by Engineer before suspending grading operations.

3.04 INSTALLATION

A. Temporary Rock Construction Exit:
   1. Provide and use at construction exit to public right-of-way. Location shown on Drawings is for reference only. Actual location to be determined by Contractor.
   2. Width: As required; 25 feet minimum.
   3. Length: 40 feet minimum.
   4. Excavate minimum of 8 inches.
   5. Place geotextile fabric full width and length, with minimum 12 inch overlap at joints.
   6. Place at least 8 inches of CDOT (3 inch) riprap.
   7. Prevent excessive tracking of mud onto right-of-way when necessary as determined by Engineer by providing wheel washing area out of direct traffic lane with drain into sediment trap or alternate Engineer approved BMP.

B. Linear Sediment Barriers: Made of bale barriers, silt fences, sediment control logs, or filter berms.
   1. Provide linear sediment barriers:
      a. Where shown on Drawings, as directed by Engineer, and as necessary.
      b. Along downhill perimeter edge of disturbed areas, including soil stockpiles, and parallel to contour of land, with ends wrapped uphill to prevent flow around them.
      c. Along top of slope or top bank of drainage channels and swales that traverse disturbed areas.
      d. Along toe of cut slopes and fill slopes.
      e. Perpendicular to flow across bottom of existing and new drainage channels and swales that traverse disturbed areas or carry runoff from disturbed areas; space at maximum of 200 feet apart.
      f. Across entrances to culverts that receive runoff from disturbed areas.
   2. Space sediment barriers with the following maximum slope length upslope from barrier:
      a. Slope of Less Than 2 Percent: 100 feet.
      b. Slope Between 2 and 5 Percent: 75 feet.
      c. Slope Between 5 and 10 Percent: 50 feet.
      d. Slope Between 10 and 20 Percent: 25 feet.
      e. Slope Over 20 Percent: 15 feet.

C. Silt Fence:
   1. Store and handle fabric in accordance with ASTM D4873.
   2. Install with top of fabric at nominal height and embedment as specified.
   3. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 18 inches, with extra post.
   4. Type Machine Sliced (MS)
      a. Mechanically install the geotextile with the salvaged edge on top.
      b. Place geotextile directly behind the soil-slicing blade as it works to achieve consistent placement and depth. Do not plow soil if using the slicing method.
      c. Roll the wheels of a tractor or skid steer on each side of the geotextile at least 2 times to compact the soil immediately next to the geotextile.
      d. Install posts adjacent to the back face of the geotextile with the studs facing away from the geotextile fabric.
      e. Secure each post by inserting three plastic zip ties through the geotextile.
   5. Type Preassembled (PA):
      a. Install preassembled silt fence with attached wooden stakes in small areas less then 1/4 acre.
      b. Pound stakes at least 18 inches into the ground.
      c. Install geotextile with the salvaged edge on top.
      d. Place the bottom edge of the geotextile into a trench 6 in deep and 6 in wide.
e. Backfill and tamp the trench for compaction.

D. Bale Barrier:
1. Trench bales into ground 4 inches and stake with two wood stakes of length allowing placement of stake so top remains flush with top of bale when embedded into ground at least 10 inches.

E. Filter Berm:
1. Provide along contour of slope and perpendicular to sheet flow for slope breaks and perimeter control.
2. Provide so beginning and end of installation points slightly up slope to create a “J” shape at each end to contain runoff from above and prevent it from flowing around ends of berm.
3. Provide at top of slope to control velocity of flow running onto slope, and to spread runoff out into sheet flow for slopes that receive runoff from above.
4. Provide perpendicular to ditch gradient for ditch checks such that top of berm in middle of ditch is lower in elevation than bottom of terminating points on ditch side slopes.
5. Immediately seed compost filter berms upon installation.

F. Sediment Control Log:
1. Prepare shallow trench for sediment control log to be placed.
2. Backfill and compact upgrade side of sediment control log with soil.
3. Stake log through back half of log at 45 degree angle with top of stake pointed upstream. Space stakes every 2 feet minimum.
4. If using more than one sediment control log for length, overlap ends 6 inches and stake both ends.
5. For ditch checks, place log perpendicular to flow and in a crescent shape with ends facing upstream.
6. Use logs with a center section of ditch check one log diameter lower than ends. Space stakes every 1 foot minimum.

G. Storm Drain Inlet Protection:
1. Implement BMPs to protect all given inlets throughout the Work to prevent passage of sediments into and through underground drainage systems.
2. Protect storm drain inlets, including manholes, catch basins, curb inlets, and other drop type inlets constructed for ingress of surface water runoff into underground drainage systems.
3. Protect storm drain inlets with sediment capture BMPs before soil disturbing activities result in sediment laden storm water runoff entering inlet.
4. Provide effective storm drain inlet protection until completion of paving or stabilizing of sources with potential for discharging to an inlet.
5. Prevent or minimize potential for unsafe flooding or siltation problems.
6. Regularly clean out BMPs and provide emergency overflow to reduce flooding potential.
7. Place BMPs without creating driving hazards or obstructions.

H. Storm Drain Curb Inlet Sediment Trap:
1. Provide for any inlet with potential to receive stormwater runoff from Site.
2. Manufactured drop in product: As detailed on drawings.
3. Filter fabric wrapped around hollow concrete blocks blocking entire inlet face area; use one piece of fabric wrapped at least 1-1/2 times around concrete blocks and secured to prevent dislodging; orient cores of blocks so runoff passes into inlet.
4. Bale barrier blocking entire inlet face area; anchor into pavement.

I. Storm Drain Drop Inlet Sediment Traps:
1. As detailed on drawings.

J. Temporary Splash Pads:
1. Stone aggregate over filter fabric; size to suit application; provide at downspout outlets and storm water outlets.

K. Stockpiles and Berms:
1. Provide and maintain perimeter protection as necessary.

3.05 EMERGENCY WORK
   A. Conduct Emergency corrective work followed by installation of necessary BMPs within 24 hours written notice from Engineer of sudden occurrence of a serious and urgent nature that is beyond normal maintenance of BMPs, and which requires immediate mobilization and movement of necessary personnel, equipment, and materials to emergency site.

3.06 MAINTENANCE
   A. General:
      1. Inspect BMPs weekly, within 24 hours after end of any storm that produces 0.5 inches or more rainfall at the Site, and daily during prolonged rainfall.
      2. Inspect vehicle exit areas from Site daily and keep clean of excess soil by routine sweeping with Engineer approved pickup broom.
      3. Repair or replace plugged, torn, displaced, damaged, or nonfunctioning BMPs within 24 hours of discovery or as soon as practicable as approved by Engineer.
      4. Maintain BMPs until permanent measures have been established.
      5. Should Contractor fail to install and/or perform appropriate BMPs as determined by Engineer, Owner may issue a written order to Contractor. Contractor shall respond within 24 hours with sufficient personnel, equipment, and/or materials and conduct the required Work or be subject to a $500 per calendar day deduction for non-completion.
      6. Should BMPs fail as determined by Engineer, Contractor shall correct the cause and alleviate remedy all sediment deposition to the fullest extent possible. If corrective action is not taken in a timely manner, Owner may issue a written order to Contractor. Contractor shall respond within 24 hours within 24 hours with sufficient personnel, equipment, and/or materials and conduct the required Work or be subject to a $500 per calendar day deduction for non-completion.
   B. Temporary Sediment Control Devices:
      1. Remove sediment from devices such as bale barriers, silt fences, ditch checks, sediment control logs, and perimeter controls weekly and when sediment reaches one-third of height of device. Reshape area as shown on the Drawings.
      2. Replace non-functional devices and devices damaged by sediment removal.
      3. Perform sediment removal within 24 hours of discovery or as soon as field conditions allow access.
   C. Storm Drain Inlet Protection Devices:
      1. Clean, remove sediment, or replace storm drain inlet protection devices on a routine basis to ensure full functionality of devices for next rainstorm event.

3.07 CLEAN UP
   A. Remove and dispose of BMPs after completing the Work unless otherwise required by the Contract or directed by Engineer.
   B. Clean out BMPs that are to remain as permanent measures.
   C. Place removed sediment in appropriate locations on Site to form suitable surface for turf establishment; do not remove from site.
   D. Where removal of BMPs would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.
   E. Remove silt curtain upon completion of the Work. Do not allow re-suspension of sediment or loss of trash and oil into water during silt curtain removal.

END OF SECTION
SECTION 32 1123
AGGREGATE BASE

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Work to provide all labor, materials, tools, and equipment necessary or incidental to aggregate and granular base construction of track, flatwork, and all as indicated in the Contract Documents.

1.02 PAYMENT
A. All aggregate base Work as outlined in the Contract Documents shall be included in the LUMP SUM contract price.
B. Furnishing and installing of specific items and/or performance of Work under certain circumstances shall not be individually paid. Costs shall be included in lump sum bid for the project. Such items of work include but are not limited to:
   1. Protection of existing improvements and previously accepted in-process improvements from damage.
   2. Base compaction, regrading and/or other efforts necessary to repair subgrade after satisfying roll test and failing to protect integrity of subgrade.
   3. Production of aggregate and granular base.
   5. Providing blue tops for grade verification.

1.03 REFERENCE STANDARDS
A. CDOT Specification Section 703 - Aggregates.
B. CDOT Specification Section 712.08 - Geotextiles.

1.04 DEFINITIONS
A. Soil Testing Laboratory: Refers to a professional geotechnical engineering firm with soil sampling and testing services that is independent from, but hired by Contractor. Soil testing laboratory's engineer shall be licensed in the State of Colorado.

1.05 SUBMITTALS
A. Manufacturer's Certification: Certificate of compliance for all materials, supplies, and equipment provided.
B. Product Data: Information on manufactured products indicating compliance with requirements of this Section.
C. Lab Test Reports: As specified; include source of each material tested and date sampled.
   1. Gradation Test Report
   2. Percent Crushing Test Report
   3. Aggregate Quality Test Report
   4. Perform tests no more than 90 calendar days before Notice of Award.

PART 2 PRODUCTS

2.01 MATERIALS
A. Aggregate Base:
   1. CDOT 703.03, Crushed stone, crushed slag, crushed gravel, natural gravel, or crushed reclaimed concrete
   2. CDOT 703.03, crushed recycled asphalt pavement material for Aggregate Base Course (RAP)
B. Granular Base:
   1. CDOT 703 - Aggregates.
C. Geotextile Fabric:
   1. ProPlay - Sport23D, 0.91 inch thickness
PART 3  EXECUTION

3.01 CONSTRUCTION REQUIREMENTS

A. Aggregate and granular base construction shall take place only after subgrade condition and grade has been approved by Engineer.

B. Construct aggregate and granular base section with material, and to depth shown on Drawings.

C. Construct aggregate and granular base in layers not more than 4-inch in compacted thickness.

D. Use smooth drum compaction equipment to limit surface indentations.

E. Eliminate surface indentations at end of each day, including those caused by tractor cleats, and roll surface with steel wheel or rubber tired roller.

F. Apply water to base material during mixing and spreading operations so that at time of compaction, moisture content is not less than 5% of dry weight.

G. Compact aggregate and granular base to 100 percent of maximum dry unit weight per ASTM D698 (standard Proctor test).

3.02 SOURCE QUALITY CONTROL

A. Soil testing laboratory shall perform indicated Source Quality Control tests indicated, and submit test reports to Engineer and Contractor per the following.
   1. Provide one (1) gradation test per 1,000 cubic yards (CV) of each class of aggregate base.
   2. Provide one (1) gradation test per 10,000 cubic yards (CV) of granular base.
   3. Provide one (1) percent crushing test of each class of aggregate base.
   4. Provide one (1) aggregate quality test of each class of aggregate base.

B. Obtain samples for testing from material in stock at locations and by methods approved by Engineer.

C. Arrange for re-testing of material failing a test, or provide alternate acceptable material as necessary to satisfy Engineer that requirements are met.

3.03 FIELD QUALITY CONTROL

A. Proof roll all Roadway and Parking Lot aggregate base with loaded tandem axle dump truck to show no yielding or rutting per Engineer's determination prior to any subsequent base or surfacing placement. Load truck for proof rolling to a minimum of 9 tons per axle. Strip aggregate, and scarify and re-compact all subgrade areas that do not pass proof rolling to the extent that it is stable when re-tested. Perform Work until subgrade is in compliance and passes proof roll test.

END OF SECTION
SECTION 32 1216
BITUMINOUS SURFACING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work to provide all labor, materials, tools, and equipment necessary or incidental to plant-mixed bituminous surfacing construction as indicated in the Contract Documents.

B. This is a Certified Plant Project. Supplier shall have sufficient testing facilities and qualified personnel including Certified Technicians. If requested by Engineer, required tests shall be performed in a timely manner and with a good quality control program.

1.02 PAYMENT

A. All bituminous surfacing Work as outlined in the Contract Documents shall be included in the LUMP SUM contract price.

B. The furnishing and installing of specific items and/or the performance of work under certain circumstances shall not be individually paid. The costs shall be included in the lump sum for the project. Such items of work include but are not limited to:
   1. Protection of existing improvements and previously accepted in-place improvements from damage.
   2. Production of bituminous mix.
   3. Testing of bituminous mix and surfacing.

1.03 REFERENCE STANDARDS

A. CDOT Specification Section 401 - Plant Mix Pavements - General

1.04 SUBMITTALS

A. Submit "Letter of Conformance" with following supporting data:
   1. Product Data: For each product specified include technical data and tested physical performance properties.
   2. Job Mix Designs: For each job mix proposed for the Work prior to placing any mix on the project.
   3. Material Certificates: Provide copies of materials certificates signed by material producer and Contractor certifying that each material item complies with or exceeds specified requirements, including job mix design.

B. Bituminous mix shall be designed using Composition of Mixtures (401.02). A current CDOT mix design may be accepted provided it represents aggregate source and bituminous plant being used for project, and is approved by Engineer. No bituminous mixture shall be placed without an approved mix design.

PART 2 PRODUCTS

2.01 MATERIALS

A. Bituminous wear course and non-wear course:
   1. Aggregate: per CDOT 703.04
      a. Gradation: As indicated on Drawings.
   2. Traffic Level: As indicated on Drawings.
   3. Air Voids:
      a. 4.0 percent for wear mixtures
      b. 3.0 percent for non-wear and shoulder mixtures
   4. Asphalt binder: per CDOT 702

B. Recycled material is not allowed in bituminous for track. Recycled material is allowed in bituminous wear course for paving trails and similar areas.
PART 3 EXECUTION

3.01 CONSTRUCTION REQUIREMENTS

A. Bituminous patching includes a full-depth sawcut, removal and replacement of subgrade as deemed necessary, and installation and compaction of aggregate base prior to the bituminous patching.

B. Limit bituminous pavement construction according to following requirements:
   1. When atmospheric temperature is above 32 degrees F and rising unless otherwise directed by Engineer.
   2. In the spring after seasonal load restrictions in vicinity of the Project have been removed.
   3. In the fall before cutoff date of November 1st for surface course.
   4. When weather conditions are suitable for the Work.
   5. When prepared base is firm and free of excess moisture as determined by Engineer.

C. Sawcut all bituminous edges to provide a straight, vertical, clean, edge to accept new surfacing.

D. Adjust all valve box, manhole and catch basin castings prior to placement of bituminous wearing course.

E. Match in-place bituminous section at patch locations.

F. Uniformly apply tack coat according to Section 32 1213 - Bituminous Tack Coat prior to bituminous pavement placement.

G. Produce bituminous mixture at no more than 30 degrees F above suppliers recommended maximum mixing temperature.

H. Prevent segregation of bituminous mixture during production, transportation, and placement.

I. Refer to CDOT Table 401-5 for minimum mixture temperatures when discharged from mixer and when delivered for use.

J. Construct joints to produce a neat, tightly bonded joint meeting specified surface tolerances.

K. Construct transverse joint, full width of paver, at right angle to centerline when mixture placement is suspended. Cut end vertically for full depth of layer and resume mixture placement unless otherwise approved by Engineer.

L. Construct longitudinal joint parallel to pavement centerline and offset at least 6-inches from previously placed longitudinal joints. Prevent longitudinal joint placement within wheel path area of traffic lanes unless unfeasible as determined by Engineer.

M. Compact all bituminous mixtures by Ordinary Compaction Method.

N. Construct bituminous pavement with maximum deviation of 1/4-inch from planned compacted section thickness.

O. Construct bituminous wear courses reasonably free of segregated, open and torn sections that are smooth and true to grade and cross section shown on the Drawings with following tolerances:
   1. Surface tolerance from edge of 10 foot straightedge laid parallel to or at right angle to centerline to be 1/4-inch.
   2. Transverse joint tolerance from edge of 10 foot straightedge centered longitudinally across transverse joint to be 1/4-inch.
   3. Height tolerance adjacent to concrete pavement and curbs following compaction to be slightly higher than but not to exceed 1/4-inch above concrete.
   4. Height tolerance adjacent to castings and other fixed structures following compaction to be slightly higher than but not to exceed 3/8-inch above casting or structure.

3.02 FIELD QUALITY CONTROL

A. Finished bituminous paving sections that will be receiving athletic surfacing shall show no deviation from general surface in excess of 1/16-inch per foot when measured with 10-foot straightedge.
B. Finished bituminous pavement sections that will be receiving any athleticsurfacing shallbe checked for accuracy and flatness with 10-foot straightedge in all directions. Surface shall also be flooded and inspected for ponding, “birdbaths”, ridges, and any other deficiencies in the pavement. After testing, all high and low areas shall be marked so that they can be sawcut, removed, and replaced. This procedure shall continue until the pavement section is acceptable to Owner, Engineer, and athletic surfacing installer.

C. Finished bituminous pavement sections that will be receiving synthetic surfacing must be allowed to cure for a period of 28 days before synthetic surfacing may be installed. No exceptions.

3.03 CLEAN UP

A. Remove all tack material and/or bituminous mixture completely from valve box lids and casting covers, or provide new lids and covers before final acceptance of Work.

END OF SECTION
PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Concrete Curb and Gutter
   B. Concrete Sidewalk and Median Pavement
   C. Exterior Footings and Small Concrete Structures
1.02 SUMMARY
   A. Work to provide all labor, materials, tools, and equipment necessary or incidental to the 
      construction of concrete flatwork including pavement, curb and gutter, driveway pavement, 
      sidewalk, and medians as indicated in the Contract Documents.
1.03 PAYMENT
   A. All concrete Work as outlined in the Contract Documents shall be included in the LUMP SUM 
      contract price.
   B. The furnishing and installing of specific items and/or the performance of work under certain 
      circumstances shall not be individually paid. The costs shall be included in the lump sum bid for 
      the project. Such items of work include, but are not limited to:
       1. Concrete mix design.
       2. Subcutting and shaping of subgrade or subbase.
       3. Addition of aggregate base and shaping.
       4. Supplying concrete to site.
       5. Dowel bars and reinforcement.
       7. Jointing and sealing.
       8. Surface curing.
       9. Protection from vehicular traffic.
      10. Protection and pedestrian traffic and graffiti.
      11. Temporary travel ways where required to maintain access as specified.
      12. Concrete testing as specified.
1.04 REFERENCE STANDARDS
   A. CDOT Sections 601 and 609 shall apply to construction of concrete curb and gutter, driveway 
      pavement, and median pavement except as modified herein.
   B. CDOT Sections 601 and 608 shall apply to construction of concrete sidewalk except as 
      modified herein.
   C. CDOT Standard Plan Sheets.
1.05 SUBMITTALS
   A. Two copies of the certified mix design shall be submitted to the Engineer for review a minimum 
      of two weeks prior to the construction of concrete work on the project. The mix proportions shall 
      be determined by an independent certified testing laboratory secured by the Contractor. A 
      current mix design may be submitted and accepted, provided the aggregate source is the same 
      as that being used for this project.
   B. A quality control plan including the following:
      1. Traffic control plan.
      2. A list of all process control or quality control testing technicians.
      3. Concrete placement plan.
      4. Concrete jointing plan when required.
      5. Concrete washout guidance plan.
      6. Pre-pour meeting dates for pours over 500 cubic yards.
      7. Procedure for placing dowel bars and reinforcement.
8. Concrete curing plan.
9. Rain protection plan.
10. Cold weather protection plan.
11. Hot weather protection plan.
12. Submit to the Engineer an organizational chart listing names and phone numbers of individuals and alternates responsible for mix design, quality control administration, and inspection.

C. Certificate of compliance with each truck load of concrete delivered as specified.
D. Strength test results from Contractor's independent testing laboratory for 28 day compressive strength.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement: Shall be from CDOT-certified sources only and be listed on the CDOT approved products list and follow CDOT 412.

B. Supplementary Cementitious Materials (SCM)
   1. Fly ash: Shall be from certified sources only and be listed on the CDOT approved list and follow CDOT 701.02.
   2. Slag cement (ground granulated blast furnace slag or GGBFS): Shall be from certified sources only and be listed on the CDOT approved list.

C. Fine Aggregate for Concrete
   1. Fine aggregate quality requirements shall comply with CDOT 703.01.
   2. Fine aggregate fineness modulus as delivered shall not deviate by more than 0.20 from the submitted gradation, unless otherwise reviewed by the Engineer.
   3. Fine aggregate shall be washed.
   4. Fine aggregate quantity of deleterious substances, as determined by mass (weight), shall not exceed the following limits:
      a. Coal and lignite: 0.3%
      b. Other deleterious substances such as shale, alkali, mica, soft and flaky particles, cumulative total: 2.5%
   5. Fine aggregate in concrete curb and gutter, driveways, sidewalks, or medians shall have a maximum allowable expansion at 14 days of 0.300.

D. Coarse Aggregate for Concrete
   1. Coarse aggregate shall be crushed rock, washed gravel, or other inert granular material meeting CDOT 703.02 except as modified in the Coarse Aggregate for General Use Table below:
2. Coarse aggregate gradation shall comply with CDOT 703.02 requirements for the individual classification.

E. Water Requirements: Mixing water used in the production of concrete shall meet CDOT 712.01.

F. Admixtures: Unless otherwise acceptable to the Engineer, all admixtures shall be from one manufacturer and shall be compatible. All admixtures shall be on the CDOT-approved/qualified list and follow CDOT 711.

G. Reinforcement Bars and Dowel Bars: All reinforcing and dowel bars shall comply with the requirements of CDOT 709.01 and 709.03, be epoxy coated, and grade 60 unless noted otherwise.

H. Joint Fillers
1. Preformed isolation/expansion joint fillers and sealers: Comply with ASTM D1751, preformed, resilient, non-extruding, asphalt impregnated joint filler, ½-inch thick unless otherwise indicated.

Coarse Aggregate for General Use Table

<table>
<thead>
<tr>
<th>Quality Test</th>
<th>Maximum Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Shale:</td>
<td></td>
</tr>
<tr>
<td>Fraction retained on the 1/2-inch sieve</td>
<td>0.4</td>
</tr>
<tr>
<td>Fraction retained on the No. 4 sieve, as a percentage of the total material</td>
<td>0.7</td>
</tr>
<tr>
<td>(b) Soft iron oxide particles (paint rock or ochre)</td>
<td>0.3</td>
</tr>
<tr>
<td>(c) Total spall materials*:</td>
<td></td>
</tr>
<tr>
<td>Fraction retained on the 1/2-inch sieve</td>
<td>1.0</td>
</tr>
<tr>
<td>Fraction retained on the No. 4 sieve, as a percentage of the total material</td>
<td>1.5</td>
</tr>
<tr>
<td>(d) Soft particles II</td>
<td>2.5</td>
</tr>
<tr>
<td>(e) Clay balls and lumps</td>
<td>0.3</td>
</tr>
<tr>
<td>(f) Sum of (c) total spall materials, (d) soft particles, and (e) clay balls and lumps</td>
<td>3.5</td>
</tr>
<tr>
<td>(g) Slate</td>
<td>3</td>
</tr>
<tr>
<td>(h) Flat or elongated pieces †</td>
<td>15.0</td>
</tr>
<tr>
<td>(i) Quantity of material passing No. 200 sieve:</td>
<td></td>
</tr>
<tr>
<td>Class A and Class D aggregates #</td>
<td>1.5</td>
</tr>
<tr>
<td>Class C and Class D aggregates ¥</td>
<td>1</td>
</tr>
<tr>
<td>(j) Los Angeles Rattler, loss on total sample</td>
<td>40.0</td>
</tr>
<tr>
<td>(k) Soundness of magnesium sulfate **</td>
<td>15.0</td>
</tr>
</tbody>
</table>

* Includes the percentages retained by shale and soft iron oxide particles, plus other iron oxide particles, unsound cherts, pyrites, and other materials with similar characteristics.

II Exclusive of shale, soft iron oxide particles, and total spall materials.

† Sum of the total spall materials, soft particles, and clay balls and lumps;

For total spall materials, use the percent in the total sample retained on the No. 4 sieve.

‡ Thickness less than 25 percent of the maximum width. Length greater than three times the maximum width.

# Each individual fraction at the point of placement consists of dust from the fracture and is free of clay or shale.

§ For each individual fraction at the point of placement.

** Loss of fire cycles for any fraction of the coarse aggregate. Do not blend materials from multiple sources to obtain a fraction meeting the sulfate soundness requirement.
2. Joint filler shall be a single piece the full depth thickness of the concrete.

I. Joint Sealers
   1. Hot-pour joint sealer: Comply with CDOT 702.04.

J. Liquid Membrane Curing Compound: Comply with CDOT 711.01.

K. Curing Covering Materials
   2. Insulating blanket: Insulating blanket shall be waterproof and have an R-value of 1 or greater.

2.02 CONCRETE

A. Mix Design
   1. Prepare design mixes for each type and strength of concrete in accordance with ACI 301 by the field experience method or, if available, by laboratory trial batch methods. Mix proportions shall produce consistent and workable concrete that can be readily worked into forms and around reinforcement without segregation or excessive bleeding.
      a. Field experience method: If field test data is available, in accordance with ACI 301, submit for acceptance the mixture proportions along with the field test data.
      b. Trial batch method: Use an AMRL-accredited laboratory for preparing and reporting proposed mix designs.
   2. Ensure compatibility of all material combinations. If the concrete materials are not producing a workable concrete mixture, a change in the material may be required. Changes will be at no additional cost to the Owner.
   3. Proportion normal mixtures to provide concrete with the following properties:
      a. Minimum compressive strength (28 days): 4000 psi.
      b. Minimum cement content: 400 pounds.
      c. Minimum cementitious content: 530 pounds.
      d. Maximum cementitious content: 658 pounds.
      e. Maximum water-cementitious materials ratio at point of placement:
         1) For machine placement: 0.42
         2) For hand placement: 0.45
      f. Slump limit: As needed for proper placement; 5-inch maximum. No minimum as long as proper consolidation is being performed.
      g. Early-strength concrete mixes shall be designed to reach opening compressive strength of 3000 psi at a predetermined time (i.e., 48 hours, 24 hours, etc.).
   4. Add air-entraining admixture at manufacturer’s prescribed rate to result in normal-weight concrete at point of placement having an air content of 6.5 percent plus 2.0 percent or minus 1.5 percent.
   5. If calcium chloride is to be used, limit the water-soluble, chloride-ion content in hardened concrete to 0.08 percent by weight of cementitious materials.
   6. Chemical admixtures: Use admixtures according to manufacturer’s written instructions. Contractors may use the following approved admixtures at their discretion as listed on the CDOT-approved products list:
      a. Type A, water-reducing and mid-range water-reducing admixtures
      b. Type B, retarding/hydration stabilizer admixtures
      c. Type C, accelerating admixtures
      d. Type D, water-reducing and retarding admixtures
      e. Type S, viscosity-modifying admixtures
      f. Admixtures containing more than 0.15 percent chloride ions, by weight of admixture, are not permitted.
   7. Supplementary cementitious materials: No ternary mixes (combination of three or more cementitious materials) will be allowed. Limit percentage by weight of supplementary cementitious materials according to ACI 301 requirements for concrete exposed to deicing chemicals as follows:
a. Fly ash: 30 percent maximum for concrete pavement, 25 percent maximum for everything else, OR
b. Slag cement: 35 percent maximum.

2.03 CURB AND GUTTER
A. CDOT Mix designation number shall be as given below for the method of placement to be used.
   1. Manual Placement: Mix No. 3A32
   2. Machine Placement: Mix No. 3A22
B. Curb and gutter foundation shall consist of at least a 6" aggregate base per CDOT 703.03.
C. Concrete curb and gutter shall be as noted and detailed on the plans.

2.04 SIDEWALK AND MEDIAN PAVEMENT
A. Method of placement shall be per CDOT 608.03(c).
B. Concrete sidewalk and median foundation shall consist of at least a 6" thick aggregate base per CDOT 703.03.
C. Concrete sidewalk shall be as specified in the plans.

PART 3 EXECUTION
3.01 PERSONNEL
A. The Contractor, or subcontractor, shall have at least two people with a current ACI concrete flatwork technician or flatwork finisher certification, and at least one of them must be on-site for all concrete pours.
B. All process control and quality control testing shall be performed by either CDOT- or ACI certified personnel.

3.02 STORAGE AND HANDLING
A. Aggregate Storage: Store aggregates so that segregation and inclusion of foreign materials are prevented. Do not use the bottom 12 inches of aggregate piles in contact with the ground.
B. Cementitious Materials: Store cement, slag cement, and fly ash in suitable moisture-proof enclosures. Do not use cementitious materials that have become caked or lumpy
C. Admixtures: Store in suitable weather-tight enclosures that will preserve quality
D. Reinforcing Steel: Store off ground on timbers or other supports.

3.03 PRE-POUR MEETING
A. A pre-pour meeting is required prior to concrete placement when concrete quantities for the project exceed 500 cubic yards.
B. Annual pre-pour meetings are required on projects with concrete quantities that exceed 500 cubic yards and are constructed over multiple years.
C. A pre-pour agenda is provided in Section 4 for reference.

3.04 MIXING EQUIPMENT
A. Batching and Mixing Equipment
   1. General
      a. Weighing and proportioning equipment: Comply with ASTM C94.
      b. Mixing equipment: Comply with ASTM C94.
      c. Material bins: Involves any structure in which materials are stored. Each part of any bin, including foundations and supports, must be adequate to withstand any stress to which it might be subjected to while in use.
   2. Batching
      a. Batching plants shall be NRMCA- or CDOT-certified with a current CDOT Certified Test Report. Provide copy of current calibrations and approvals.
      b. Coordinate the batch plant operation with the placement operation in order to ensure a steady supply of concrete.
c. Operate the batch plant and trucks to minimize dust, noise, or truck nuisances as part of the quality control plan.

3. Mixing (Ready-mixed Concrete)
   a. Ensure the concrete is uniform in composition and consistency. If non-uniform, concrete producers must take corrective action.
   b. Ready-mixed concrete is defined as concrete proportioned in a central plant and mixed in a stationary mixer for transportation in trucks without agitation; proportioned at a central plant, and only partially mixed in a stationary mixer for transportation and finish mixing in a transit mixer; or proportioned at a central plant and then mixed in a transit mixer prior to or during transit.
   c. When necessary to add additional mixing water at the site of placement, mix the batch at least an additional 50 revolutions of the drum at mixing speed or five minutes, whichever is faster.
   d. All methods: Deliver each truck load of concrete with a computerized certificate of compliance showing plant name, Contractor, project data, batch quantities and total yardage, w/cm, mix designation, time batched, and water available to add on-site. Give a record of the certificates of compliance for each pour to the Engineer.
   e. Ensure the methods of delivering and handling the concrete are such that objectionable segregation or damage to the concrete will not occur, and concrete placement will occur with a minimum of rehandling.
   f. Thoroughly clean the truck compartment in which concrete is transported, and flush with water to ensure that hardened concrete will not accumulate. Discharge the flushing water from the truck compartment to the designated discharge point before it is charged with the next batch.
   g. Delivery requirements: Place concrete into the work in accordance with the following:
      1) Type 1 concrete: within 90 minutes of batching, and
      2) Type 3 concrete: within 90 minutes of batching when all admixtures are added at the plant at the manufacturer’s recommended dosage rates listed on the Approved Products list.
      3) In any case, do not add additional mixing water once the concrete is 60 minutes old.
      4) Mix the load a minimum of five minutes or 50 revolutions at mixing speed after addition of any admixture.
      5) The contractor may transport Type 3 concrete in non-agitating equipment if the concrete is discharged within 45 minutes of batching.
      6) Batch time starts when the batch plant or the transit mix truck adds the cement to the other batch materials.

B. Concrete Washout Guidance
   1. These specifications will be governed by the Urban Drainage and Flood Control District, Urban Storm Drainage Criteria Manual, Volume 3.

3.05 CONCRETE PLACEMENT EQUIPMENT

A. Slipform Construction Equipment
   1. Curb and Gutter Construction
      a. Place concrete curb and gutter using a slipform machine capable of placing and forming the concrete to the dimensions, quality, workmanship and appearance as required by the Contract. Hand finish the surface and texture as required by the Contract.

B. Fixed-Form Construction
   1. Place concrete using one or more machines to spread, screed, and consolidate between previously-set side forms. Vibrate these areas using hand-held or machine-mounted internal vibrators.
   2. Use a tachometer or similar device to demonstrate to the Engineer that the paving equipment vibration meets the requirements in this section.
3. Use hand-held vibrators to consolidate concrete adjacent to side forms and fixed structures. Operate the hand-held vibrators at a speed of at least 3,600 VPM (60 Hz). Do not allow the vibrator head to contact the joints, load transfer devices, reinforcement, grade, or side forms. If the vibrator fails, suspend operations and remove unconsolidated concrete.
4. Continue vibration to achieve adequate consolidation, without segregation, for the full depth and width of the area placed.
5. Provide an adequate number and capacity of machines to perform the work at a rate equal to the concrete delivery rate.
6. Strike off concrete with a vibrating screed, laser screed, or a roller/clary screed as reviewed by the Engineer. Finish small or irregular areas that are inaccessible to finishing equipment using other methods as reviewed by the Engineer.
7. Discontinue any operation that displaces the side forms from the line or grade or that causes undue delay, as determined by the Engineer, due to mechanical difficulties.

C. Hand-Finishing Equipment: Provide all finishing tools necessary for proper finishing of the concrete including straightedges for checking and correcting finished concrete surfaces.

D. Forms
1. Rigid forms: Steel, minimum thickness of five gauge and height at least equal to design thickness of pavement with base width at least 6 inches.
   a. Minimum section length of 10 feet and joint connections designed to allow horizontal and vertical adjustment with locking device to hold abutting sections firmly in alignment.
   b. Bracing, support, and staking must prevent deflection or movement of forms.
2. Flexible forms: Use steel, plastic, or wood flexible forms for curves with a radius less than 100 feet.
   a. Bracing, support, and staking must prevent deflection or movement of forms.
   b. Ensure that forms used to shape back of curbs at returns have height at least equal to design thickness of pavement and curb height.
   c. Forms must be free from scale and surface irregularities.

E. Curing Equipment: Before application, agitate the curing compound as received in the shipping container to obtain a homogenous mixture. Protect membrane-curing compounds from freezing before application. Handle and apply the membrane-curing compound in accordance with the manufacturer's recommendations. An airless spraying machine is required to have the following:
   1. A recirculating bypass system that provides for continuous agitation of the reservoir material,
   2. Separate filters for the hose and nozzle, and
   3. Multiple or adjustable nozzle system that provides for variable spray patterns.

F. Concrete Saws: Use power-operated concrete saws capable of cutting hardened concrete without damage.

G. Joint Sealing Equipment: Use equipment capable of cleaning the joint and heating and installing sealant in joints according to manufacturer's recommendations.

3.06 CURB AND GUTTER CONSTRUCTION

A. Joint Construction
1. Place 1/2-inch expansion joints transversely at the ends of curved sections and at the ends of the curved portions of entrance and street returns. Place longitudinal expansion joints as shown on the plans. Place expansion joints at locations where the concrete surrounds or adjoins an existing fixed object, such as a fire hydrant, building foundation, or other rigid structure.
2. Provide contraction joints at the following intervals, except as otherwise shown on the plans:
   a. Adjacent to bituminous mainline, every 10 feet.
   b. Adjacent to concrete mainline, match concrete mainline transverse joints.
c. In solid median construction, every 10 feet.

3. Form or saw the contraction joints, as reviewed by the Engineer, to a depth of at least 2 inches deep.

4. Align joints with joints in adjoining work unless a 1/2-inch preformed isolation/expansion joint isolates the work. Place transverse joints at right angles to the centerline of the pavement unless otherwise required by the contract.

5. Use an edging tool with a radius no greater than 1/2 inch to round edges of longitudinal construction joints between a concrete median or gutter section and a concrete pavement.

6. Do not saw or seal longitudinal construction joints between a concrete median and concrete pavement, or between a gutter section and concrete pavement.

B. Surface Treatment

1. Surface finish with a fine concrete finishing broom in the transverse direction.

3.07 SIDEWALK, DRIVEWAY, AND MEDIAN CONSTRUCTION

A. Joint Construction

1. Divide the pavement into square panels of uniform size no greater than 36 square feet and outlined with contraction or expansion joints as shown on the plans.

2. Provide straight joints parallel with or at right angles to the pavement centerline. Align the joints with joints in adjoining work unless isolated by 1/2-inch preformed isolation material.

3. The Contractor may form or saw the joints in walking surfaces as approved by the Engineer. If forming the joints, round joints within the walking surface with a 1/4-inch-radius grooving tool, and round edges of the concrete paving with an edging tool having a radius no greater than 1/2-inch.

4. Extend contraction joints to a depth of at least 1/3 of the pavement thickness. If saw cutting, provide a minimum of 1/8-inch-wide contraction joints.

5. Provide isolation/expansion material where necessary to protect work and adjacent structures in accordance with CDOT 705.01(b), that is, 1/2-inch wide and equal in depth to the full thickness of the pavement.

6. Modify joint construction if a fixed object or structure extends through the pavement, as directed by the Engineer. Place isolation/expansion material 1/2-inch thick adjacent to fixed objects to separate the object from the abutting concrete edges.

7. Match driveway pavement jointing with adjacent curb and gutter and sidewalk jointing. Mismatched jointing will require removal and replacement of components to achieve desired results. All removal and replacement of rejected construction shall be at the Contractor's expense.

B. Surface Treatment

1. Surface finish with a fine concrete finishing broom.

C. Driveway Pavement Width

1. Shall be verified in the field by Owner’s representative prior to placement of concrete.

3.08 CURING OF ALL CONCRETE

A. An airless spraying machine is required for curing all concrete. Airless sprayers may be used for small and irregular areas provided they have the ability to mix the curing compound in the container and maintain open nozzles.

B. Apply the curing compound in accordance with the following:

1. Apply liquid curing compound in a fine spray to form a continuous, uniform film on the horizontal surface and vertical edges of pavement, curbs, and back of curbs immediately after surface moisture has disappeared, but no later than 30 minutes after finishing. With approval of the Engineer, the timing of cure application may be adjusted due to varying weather conditions and concrete mix properties to ensure acceptable macro texture is achieved and bleed has evaporated.

   a. For concrete pavement, use CDOT-approved 711.01 AMS white pigment liquid curing compound.
b. For all other concrete and colored concrete pavement, use either a CDOT-approved 711.01 white pigment liquid curing compound or a CDOT approved curing compound with a fugitive dye. The Engineer may approve the use of a clear curing compound.

c. Apply curing compound to all concrete surfaces at an application rate of 150 square feet per gallon. Apply homogeneously to provide a uniform solid coverage on all exposed concrete surfaces (equal to a white sheet of typing paper when using pigmented curing compound). Some CDOT-approved curing compounds may have a base color (i.e., yellow) that cannot comply with the above requirement. In this case, provide a uniform solid opaque consistency meeting the intent of the above requirement.

2. Ensure liquid curing materials are well agitated in the supply drum or tank immediately before transfer to the sprayer. Keep curing materials well agitated during application.

3. If forms are used, apply to pavement edges and back of curbs within 30 minutes after forms are removed.

4. If the curing compound is damaged during the curing period, immediately repair the damaged area by respraying.

5. If the Engineer determines that the initial or corrective spraying may result in unsatisfactory curing, the Engineer may require the Contractor to use the blanket curing method, at no additional cost to the Owner.

3.09 CONCRETE PROTECTION - INCLUDE THESE PLANS IN THE CONTRACTOR'S QUALITY CONTROL PLAN

A. Protection Against Rain
   1. Protect the concrete from damage due to rain. Have available materials for protection of the edges and surface of concrete. Should any damage result, the Engineer will suspend operations until corrective action is taken.

B. Protection Against Cold Weather
   1. If the National Weather Service forecast for the construction area predicts air temperatures of 36 °F or less within the next 24 hours and the contractor wishes to place concrete, submit a cold weather protection plan.
   2. Protect the concrete from damage including freezing due to cold weather. Should any damage result, the Engineer will suspend operations until corrective action is taken.
   3. Cold Weather Protection Plan:
      a. Submit in writing to the Engineer a proposed time schedule and plans for cold weather concrete protection that provide provisions for adequately protecting the concrete during placement and curing. Do not place concrete until the Engineer accepts the Contractor's cold weather protection plans.

C. Protection Against Hot Weather
   1. If the National Weather Service forecast for the construction area during concrete placement is such that the combined factors of temperature, wind, and humidity are detrimental to concrete placement, develop a hot weather protection plan.
   2. The definition of hot weather conditions is defined in the PCA Design and Control of Concrete Mixtures as when the rate of evaporation of bleed water per hour exceeds 0.2 lb. of water per square foot per hour. A chart published by ACI and PCA can be used to predict the bleed water rate.
   3. Hot Weather Protection Plan:
      a. Submit in writing to the Engineer a proposed time schedule and plans for hot weather concrete protection that provide provisions for adequately protecting the concrete during placement and curing. Do not place concrete until the Engineer accepts the Contractor's hot weather protection plans.

3.10 USE OF PAVEMENT

A. Opening Pavement and Driveways to Traffic
1. Do not open a new pavement slab to general public traffic or operate paving or other heavy equipment on it until the concrete has attained an age of seven days or it has reached a minimum compressive strength of 3,000 psi, as reviewed by the Engineer.

2. If the pavement joints are widened, seal the joints before operating paving or other heavy equipment and allowing general public traffic on the pavement.

3. Cast the compressive strength control specimens in accordance with ASTM C31, “Making and Curing Concrete Test Specimens in the Field.” Cure the control specimens in the same manner and under the same conditions as the pavement represented. The Contractor shall test the control specimens in accordance with the "Minimum Concrete Testing Rates" table.

4. Perform operations on new pavement as reviewed by the Engineer and in accordance with the following:
   a. When moving on and off the pavement, construct a ramp to prevent damage to the pavement slab.
   b. Operate the paving equipment on protective mats to prevent damage to the pavement surface and joints. Before placing the protective mats, sweep the pavement surface free of debris.
   c. Operate equipment on a slab without causing damage. If damage results, suspend operations and take corrective action as reviewed by the Engineer. Do not operate the equipment wheels or tracks within 4 inches of the slab edge.

B. Opening of Sidewalks and Medians to Pedestrian Traffic
   1. Normal pedestrian foot traffic can walk on the finished concrete as soon as practical without causing damage to the fine broom finish.
   2. Construction traffic shall not be allowed for three days or until the concrete reaches a compressive strength of 3000 psi.

C. Backfill Construction – Operating Vibratory Equipment
   1. Protect newly placed concrete from damage by adjacent vibratory or backfilling operations for a minimum of 24 hours.
   2. Do not perform vibratory operations and backfilling until 72 hours after placing the concrete or after the concrete reaches a compressive strength of at least 3000 psi.

3.11 CONCRETE WARRANTY PERIOD
   A. During the warranty period indicated in the Supplementary Conditions, necessary repairs shall include but not be limited to defects in concrete and workmanship such as cracking, pop-outs, spalling, improper joint placement and settlement.

END OF SECTION
SECTION 33 0513
MANHOLES AND STRUCTURES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Precast Manholes and Catch Basins
B. Adjustment of Manhole and Catch Basin Castings

1.02 PAYMENT
A. All work as outlined in the plans and specifications shall be included in the Lump Sum contract price.

1.03 REFERENCE STANDARDS
A. CDOT Section 604 - Manholes, Inlet, and Meter Vaults
B. CDOT M&S Standard Plans

1.04 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Manufacturer's Certification: Certificate of compliance for all materials, supplies, and equipment provided.
C. Product Data: Provide data on castings and covers, component construction, features, configuration, and dimensions.
D. Shop Drawings: Indicate structure locations, elevations, piping sizes and elevations of penetrations.

1.05 QUALITY ASSURANCE
A. Manufacturer: Company certified in manufacturing products meeting CDOT specifications.
B. Manufacturer: Company specializing in manufacturing products specified in this section with minimum 3-years documented experience.

1.06 SITE CONDITIONS
A. Cold and Hot Weather Requirements: Comply with requirements of ACI 530.1/ASCE 6/TMS 602 or applicable building code, whichever is more stringent.
B. Maintain materials and surrounding air temperature to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry work.

PART 2 PRODUCTS

2.01 MATERIALS
A. Precast Concrete Storm Drainage Manholes and Catch Basins:
   1. Storm drainage manholes and catch basins shall conform to the CDOT Standard Design as indicated on the plan set.
   2. Reinforced polypropylene plastic steps shall be furnished for all storm drainage manholes.
   3. Catch basins shall be furnished with holes for underdrain connections. Jack hammering holes for underdrain in the field will not be allowed. Holes may be cored with an appropriate tool in the field.
B. Nyloplast Storm Sewer Inlet Structures
   1. Nyloplast structures shall be of the size and type as indicated on the plans.
C. Castings:
   1. All manhole and catch basin casting assemblies shall meet the certification requirements of CDOT and be manufactured by a CDOT approved source.
   2. Storm drainage manhole and catch basin casting assemblies shall be specified on the plan set.
D. Adjusting Rings:
1. Concrete adjusting rings meeting CDOT specifications shall be used.

E. Geotextile Fabric:
   1. CDOT 712.08

F. Manhole Sections: ASTM D 3753, glass-fiber reinforced polyester with integral steps.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify items provided by other sections of Work are properly sized and located.
B. Verify that built-in items are in proper location, and ready for roughing into Work.
C. Verify excavation for manholes is correct.

3.02 PREPARATION

A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

3.03 MANHOLES

A. Excavation and Trench Preparation:
   1. Interference of Underground Structures: If an existing utility is shown on the plan set and no bid item addresses removing and restoring or working around the utility, the Contractor must remove and restore or protect the utility. This work shall be considered incidental to the manhole installation.
   2. The Contractor shall install and operate a dewatering system to maintain all trenches free of water wherever necessary. The Contractor shall be responsible for remediation of any damage to adjacent structures or buildings caused by the dewatering operations. The Contractor shall make his own subsurface investigations and determine what dewatering methods to utilize to prevent such damage.
   3. Existing inverts shall be protected during construction. If debris enters the system, it shall be the responsibility of the Contractor to clean the sewer.

B. Existing System Connections:
   1. When connecting to an existing pipe or manhole in the sanitary sewer/storm drainage system, the Contractor must expose and verify the elevation of the connection point prior to installing any pipe or manhole accessories. If the existing elevation does not match that shown on the plan set, the Contractor shall notify the Engineer, at which time the Engineer may adjust the proposed grades. Should the Contractor verify the depth and location of existing connection pipes, no additional compensation or time extension will be granted in the event of complications.
   2. When connecting to an existing sanitary manhole, an approved watertight connection shall be made.

C. A 6" rock base shall be placed under all structures.

D. Place concrete base pad, trowel top surface level.

E. Place manhole sections plumb and level, trim to correct elevations, anchor to base pad.

F. Form and place manhole cylinder plumb and level, to correct dimensions and elevations. As work progresses, build in fabricated metal items.

G. Cut and fit for pipe.

H. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour as required.

I. Set cover frames and covers level without tipping, to correct elevations.

J. Coordinate with other sections of work to provide correct size, shape, and location.

3.04 CASTING ADJUSTMENT

A. Castings shall be raised to match grade with surface.

B. Unless noted otherwise in the plans, if castings are in pavement that will have several lifts applied, the castings shall be raised with each subsequent lift.
C. Up to one insert is allowable for adjustment
   1. Install insert per manufacturer’s recommendations.

3.05 MANHOLE ADJUSTMENT
   A. Manholes requiring adjustment shall require a minimum of 2 adjusting rings and a maximum of 6 adjusting rings.
   B. All applicable sections of this specification shall apply to the adjustment of the manhole or catch basin.
   C. Up to one insert is allowable for adjustment.
      1. Install insert per manufacturer’s recommendations.

3.06 EXISTING STRUCTURE ADJUSTMENT
   A. Existing manhole adjustment shall consist of the following:
      1. Removal of the existing manhole casting and rings.
      2. Removal and replacement of the required adjusted rings as specified in the previous paragraph, 'Manhole Adjustment'.
      3. Replacement of the existing casting or installation of a new casting as identified in the drawings.
      4. Installation of an external manhole seal to be placed around the casting and all adjusting rings. Installation shall be in accordance with the manufacturer’s instructions.
      5. Backfill/construction of the proposed pavement section.
   B. Up to one insert is allowable for adjustment.
      1. Install insert per manufacturer’s recommendations.

3.07 FIELD QUALITY CONTROL
   A. No exception to the referenced specification is made.

END OF SECTION
SECTION 33 1118
WATER DISTRIBUTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work to provide all labor, materials, tools, and equipment necessary or incidental to watermain and service lateral construction as indicated in the Contract Documents.

1.02 PAYMENT

A. All work as outlined in the Contract Documents shall be included in the Lump Sum contract price.

B. The furnishing and installing of specific items and/or the performance of work under certain circumstances shall not be individually paid. The costs shall be included in the lump sum bid for the lump sum bid. Such items of work include, but are not limited to:
   1. Interference with other underground structures and utilities.
   2. The removal and restoration, or protection of existing utilities which are shown on the plans and for which there is no bid item for removing and restoring, or working around the utility.
   3. Unless separately itemized in the Schedule of Unit Prices, any dewatering necessary for watermain construction.
   4. Locating and connecting to an existing watermain, unless itemized separately in the Schedule of Unit Prices.
   5. Furnishing and installing electrical connections to in-place watermain.
   7. Thrust blocking or metal ties.
   8. Maintenance of service unless a separate item is provided on the Proposal.
   9. Compaction, hydrostatic, leakage, coliform bacteria and continuity testing.
   10. Delays due to other utility conflicts, which result during the course of construction.
   11. Protecting existing improvements from damage.
   12. Valve operating nut, and extension rods.
   13. Extension rods for curb stops.
   14. Polyethylene encasement of pipe and fittings.
   15. Trace wire and terminal boxes.
   16. Disinfection, including treating all pipe and fittings with a 5% hypochlorite solution and flushing as described in AWWA C651 - Disinfecting Watermains.

1.03 REFERENCE STANDARDS

A. CDOT Specification Sections 105.17 shall apply to the removal and replacement of deficient materials, except as modified herein.

1.04 SUBMITTALS

A. Product Data: Provide manufacturer's data on pipe materials, pipe fittings, valves and accessories.

B. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.

C. Project Record Documents: Record actual locations of piping, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

D. Test Reports: Indicate results comparative to specified requirements.

E. Disinfection Report:
   1. Type and form of disinfectant used.
   2. Date and time of disinfectant injection start and time of completion.
   3. Test locations.
   4. Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
   5. Date and time of flushing start and completion.
6. Disinfectant residual after flushing in ppm for each outlet tested.

F. Bacteriological Report:
1. Date issued, project name, and testing laboratory name, address, and telephone number.
2. Time and date of water sample collection.
3. Name of person collecting samples.
4. Test locations.
5. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
6. Coliform bacteria test results for each outlet tested.
7. Certification that water conforms, or fails to conform, to bacterial standards of the state of Minnesota.

1.05 QUALITY ASSURANCE
A. Testing Firm: Company specializing in testing potable water systems, certified by governing authorities of the State in which the Project is located.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Deliver and store fittings and appurtenances in shipping containers with labeling in place.
B. Store pipe on a clean and stable surface. Ensure that pipe remains free of material and debris.
C. Store and handle pipe and appurtenances as recommended by manufacturer to prevent scratching, cutting, or gouging.

1.07 QUALITY ASSURANCE
A. Provide certified pipe layer during pipe laying operations.
B. Pipe layer shall possess current and up to date card and have attended a pipe layers’ certification course as offered by The Minnesota Utility Contractors Association or equivalent training that produced certification and a registration card.
C. Failure to provide a certified pipe layer on-site may result in Engineer suspending all construction activities until one is provided.

PART 2 PRODUCTS
2.01 AGGREGATE FOUNDATION, BEDDING, ENCASEMENT, AND BACKFILL
A. As specified in Section 31 0010 - Application of Water.

2.02 WATER PIPE
A. Materials, General:
   1. NSF61 Certified.
   2. Virgin material that is homogeneous throughout, and free of visible cracks, holes, foreign materials, blisters, and other deleterious faults.
   3. Discard and remove from site any pipe with defects greater than 10 percent of wall thickness, concentrated ridges, discoloration, excessive spot roughness, pitting, variable wall thickness, or other defects of manufacturing or handling.
   4. Provide pipe and fittings of each material type from same manufacturer.
   5. Method of joining dissimilar materials and any special fittings employed shall be subject to approval of Engineer.
   6. Service installation shall include all water pipe of 3-inch nominal inside diameter and less.
   7. Main installation shall include all water pipe of 4-inch nominal inside diameter and greater.
B. Polyvinyl Chloride (PVC) Pipe: According to ASTM D1784, and AWWA C900 or C905 with ductile iron pipe equivalent outside diameters.
   1. Minimum Design Thickness:
      a. For pipe sizes 4-inch through 12-inch: DR-14 (Class 305).
   2. Joint Type: Use push-on type, unless otherwise specified in Contract Documents or authorized by Engineer.
      a. Push-on: According to AWWA C900 or C905, and ASTM D3139.
b. Mechanically Restrained: Ductile iron mechanical device designed for joint restraint of AWWA C900 or C905 pipe in accordance with ASTM F1674.

c. Integrally Restrained: AWWA C900 or C905 pipe with restraining system manufactured integrally into pipe end.


4. Markings on Pipe:
   a. Name of manufacturer.
   b. Size and class.
   c. Spigot insertion depth gauge.

2.03 FITTINGS

A. Gray Iron Fittings: Not permitted.

B. Ductile Iron Fittings (for use with DIP and PVC Pipe): According to AWWA C153.
   1. Working Pressure:
      a. For pipe sizes 3-inch through 24-inch: 350 psi.
   2. Coating:
      a. Interior and exterior fusion-bonded epoxy coating according to AWWA C116.
   3. Joint Type:
      a. Mechanical joint system with gland using breakaway torque bolts to engage thrust restraint.

2.04 HYDRANTS

A. Valve Opening Diameter: Shall be minimum 5-1/4-inches, and shall be of the compression type, opening against the pressure and closing with the pressure.

B. Bury Length: Shall generally be 8-feet. Furnish depth required so that branch service is set at no more than 4-percent grade and groundline groove matches ground at hydrant location. Verify requirements in field prior to ordering hydrant.

C. Hydrant Extensions: If required, furnish in multiples of 6-inches with rod and coupling to increase barrel length.

D. Valve Seat and Threads: Bronze.

E. Draining System: Shall be all bronze and positively activated by the main operating rod.

F. Hydrant shall permit removal of all working parts through standpipe without need for excavation.

G. Hose and Streamer Connection: Size and thread type required by City. Caps shall be equipped with chains.

H. Hydrant Base Connection: 6-inch mechanical joint for 5-1/4-inch hydrant valve opening.

I. Operating Nut: Size and shape required by City.

J. Finish: Factory finish with primer and two coats of enamel in color required by City.

K. Permanent Markings Indicating:
   1. Manufacturer's name.
   2. Year of manufacture.

L. External Bolts and Nuts: stainless steel according to ASTM A 193, Grade B 8.

M. Provide reaction blocking, tie rods, or joint restraint to prevent movement.

N. Manufacturer: Waterous Improved Pacer Style, Model WB-67-250, with safety flange and stem coupling meeting the following requirements:

2.05 VALVES AND VALE HOUSINGS

A. Valve Housing:
1. Valve Box (for underground valve installation): Cast iron, 3-piece screw type, suitable for depth of 7-1/2 feet to center line of pipe with minimum 6-inch adjustment above and below specified pipe depth.
2. Valve box shaft shall be 5-1/4 inch inside diameter.
3. Provide lid with stay-put cover with raised letters indicating "WATER".
4. Valve Stem Extension: Provide extension rod for all valves installed with greater than 8-feet of cover to bring operating nut depth to approximately 6-feet.
6. Gate Valve Box Adapter: Adapter, Inc., or Engineer approved substitution.
7. Valve and box are considered an integral unit.

B. Valve, General:
1. Manufacturer's name and pressure rating cast on valve body.
2. Direction of Opening: Counterclockwise.
3. Joints:
   a. For buried installations, use mechanical joints per AWWA C111.
   b. For installations above ground and within structures, flanged with dimensions and drillings according to AWWA C110.

C. Gate Valve:
1. According to AWWA C515 (ductile iron), NSF61 certified, and the following:
   b. Valve Body and Bonnet: Ductile iron with fusion-bonded epoxy coating conforming to AWWA C550.
   c. Mechanical Joint Ends: Fully machined hub end gasket seating surfaces to fixed dimensions and tolerances.
   d. Trim: Bronze.
   e. Single disk type with resilient seat bonded or mechanically attached to either the gate or valve body, and wedge shall be ductile iron fully encapsulated with EPDM rubber, shall be symmetrical and seal equally well with flow in either direction.
   f. Stem: Non-rising with O-Ring seals.
   g. Operating Nut: 2-inch square.
   h. External Bolts and Hex Nuts: Stainless steel according to ASTM A 240, Type 304.
   i. Operating Gears: Cut tooth steel gears, housed in heavy ductile or cast iron extended type grease cases.
   j. Permanent Markings Indicating:
      1) Open indicating arrow.
      2) Manufacturer's name.
      3) Pressure rating.
      4) Year of manufacture.
      5) Size

2.06 MECHANICAL JOINT RESTRAINT SYSTEM:
A. Body: Ductile iron gland according to ASTM A536 and AWWA C600 with fusion-bonded epoxy coating according to AWWA C116.
B. Manufacturer:
   1. Star Pipe Products StarGrip
   2. EBBA Iron Mega-Lug
   3. Engineer approved substitution.
C. Joint flexibility shall be maintained after burial of the restraining mechanism.

2.07 T-BOLTS AND HEX NUTS:
A. Corrosion-resistant, high-strength, low-alloy steel according to AWWA C111 with ceramic-filled, baked on fluorocarbon resin coating equal to NSS Cor-Blue, or Engineer approved substitution.
B. Include factory-applied lubricant that produces low coefficient of friction for ease of installation.
2.08 TIE RODS:
A. Stainless steel, corrosion-resistant coating, or coated with Engineer approved rustproofing material, and fully wrapped with 8 mil poly film.

2.09 SACRIFICIAL ANODE:
A. Each buried fitting, valve, and hydrant gland shall include two 6-ounce large zinc anode caps as manufactured by Trumball Industries, or Engineer approved substitution.

2.10 CONDUCTIVITY:
A. Maintain through pipe and fittings with external copper jumper wire or specialty gaskets conforming to conductivity requirements.
B. Wedge type conductivity connectors are not permitted.

2.11 POLYETHYLENE JACKET:
A. According to AWWA C105.
B. Provide tubes or sheets with 8 mil nominal film thickness.

2.12 TRACER WIRE AND APPURTENANCES:
A. Tracer Wire:
1. #12 AWG copper clad steel, with minimum 450 lb. break load.
2. 30 mil thick blue HDPE insulation intended for direct burial use at 30 volts.
B. Connectors:
1. Direct bury wire connectors shall include 3-way lockable connectors and mainline to lateral lug connectors specifically manufactured for use in underground tracer wire installations. Connectors shall be dielectric silicon filled to seal out moisture and corrosion, and shall be installed in a manner so as to prevent any uninsulated wire exposure.
2. Non locking friction fit, twist on or taped connectors are not permitted.
C. Grounding:
1. Grounding of tracer wire shall be achieved by use of drive-in magnesium grounding anode rod with a minimum of 20-feet of #14 HDPE insulted copper clad steel wire connected to the anode specifically manufactured for this purpose.
D. Termination Box:
1. All tracer wire termination points shall utilize an approved tracer wire access box (above ground access box or grade level/in-ground access box as applicable), specifically manufactured for this purpose.
2. All grade level/in-ground access boxes shall be appropriately identified with “water” cast into the cap and be color coded.
3. All tracer wire access boxes must include a manually interruptible conductive/connective link between the terminal(s) for the tracer wire connection and the terminal for the grounding anode wire connection.
E. Manufacturer:
1. SnakePit Light Duty Adjustable Box as manufactured by Copperhead Industries LLC.
2. Engineer approved substitution.

2.13 WATER SERVICE PIPE AND FITTINGS
A. General:
1. Corporation stops, saddles, curb stops, and curb stop boxes shall conform to AWWA C800.
2. Permanently and plainly mark fittings with name or trademark of manufacturer.
3. Threads for underground service line fittings: Conform to AWWA C800.
B. Water Service Pipe:
1. 1-inch, 1-1/2 inch, or 2-inch inside diameters only.
2. Water service pipe of 3/4-inch and 1-1/4-inch inside diameter conforming to same requirements shall only be used for repairs to existing copper services of same size.
3. Copper Pipe:
   a. According to ASTM B88, Type K, Soft Annealed Temper.
   b. Joints: Compression connection.

4. Polyethylene Pipe:
   a. According to AWWA C901.
   b. Working Pressure: 250 psi working pressure according to ASTM D2737, SDR 9.
   c. Joints: Compression connection.
   d. Tubing Size: SDR 9, CTS (copper tubing size)
   e. Color: Blue.
   f. Polyethylene Compound: PE4710 according to ASTM D3350.
   g. Mark pipe according to AWWA C901. Marking shall be legible and remain legible under normal handling and installation practices.
      1) Indent marking may be utilized provided:
         (a) The marking does not reduce the wall thickness to less than the minimum value for the pipe or tubing.
         (b) The marking does not reduce the wall thickness to less than the minimum value for the pipe or tubing.
         (c) Marks do not provide leakage channels when elastomeric gasket compression fittings are used to make the joints.
   h. Manufacturer:
      1) Blue Ultra, PE 4710, CTS, by Polyethylene Technology Inc.
      2) Engineer approved substitution.

C. Corporation Stop:
   1. Ball style compression fitting.
   2. AWWA standard threads on inlet side.
   3. 300 psi working pressure rating.
   4. Use stainless steel insert stiffeners in all applications where polyethylene CTS tubing is used in conjunction with compression fittings. Provide solid, 304 tubular stainless steel stiffeners, dimpled and flanged to retain placement within service line.
   5. Hydraulic seal provided with corporation stop shall be affected by compression of a beveled rubber gasket, which simultaneously activates a mechanical (stainless steel) restraint ring as compression nut is tightened. Stainless steel restraint ring, retained within rubber gasket and having rubber ends, shall fully engage tubing circumference with both edges of crescent shaped ring.
   6. Compression nut shall have an integrally cast lug specifically designed for attaching tracer wire when using polyethylene pipe. Lug shall have 1/4-inch diameter tracer wire hole, parallel to service line. An additional hole with tap, placed perpendicular to tracer wire hole, will include a 5/16-inch by 1-inch long (18 threads per inch) silicon-bronze slotted hex screw to permanently secure tracer wire within tracer wire hole.
   7. Plug style corporation stops are not authorized for use and do not meet the 300 psi working pressure rating.
   8. Manufacturer: (for copper service lines)
      a. Mueller B-25008N
      b. AY MacDonald 74701BQ
      c. Ford FB1000-4-Q (1-inch)
      d. Engineer approved substitution.
   9. Manufacturer: (for polyethylene service lines)
      a. Mueller B-25008N
      b. AY MacDonald 74701BQA
      c. Ford FB1000-4-Q (1-inch)
      d. Engineer approved substitution.

D. Curb Stop:
   1. Ball style compression fitting.
   2. 300 psi working pressure.
3. Threaded to conform to Minneapolis Pattern.
4. AWWA standard threads on inlet and outlet side.
5. Use stainless steel insert stiffeners in all applications where polyethylene CTS tubing is used in conjunction with compression fittings. Provide solid, 304 tubular stainless steel stiffeners, dimpled and flanged to retain placement within the service line.
6. The hydraulic seal provided with the curb stop shall be affected by compression of a beveled rubber gasket, which simultaneously activates a mechanical (stainless steel) restraint ring as the compression nut is tightened. The stainless steel restraint ring, retained within the rubber gasket and having rubber ends, shall fully engage the tubing circumference with both edges of the crescent shaped ring.
7. The compression nut shall have an integrally cast lug specifically designed for attaching tracer wire when using polyethylene pipe. The lug shall have a 1/4-inch diameter tracer wire hole, parallel to the service line. An additional hole with tap, placed perpendicular to the tracer wire hole, will include 5/16-inch by 1-inch long (18 threads per inch) silicon-bronze slotted hex screw to permanently secure the tracer wire within the tracer wire hole.
8. Manufacturer: (for copper service lines)
   a. Mueller B-25155N
   b. AY MacDonald 76104Q
   c. Ford B44-444M-NLQ (1-inch) or B44-666M-NLQ (1-1/2-inch)
   d. Engineer approved substitution.
9. Manufacturer: (for polyethylene service lines)
   a. Mueller B-25155N
   b. AY MacDonald 76104QA
   c. Ford B44-444M-NLQ (1-inch) or B44-666M-NLQ (1-1/2 inch)
   d. Engineer approved substitution.
E. Curb Stop Box:
   1. Conform with AWWA C800.
   2. Minneapolis thread pattern with 1-1/2-inch top section.
   3. Supported by minimum 3/4 of its thread diameter on body of curb stop.
   4. 8-feet long at full extension.
   5. Manufacturer: (for copper service line)
      a. Mueller H-10302
      b. AY MacDonald 5622
      c. Ford EM2-80-67
      d. Engineer approved substitution.
   6. Manufacturer: (for polyethylene service line)
      a. Ford EM2-80-67-TW
      b. Engineer approved substitution.
F. Service Saddle:
   1. Saddle type tap required on PVC and HDPE main line service connections.
   2. Double bolt stainless steel type saddle with Nitrile (Buna N) rubber seal.
   3. Manufacturer:
      a. Smith-Blair 372
      b. Cascade CSC2
      c. Ford FS313
      d. PowerSeal 3412AS
      e. Engineer approved substitution.

PART 3 EXECUTION

3.01 WATERMAIN SHUT-OFF

A. Provide Owner and Engineer 24-hour advance notice as to what watermain is requested to be shut-off and when.
B. Provide affected property owners 24-hour advance notice before water service interruption.
C. Coordinate requirements for shutting off water system directly with Owner.
D. Provide temporary water service to affected property owners in advance of Work when duration of shut-off will exceed 4-hours, and remove following completion of Work.

3.02 PREPARATION
A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
B. Remove scale and dirt on inside and outside before assembly.
C. Prepare pipe connections to equipment with flanges or unions.

3.03 INSTALLATION - PIPE
A. Maintain minimum of 18-inch vertical separation and 10-foot horizontal separation of watermain from sewer piping.
B. Avoid damage to existing utilities where proposed watermain intersects existing utilities. Removal and replacement of existing utilities as necessary shall be incidental to proposed watermain construction. No additional payment will be made for crossing existing utilities shown on Drawings.
C. Group piping with other site piping work whenever practical.
D. Establish elevations of buried piping to ensure not less than 7.5 feet cover.
E. Install pipe to indicated elevation to within tolerance of 0.1 foot.
F. Install ductile iron piping and fittings to AWWA C600.
G. Install grooved and shouldered pipe joints to AWWA C606.
H. Route pipe in straight line unless otherwise indicated in the Contract Documents.
I. Install pipe to allow for expansion and contraction without stressing pipe or joints.
J. Install access fittings to permit disinfection of water system as specified.
K. Install polyethylene jacket on all ductile iron pipe.

3.04 INSTALLATION - VALVES AND HYDRANTS
A. Set valves on solid bearing.
B. Center and plumb valve box over valve. Set box cover flush with finished grade.
C. Set hydrants plumb; locate pumper nozzle perpendicular to and facing roadway.
D. Set hydrants to grade, with nozzles at least 20 inches above ground.
E. Install polyethylene jacket on all iron fittings and hydrant riser.
F. Plug hydrant drain hole outlet where groundwater table is above drain and equip with tag stating the need for pumping after use.

3.05 INSTALLATION - POLYETHYLENE JACKET
A. When so required by the Contract Documents the pipeline, including valves, fittings, hydrants, and appurtenances, shall be fully encased in polyethylene film meeting these requirements.
B. Furnish tube form polyethylene for installation on pipe and all pipe-shaped appurtenances such as bends, reducers, off-sets, etc.
C. Furnish sheet film polyethylene for all odd-shaped appurtenances such as valves, tees, crosses, etc.
D. Install polyethylene tubing as follows:
   1. Install polyethylene tubing prior to lowering into the trench.
   2. Tubing length shall be sufficient to provide a minimum overlap at all joints of one foot or more.
   3. Overlap may be accomplished with a separate sleeve tube placed over one end of the pipe prior to connecting another section of pipe, or by bunching extra overlap material at the pipe ends in accordion fashion.
4. Following pipe jointing and positioning the overlap material, the overlap shall be secured in place with plastic adhesive tape wrapped circumferentially around the pipe not less than three (3) times.

5. Following encasement, the circumferential slack in the tubing film shall be folded over at the top of the pipe to provide a snug fit along the barrel of the pipe and be held in place with plastic adhesive tape applied at intervals of approximately three feet (3') along the pipe length.

6. Rips, punctures, or other damage to the tubing shall be repaired as they are detected with plastic adhesive tape and overlapping patches cut from sheet or tubing material.

7. At odd-shaped appurtenances such as gate valves, the tubing shall overlap the joint and be secured with tape, after which the appurtenance piece shall be wrapped with a flat film sheet or split length of tubing by passing the sheet under the appurtenance and bringing it up around the body. Seams shall be made by bringing the edges together, folding over twice, and taping down.

8. Where encasement is terminated, it shall extend for at least two feet (2') beyond the joint area.

9. Make openings in the tubing for branches, service taps, air valves and similar appurtenances by cutting an X-shaped slit and temporarily folding back the film. After installing the appurtenance, the cut tabs shall be secured with tape and the encasement shall be completed as necessary for an odd-shaped appurtenance.

E. Maintain free drainage from weep holes of hydrants.

3.06 INSTALLATION - TRACER WIRE

A. Tracer wire shall be provided along the axis of all non conductive pipe in such a manner to allow proper access for connection of line tracing equipment, proper locating of wire without loss or deterioration of low frequency (512Hz) signal for distances in excess of 1,000 linear feet, and without distortion of signal caused by multiple wires being installed in close proximity to one another.

B. Tracer wire system shall be installed as a single continuous wire, except where using approved connectors, and provide full tracing/locating capabilities from a single connection point. No looping or coiling of wire is permitted.

C. All mainline tracer wires shall be interconnected at intersections, at mainline tees and mainline crosses. At tees, the three wires shall be joined using a single 3-way lockable connector. At Crosses, the four wires shall be joined using a 4-way connector. Use of two 3-way connectors with a short jumper wire between them is an acceptable alternative. Tracer wire shall be installed along the bottom half of the pipe and taped at 5-foot intervals.

D. At all mainline dead-ends, tracer wire shall go to ground using an approved connection to a drive-in magnesium grounding anode rod, buried at the same depth as the tracer wire.

E. Mainline tracer wire shall not be connected to existing conductive pipes. Treat as a mainline dead-end, ground using an approved waterproof connection to a grounding anode rod buried at the same depth as the tracer wire.

F. All service lateral tracer wires shall be a single wire, connected to the mainline tracer wire using a mainline to lateral lug connector, installed without cutting/splicing the mainline tracer wire, and shall terminate at an approved tracer wire access box as specified.

G. Where an existing tracer wire is encountered on an existing utility that is being extended or tied into, the new tracer wire and existing tracer wire shall be connected using an approved splice connector, and shall be properly grounded at the splice location as specified.

H. Above-ground tracer wire access boxes shall be installed on all fire hydrants.

I. All conductive and non-conductive service lines shall include tracer wire.

J. Termination/Access:

1. A minimum of 2 ft. of excess/slack wire is required in all tracer wire access boxes after meeting final elevation.
2. Grounding anode wire shall be connected to the identified (or bottom) terminal on all access boxes.

3. Service Lateral locations on public property:
   a. Tracer wire shall terminate at an approved grade level/in-ground tracer wire access box, located at the edge of the road right-of-way, and out of the roadway.

4. Service Lateral locations on private property:
   a. Tracer wire shall terminate at an approved above-ground tracer wire access box, affixed to the building exterior directly above where the utility enters the building, at an elevation not greater than 5 vertical feet above finished grade, or terminate at an approved grade level/in-ground tracer wire access box, located within 2 linear feet of the building being served by the utility.

5. Hydrant locations:
   a. Tracer wire shall terminate at an approved above-ground tracer wire access box, mechanically affixed to the hydrant grade flange. (affixing with tape or plastic ties shall not be acceptable)

6. Long-run locations, in excess of 1,000 linear feet without service laterals or hydrants:
   a. Tracer wire access shall be provided utilizing an approved grade level/in-ground tracer wire access box, located at the edge of the road right-of-way, and out of the roadway. The grade level/in-ground tracer wire access box shall be delineated using a minimum 48" polyethylene marker post, color coded per APWA standard for the specific utility being marked.

K. Grounding:
1. Shall be properly grounded with anode at all dead ends/stubs as a minimum.
2. Grounding anode shall be buried at the same elevation as the utility.
3. When grounding at dead ends/stubs, the grounding anode shall be installed in a direction 180 degrees opposite of the tracer wire, and at the maximum permissible distance.
4. When grounding the tracer wire in areas where the tracer wire is continuous and neither the mainline tracer wire or the grounding anode wire will be terminated at/above grade, install grounding anode directly beneath and in-line with the tracer wire. Do not coil excess wire from grounding anode, but trim to an appropriate length before connecting to tracer wire with a mainline to lateral lug connector.
5. Where the anode wire will be connected to a tracer wire access box, a minimum of 2 ft. of excess/slack wire is required after meeting final elevation.

L. Damage to the tracer wire during installation shall be repaired immediately by removing the damaged wire, and installing new wire with approved connectors. Taping and/or spray coating shall not be permitted.

3.07 FIELD QUALITY CONTROL

A. Testing:
1. Disinfect, Bacteriological Test, and Flush:
   a. Disinfect water system prior to being placed into service.
   b. Provide and attach all equipment required to perform the work.
   c. Disinfection materials and procedures, and the collection and testing of water samples, shall be in accordance with the provisions of AWWA C-651.
   d. Schedule disinfecting activity to coordinate with start-up, testing, adjusting and balancing, demonstration procedures, including related systems.
   e. Maintain disinfectant in system for minimum 24 hours.
   f. Flushing operations and the form of chlorine and method of application to be used shall be subject to approval of the Engineer.
   g. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.
   h. After the final flushing, the water shall be tested for bacteriological quality and found to meet bacterial standards of the state of Minnesota.
   i. Replace permanent system devices removed for disinfection, testing, and flushing.
2. Hydrostatic Pressure Test:
a. Following installation of pipe, fittings, valves, and blocking, all newly-laid watermain, unless directed otherwise by the Engineer, shall be subject to hydrostatic pressure of one hundred fifty (150) pounds per square inch for a test duration of at least two (2) hours.

b. Watermain segments to be tested shall be filled with water and all air expelled at the highest point. Required taps to expel air or to fill the watermain shall be supplied and installed by the Contractor and shall be three quarters inch (3/4") minimum and shall include an approved service saddle when required.

c. Apply test apparatus at the lowest elevation on the test segment by means of a service tap, special tap, or hydrant.

d. Test apparatus pressure gauge shall be a standard pressure gauge with a dial registering from 0-200 psi, and have a dial size of four and one half inches (4 1/2") with one (1) psi increments.

e. The hydrostatic test pressure requirement for an acceptable test shall be a maximum pressure drop of two (2) psi during the last hour of the two (2) hour pressure test.

f. Investigate the cause of any failing test, make corrections, and retest until the pressure drop requirement is met.

3. Tracer Wire Test:
   a. Locate all new tracer wire installations using typical low frequency (512Hz) line tracing equipment in the presence of the Engineer prior to final acceptance. If the tracer wire installations are not able to be located, make necessary repairs, and relocate the new tracer wire in the presence of the Engineer.

4. Operational Test:
   a. Prior to final acceptance, and in the presence of the Engineer and Owner, operate all valves, hydrants, and water services to ascertain that the entire facility is in good working order; that all valve boxes are centered and valves are opened; that all hydrants operate and drain properly; that all curb boxes are plumb and centered; and that water is available at all curb stops.

5. Trench Compaction Testing in accordance with Section 31 0010 - Application of Water.

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

END OF SECTION
SECTION 33 3114
SANITARY SEWER

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Work to provide all labor, materials, tools, and equipment necessary or incidental to sanitary sewer pipe and structure Work as indicated in Contract Documents.

1.02 REFERENCE STANDARDS
A. CDOT Section 604 - Manholes, Inlet, and Meter Vaults

1.03 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Manufacturer's Certification: Certificate of compliance for all materials, supplies, and equipment provided.
C. Product Data: Provide manufacturer's data on pipe, fittings, and accessories.
D. Shop Drawings: Indicate structure locations, elevations, pipe sizes, and location and elevations of penetrations.
E. Record Documents: Include location of piping, connections, manholes, cleanouts, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.04 QUALITY ASSURANCE
A. Manufacturer: Company certified in manufacturing precast concrete products meeting CDOT specifications.
B. Manufacturer: Company specializing in manufacturing products specified in this section with minimum 3-years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Deliver and store fittings and appurtenances in shipping containers with labeling in place.
B. Store pipe on a clean and stable surface. Ensure that pipe remains free of material and debris.
C. Store and handle pipe and appurtenances as recommended by manufacturer to prevent scratching, cutting, or gouging.

PART 2 PRODUCTS

2.01 AGGREGATE FOUNDATION, BEDDING, ENCASEMENT, AND BACKFILL
A. As specified in Section 31 2317 - Trenching.

2.02 SANITARY SEWER PIPE AND FITTINGS
A. General:
1. Virgin material that is homogeneous throughout, and free of visible cracks, holes, foreign material, blisters, and other deleterious faults.
2. Discard and remove from Site any pipe with defects greater than 10% of wall thickness, concentrated ridges, discoloration, excessive spot roughness, pitting, variable wall thickness, or other defects of manufacturing or handling.
3. Provide pipe and fittings of each material type from same manufacturer.
B. Polyvinyl Chloride (PVC) Pipe and Fittings:
1. Design and Thickness: (for maximum cover of 21-ft.)
   a. Service pipe sizes 4-in. and 6-in.: ASTM D3034 SDR-26
   b. Pipe sizes 8-in. to 15-in.: ASTM D3034 SDR-35
2. Material: ASTM D1784c cell classification 12454
4. Gaskets: ASTM F477
5. **Fittings:** Same material as pipe with heavy duty thickness rating, and molded or formed to suit pipe size and end design in required tees, bends, elbows, cleanouts, reducers, traps and other configurations required.

### 2.03 MANHOLES AND APPURTENANCES

**A. Precast Concrete Manhole Sections:**
1. **Design:** CDOT 712.05 with AASHTO HS25 truck load rating.
2. **Type:** CDOT Standard Plan M-604-20, unless otherwise indicated on Drawings, including integral base section with smooth formed inverts and rubber gasketed tongue and groove joints. All pipe openings shall have integral cast watertight seal.
3. Reinforced polypropylene plastic steps shall be furnished for all sanitary sewer manholes.

**B. Castings:**
1. **Design:** CDOT 712.06 & 712.05 and on CDOT approved products list.
2. **Type:** CDOT 712.06
3. **Manhole Cover:** Solid lid with two concealed lift holes, machined bearing surfaces, rubber O-ring gasket, no lug, and 2-in. raised letters stamped "SANITARY SEWER" unless otherwise indicate on Drawings.

**C. Adjusting Rings:**
1. **Concrete:** CDOT Section 712.05
2. **HDPE:** As manufactured by Ladtech, Inc., 6704 Meadowlark Crt., Lino Lakes, MN 55038, or approved equal.

**D. External Ring Seal:**
1. **External rubber sleeve ring seal as indicated on Drawings.**
2. **Manufacturer:**
   a. Infi-Shield by Sealing Systems, Inc.
   b. Chimney Seal by Cretex Specialty Products.
   c. Approved equal.

### PART 3 EXECUTION

**3.01 EXAMINATION**

A. Verify items provided by other sections of Work are properly sized and located.
B. Verify built-in items are in proper location, and ready for roughing into Work.
C. Verify manufactured items delivered to Site are undamaged, stored properly, and ready for Work.
D. Notify Engineer of damaged items for determination of acceptance or rejection.
E. Promptly remove rejected materials from Site.

**3.02 TRENCHING**

A. See Section 31 2317 - Trenching for additional requirements.
B. Verify that trench cut is ready to receive Work and excavations, dimensions, and elevations are as indicated on Drawings.
C. Hand trim excavation for accurate placement of Work to elevations indicated.
D. Install and operate dewatering system to maintain all trenches free of water wherever necessary. Assume responsibility for any damage to adjacent structures or buildings caused by dewatering operations. Make own subsurface investigations and determine what dewatering methods to utilize to prevent such damage.

**3.03 MAINTENANCE OF SERVICE**

A. Maintain sanitary sewer service during Work, and provide equipment to bypass and control sanitary sewer flow around Work, if necessary.
B. In event of interruption to sanitary sewer service, Contractor is sole party responsible to notify affected parties.
C. Failure to maintain service could result in direct damage claims as well as consequential damage claims against Contractor.

3.04 CONSTRUCTION

A. Protect existing inverts during Work and clean if debris enters sewer.

B. Expose and verify location and elevation of existing sewer prior to laying any pipe to or from connection point when connection to existing or proposed sanitary sewer or structure is made. If location or elevation of existing sewer does not match location or elevation indicated on Drawings, notify Engineer immediately, at which time Engineer may adjust proposed alignment or grades. Allow reasonable amount of time for Engineer to make assessment of conditions and determine alternate means of construction if necessary. As a minimum, Engineer shall be allowed one Working Day from time of notification to make assessment and determination of alternate Work without submittal of Change Proposal for adjustment in Contract Price or Contract Times.

C. Provide suitable adapter of either insert coupling type or banded coupling type for connection of dissimilar materials or for repair of similar material. Adapter and band material shall meet requirements of either ASTM D3212 and ASTM F477, or ASTM C1173, and bear manufacturer's identifying mark and size.

D. If an existing utility is indicated on Drawings and no bid item for removing and restoring, or working around utility is provided for Work, remove and restore, or protect utility incidental to Project.

E. Handle all materials carefully to prevent damage to protective coatings and linings, preclude contamination of interior areas, and avoid jolting, contact, dropping, or dumping.

F. Repair/connect existing tile and storm sewer when encountered as directed by Engineer.

3.05 CONSTRUCTION - PIPE, FITTINGS, AND APPURTEANCES:

A. Provide pipe, fittings, and appurtenances of size, type, and at location indicated on Drawings.

B. Install per manufacturers' instructions and the following:

C. All underground piping installed through proposed building areas or occupied by existing buildings shall comply with all appropriate provisions of State of Minnesota Plumbing Code, Minnesota Rules Chapter 4714.

D. Proceed with trench excavation and bedding preparations ahead of pipe placement as will permit proper laying and joining of units at prescribed grade and alignment without unnecessary deviation or hindrance.

E. Excavate trench for all pipe 6-in. below pipe barrel to permit installation of granular bedding or foundation material.

F. Bed pipe under ordinary trench conditions in compacted granular bedding from 6-in. below bottom of pipe to spring line of pipe.

G. Where trench foundation has been found to be unstable and not suitable for bedding by Engineer, install compacted foundation material from minimum of 6-in. below pipe up to bottom of pipe, and place remaining required bedding material over foundation. If 6-in. of foundation material proves insufficient, request use of additional foundation material from Engineer. No additional foundation material shall be used without prior approval of Engineer.

H. Remove foreign matter or dirt from inside of pipe and fittings before lowering into position in trench and keep clean throughout installation.

I. Lower pipe into laying position with suitable restraining devices. Under no circumstances shall pipe be dropped into trench.

J. Prior to laying pipe, while suspended for lowering into trench, inspect pipe and appurtenances to detect damage or unsound conditions that may be cause for corrective action or rejection; notify Engineer of any defects.
K. Immediately prior to laying pipe, inspect joint surfaces of pipe and fittings for presence of foreign matter, coating blisters, rough edges or projections, and correct by cleaning, trimming or repair as necessary.

L. Lay pipe with bell or grooved end upgrade starting from downstream end of installation unless otherwise allowed by Engineer.

M. Mark spigot end of pipe as necessary to indicate point of complete closure. As each length of bell and spigot pipe is placed in laying position, center spigot end in bell and force "home" bringing pipe to correct line and grade.

N. Lay pipe to line and grade indicated on Drawings, with maximum variation from true grade of 1/8-in. in 10-ft.

O. Secure pipe in place in compacted granular encasement from spring line of pipe to 12-in. above top of pipe.

P. Connect pipe to existing lines or manholes as indicated on Drawings, or as otherwise approved by Engineer.

Q. Comply with pipe manufacturer recommendations where deflection of joints is necessary to make satisfactory closure or produce required curvature, grade, or alignment, and shall not exceed that which will assure watertight joints.

R. Bulkheading Open Pipe Ends:
   1. Provide and maintain temporary plug or cap for all pipe and fitting ends to be left open for future connection.
      a. Install prefabricated plug or cap for pipe sizes of 24-in. or less made of same material as pipe, or approved alternate material, to make watertight seal as required for pipe joints.
      b. Install plug or cap for pipe sizes greater than 24-in. constructed with 2-in. timber planking securely fastened together.
      c. Adequately block plug or cap in place to prevent flooding of existing downstream sewer system. Place plug or cap at beginning of Project or at end of each working day.
   2. Provide permanent watertight plug on open end of pipe when flows are diverted from existing sewer to be abandoned in place.
      a. Construct permanent watertight plugs with mortar/grout with thickness of not less than 1 pipe diameter.

S. Sewer and Water Separation:
   1. Provide 18-in. minimum separation measured vertically between gravity sewer and water pipes with preference that water crossing above gravity sewer when possible.
      a. Center length of water pipe at point of crossing, so that joints are equidistant and as far as possible from sewer.
      b. Adequately support sewer and water pipe crossing to prevent settling and deflection of joints.
      c. When conditions prevent vertical separation described, provide gravity sewer constructed to equivalent watermain standards for 10-ft. on either side of crossing, and pressure tested to assure water tightness prior to backfilling.
   2. Provide 10-ft. minimum separation measured horizontally between gravity sewer and water pipes.
      a. When conditions prevent horizontal separation described, provide one of the following:
         1) Place bottom of water pipe 18-in. minimum above top of gravity sewer on undisturbed shelf; or
         2) Provide gravity sewer constructed to equivalent watermain standards and pressure tested to assure water tightness prior to backfilling.
      3. Provide 10-ft. minimum separation measured horizontally between sewer and water service pipes.
a. When conditions prevent horizontal separation described, place bottom of water service pipe 12-in. minimum above top of sewer service on undisturbed shelf.

T. Sanitary Sewer Service Lateral Installation:
1. Keep accurate records as to location of lateral connections constructed. Measurements to service line shall be taken from two nearest permanent structures (i.e. hydrants, valves, manholes, buildings) as directed by Engineer. Final payment for Project will not be made until location information is provided to Owner.

3.06 CONSTRUCTION - MANHOLE STRUCTURES
A. Coordinate manhole structure construction with other sections of Work to provide correct size, shape, and location of structures as indicated on Drawings.
B. Form bottom of trench excavation clean and smooth to correct elevation.
C. Establish elevations of pipe inverts for inlets and outlet as indicated on Drawings.
D. Provide minimum of 6-in. thick compacted rock foundation under all structures.
E. Provide precast base with smooth formed invert integrally cast with bottom barrel section level and to elevation necessary for subsequent Work.
F. Provide precast barrel and cone sections with tongue and groove joints, and placed plumb and level to correct elevations. Join with appropriate gasket to provide watertight seal.
G. Provide steps oriented over outlet pipe for all manholes.
H. Provide integrally cast water stop collars for all pipe openings.
I. Provide minimum of 3 and maximum of 6 standard 2-in. adjusting rings centered on structure opening.
   1. Set concrete adjusting rings in full mortar bed, and wrapped in geotextile fabric.
   2. Set HDPE adjusting rings per manufacturers recommendations.
J. Provide casting assembly centered on structure opening, level without tipping, and adjusted such that top is 1/2-in. lower than adjacent surface without use of wedges or shims. Set in full mortar bed to provide uniform bearing surface when using concrete adjusting rings. Set per manufacturers recommendations when using HDPE adjusting rings.
K. Provide external ring seal per manufacturers recommendations.
L. Existing structure adjustment:
   1. Remove existing structure sections, adjusting rings, and casting assembly as necessary.
   2. Provide replacement structure sections as necessary for adjustment.
   3. Provide replacement adjusting rings as specified above.
   4. Replace existing casting or provide replacement casting as identified on Drawings.
      a. Up to one casting insert installed per manufacturer’s recommendations is allowable for adjustment.

3.07 FIELD QUALITY CONTROL
A. Coordinate field quality control testing per the following:
   1. Notify Engineer at least 24-hr. in advance of any testing.
   2. Provide competent and knowledgeable individual to perform testing.
   3. Perform testing under Engineer’s supervision for acceptance.
   4. Leakage Testing:
      a. Provide all necessary equipment and materials required for testing.
      b. Perform leakage testing of all gravity sanitary sewer pipe and service laterals following completion of sanitary sewer Work, but prior to surface restoration Work.
      c. Leakage testing shall be completed by air test or hydrostatic testing method, at Contractor’s discretion.
   5. Deflection Testing on Plastic Pipe:
      a. Provide all necessary equipment and materials required for testing.
      b. Perform deflection test after trench backfill to desired grade has been in place for minimum of 30-days.
c. Perform test by pulling rigid ball or nine-point mandrel through pipe without aid of mechanical pulling devices. Ball or mandrel shall have minimum diameter equal to 95% of actual inside diameter of pipe. Maximum allowable deflection shall not exceed 5% of pipe's internal diameter. Line is considered acceptable if ball or mandrel can progress through line without binding.
d. Time of test, method of testing, and equipment used for test shall be subject to approval of Engineer.

6. Televising:
a. Perform televising of all installed sewer main unless otherwise approved by Engineer.
b. Flush sewer line immediately prior to televising.
c. Contractor specializing in televising shall perform Work.
d. Perform televising using crawler type in-pipe color camera at moderate to slow pace with sufficient lighting to inspect interior of pipe.
e. Provide DVD video of televising in duplicate to Engineer along with written report. Video shall contain the following:
   1) Indicate segment start and end locations by manhole number or other distinguishable feature from center of structure.
   2) Indicate segment pipe size.
   3) Indicate running footage along sewer line zeroed out at beginning of each segment.
   4) Indicate footage location of all service wyes and fittings, and rotate camera to view up intersecting sewer line.
   5) Indicate unusual conditions and provide more detailed and longer viewing of specific instance (i.e. - bad joint, material in line, settlement of line, etc.)
f. Reflush and retelevis any location found to not be clean.

7. Trench Compaction Testing:
a. Perform per Section 31 2317 - Trenching.

B. Coordinate and pay to re-test sanitary sewer work following corrective action when test results indicate specified test results were not obtained.

3.08 PROTECTION

A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION
SECTION 33 4112
STORM SEWER

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Storm drainage piping, fittings, and accessories.
   B. Catch basins, Paved area drainage, and Site surface drainage.

1.02 PAYMENT
   A. Lump Sum Bid
      1. All work as outlined in the plans and specifications shall be included in the Lump Sum contract price.
   B. The furnishing and installing of specific items and/or the performance of work under certain circumstances shall not be individually paid. The costs shall be included in the lump sum bid for the project, as indicated. Such items of work include, but are not limited to:
      1. Interference of other underground structures and utilities.
      2. The removal and restoration or protection of existing utilities which are shown on the plans and for which there is no bid item for removing and restoring or working around the utility.
      3. Unless separately itemized in the Schedule of Unit Prices, any dewatering necessary for storm sewer construction.
      4. Foundation materials placed in lieu of performing necessary dewatering.
      5. Locating and connecting to an existing storm sewer manhole or lateral stub.
      6. Furnishing and installing watertight plugs for stubbed storm sewer lines.
      7. Geotextile fabric or other materials necessary for pipe installation.
      8. Maintenance of an appropriate storm water outlet during construction.
      9. Protecting the inverts of other utility pipes from the accumulation of debris and soil, the removal of blockages which threatens to damage property, and/or cleaning of the both the newly constructed lines and the existing lines of all debris and soil which accumulate during the construction.

1.03 REFERENCE STANDARDS
   A. CDOT Specification Sections 105.17 shall apply to the removal and replacement of deficient materials, except as modified herein.
   C. Unless otherwise noted, the provisions in this Section are in addition to the referenced specification.

1.04 SUBMITTALS
   A. Product Data: Provide data indicating pipe and pipe accessories.
   B. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
   C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
   D. Project Record Documents:
      1. Record location of pipe runs, connections, catch basins, cleanouts, and invert elevations.
      2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.01 AGGREGATE FOUNDATION, BEDDING, ENCASEMENT, AND BACKFILL
   A. As specified in Section 31 0010 - Application of Water.

2.02 STORM SEWER PIPE AND FITTINGS
   A. Materials, General:
1. Unless specifically noted on the Drawings or within the Proposal, provide one of the following pipe types in accordance with these specifications.

2. Virgin material that is homogeneous throughout, and free of visible cracks, holes, foreign material, blisters, and other deleterious faults.

3. Discard and remove from site any pipe with defects greater than 10 percent of wall thickness, concentrated ridges, discoloration, excessive spot roughness, pitting, variable wall thickness, or other defects of manufacturing or handling.

4. Provide pipe and fittings of each material type from same manufacturer.

B. Polyvinyl Chloride (PVC) Pipe and Fittings:
      a. For pipe sizes 4-inch to 15-inch: ASTM D3034.
      b. For pipe sizes 18-inch and greater: ASTM F679.
   2. Thickness:
      a. For pipe sizes 4-inch to 12-inch: SDR-26.
      b. For pipe sizes 15-inch and greater: SDR-35.
   5. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.03 CATCH BASIN, CLEANOUT, AND AREA DRAIN COMPONENTS

A. Castings:
   1. All casting assemblies shall meet the certification requirements of the Colorado Department of Transportation and be manufactured by a CDOT approved source.
   2. Storm drainage manhole and catch basin casting assemblies shall be specified on the plan set.
   3. Structures: Refer to CDOT Section 604 - Manholes, Inlet, and Meter Vaults

PART 3 EXECUTION

3.01 TRENCHING

A. See Section 31 0010 - Application of Water for additional requirements.

B. Hand trim excavation for accurate placement of pipe to elevations indicated.

3.02 MAINTENANCE OF SERVICE

A. It will be necessary to maintain service during the construction period. Failure to maintain storm sewer service could result in direct damage claims as well as consequential damage claims against the Contractor. In the event of an interruption in storm sewer service, the Contractor is the sole party responsible to notify the Utility and consumers who may be affected.

B. If needed, the Contractor shall furnish, install, and maintain equipment to bypass and control the storm and/or sanitary sewer flow around the construction zone. Failure to operate and maintain the bypass equipment could result in direct damage claims as well as consequential damage claims to the Contractor.

3.03 INSTALLATION OF PIPE AND FITTINGS

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
   2. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3mm) in 10 feet (3m).
   3. All underground storm drainage piping installed through proposed building areas or occupied by existing buildings shall comply with all appropriate provisions of the State of Minnesota Plumbing Code, Minnesota Rules Chapter 4715.0550.
4. Interference of Underground Structures
   a. If an existing utility is shown on the plans and there is no bid item for removing and restoring, or working around the utility, the Contractor shall be required to remove and restore, or protect the utility.

5. Excavation Limits and Requirements
   a. The trench for all Plastic pipe shall be undercut six-inches below the pipe barrel to permit the installation of granular bedding or foundation material.
   b. The Contractor shall install and operate a dewatering system to maintain all trenches free of water wherever necessary. The Contractor shall be responsible for any damage to adjacent structures or buildings caused by the dewatering operations. The Contractor shall make his own subsurface investigations and determine what dewatering methods to utilize to prevent such damage.
   c. Existing inverts shall be protected during construction. If debris enters the sewer, it shall be the responsibility of the Contractor to clean the sewer.

6. Preparation and Maintenance of Foundation
   a. Plastic Pipe Materials
      1) In ordinary trench conditions, the pipe shall be bedded in compacted granular bedding, which extends from 6" below the bottom of the pipe to the spring line of the pipe.
   b. Where the trench foundation has been found to be unstable and not suitable for bedding, the Contractor shall install compacted foundation material from 6" below the bottom of the pipe to the bottom of the pipe. Bedding materials shall then be placed to the spring line of the pipe. If 6 inches of foundation material prove insufficient, the Contractor may request the use of additional foundation material from the Engineer. No additional foundation material shall be used without prior approval from the Engineer or their representative.

7. Connection and Assembly of Joints
   a. All joints shall be watertight.

8. Bulkheading Open Pipe Ends
   a. The Contractor shall furnish, install, and maintain a temporary, watertight plug adequately blocked in place to prevent flooding of the existing downstream sewer system. The plug shall be placed at the beginning of the Project or at the end of each working day the end of the day's operation.
   b. When flows are diverted from an existing sewer to be abandoned in place, the Contractor shall construct a watertight plug on the open end of the abandoned sewer.
   c. Permanent watertight plugs shall be constructed with an approved concrete grout with a thickness of not less than 1 pipe diameter.

9. Storm Sewer Lateral Installation
   a. The Contractor shall keep accurate records as to the location of the lateral connections constructed. Measurements to service line shall be taken from the two nearest permanent structures (i.e. hydrants, valves, manholes, buildings) as directed by the Engineer. Final payment for the project will not be made until the information is in the possession of the Owner.

10. Connect to Existing Storm Sewer
    a. When encountered, existing tiles, storm sewer, and other piping shall be repaired or connected by the Contractor as directed by the Engineer or their representative.
    b. When connection to an existing storm sewer is made at an existing or proposed manhole, the Contractor shall expose and verify the elevation of the existing sewer prior to laying any storm sewer to, or from, the connection point. If the elevation of the existing sewer does not match the elevation shown on the plans, the Contractor shall notify the Engineer, at which time the Engineer may adjust the proposed grades.

11. The Contractor shall tie outlet apron joints and the next three pipe joints upstream. The Contractor shall also tie inlet apron joints and the next three pipe joints downstream.

3.04 INSTALLATION OF MANHOLES
   A. Form bottom of excavation clean and smooth to correct elevation.
B. Establish elevations and pipe inverts for inlets and outlets as indicated.
C. Ensure that structure is plumb and level.
D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

### 3.05 SUBDRAIN

A. Subgrade Preparation:
   1. Comply with CDOT 307.05.
   2. Scarify top 6 inches of subgrade.
   3. Dry material or apply water as necessary to obtain required density and stability.
   4. Use Quality Compaction Method.
   5. Installation of subdrain pipe:
      a. Connect into each storm sewer structure.
      b. Construct perforated subdrain service stubs as shown on the Drawings.
      c. Cap end of each service and mark with a 3/8-inch by 30-inch steel rod.

### 3.06 FIELD QUALITY CONTROL

A. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
B. Deflection Testing
C. Trench Compaction Testing in accordance with Section 31 0010 - Application of Water.

### 3.07 PROTECTION

A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION