CITY OF TULSA, OKLAHOMA

TULSA, OKLAHOMA

BIDDING REQUIREMENTS
AND
CONTRACT DOCUMENTS

for the construction of the

ZINK DAM IMPROVEMENTS

[D: Contract No. ________]

VOLUME 1
DIVISIONS 01 THROUGH 25

****

****

CH2M HILL

Tulsa, Oklahoma

October 2019

© CH2M HILL 2019. All rights reserved.
This document and the ideas and designs incorporated herein, as an instrument of professional service, is the property of CH2M HILL and is not to be used in whole or part, for any other project without the written authorization of CH2M HILL. Any reuse, modification, or alteration of this document and the ideas and designs incorporated herein is at the sole risk of the party(ies) reusing, modifying, or altering it. All references to CH2M HILL and its employees and all professional seals shall be removed prior to any reuse, modification, or alteration of this document.
# TABLE OF CONTENTS

**VOLUME 1**

## SPECIFICATIONS

### DIVISION 01—GENERAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 11 00</td>
<td>Summary of Work</td>
<td>1-</td>
</tr>
<tr>
<td>01 29 00</td>
<td>Payment Procedures</td>
<td>1-</td>
</tr>
<tr>
<td>01 31 13</td>
<td>Project Coordination</td>
<td>1-</td>
</tr>
<tr>
<td>01 31 19</td>
<td>Project Meetings</td>
<td>1-</td>
</tr>
<tr>
<td>01 32 00</td>
<td>Construction Progress Documentation</td>
<td>1-</td>
</tr>
<tr>
<td>01 33 00</td>
<td>Submittal Procedures</td>
<td>1-</td>
</tr>
<tr>
<td>Supplement:</td>
<td>Transmittal of Contractor’s Submittal Form</td>
<td>1-</td>
</tr>
<tr>
<td>01 43 33</td>
<td>Manufacturers’ Field Services</td>
<td>1-</td>
</tr>
<tr>
<td>Supplement:</td>
<td>Manufacturer’s Certificate of Proper Installation</td>
<td>1-</td>
</tr>
<tr>
<td>01 45 16.13</td>
<td>Contractor Quality Control</td>
<td>1-</td>
</tr>
<tr>
<td>01 45 33</td>
<td>Special Inspection, Observation, and Testing</td>
<td>1-</td>
</tr>
<tr>
<td>Supplements:</td>
<td>Contractor’s Statement of Responsibility</td>
<td>1-</td>
</tr>
<tr>
<td></td>
<td>Fabricator’s Certificate of Compliance</td>
<td>1-</td>
</tr>
<tr>
<td></td>
<td>Statement of Special Inspections</td>
<td>1-</td>
</tr>
<tr>
<td>01 50 00</td>
<td>Temporary Facilities and Controls</td>
<td>1-</td>
</tr>
<tr>
<td>01 57 13</td>
<td>Temporary Erosion and Sediment Control</td>
<td>1-</td>
</tr>
<tr>
<td>01 61 00</td>
<td>Common Product Requirements</td>
<td>1-</td>
</tr>
<tr>
<td>Supplement:</td>
<td>Manufacturer’s Certificate of Compliance</td>
<td>1-</td>
</tr>
<tr>
<td>01 64 00</td>
<td>Owner-Furnished Products</td>
<td>1-</td>
</tr>
<tr>
<td>01 77 00</td>
<td>Closeout Procedures</td>
<td>1-</td>
</tr>
<tr>
<td>01 78 23</td>
<td>Operation and Maintenance Data</td>
<td>1-</td>
</tr>
<tr>
<td>Supplement:</td>
<td>Maintenance Summary Form</td>
<td>1-</td>
</tr>
<tr>
<td>01 88 15</td>
<td>Anchorage and Bracing</td>
<td>1-</td>
</tr>
<tr>
<td>01 91 14</td>
<td>Equipment Testing and Facility Startup</td>
<td>1-</td>
</tr>
<tr>
<td>Supplements:</td>
<td>Unit Process Startup Form</td>
<td>1-</td>
</tr>
<tr>
<td></td>
<td>Facility Performance Demonstration/Certification Form</td>
<td>1-</td>
</tr>
</tbody>
</table>

*Not Included in this Submittal*
### DIVISION 02—EXISTING CONDITIONS

02 41 00  Demolition .......................................................... 1-
02 41 01  Electric Utilities Demolition ................................... 1-
02 61 00  Removal and Disposal of Contaminated Soil ............ 1-

### DIVISION 03—CONCRETE

03 01 32  Repair of Vertical and Overhead Concrete Surfaces .... 1-
03 01 33  Repair of Horizontal Concrete Surfaces ................ 1-
03 10 00  Concrete Forming and Accessories ....................... 1-
03 15 00  Concrete Joints and Accessories ......................... 1-
03 21 00  Steel Reinforcement ........................................ 1-
03 30 00  Cast-in-Place Concrete .................................. 1-
           Supplements:                                          
           Concrete Mix Design, Class 5000F3S1P2C2 ............... 1-
           Concrete Mix Design, Class 4500F2S1P1C1 ............... 1-
           Concrete Mix Design, Class 4500F1S1P0C1 ............... 1-
           Concrete Mix Design, Class 4500F3S1P1C2 ............... 1-
03 37 13  Shotcrete .................................................... 1-
03 37 14  Faux Rock .................................................... 1-
03 39 00  Concrete Curing ........................................... 1-
03 45 39  Sculpted Concrete ........................................ 1-
03 50 00  Articulating Concrete Block (ACB) System ............. 1-
03 62 00  Grouting ..................................................... 1-
           Supplement:                                          
           24-hour Evaluation of Nonshrink Grout Test Form and  
           Grout Testing Procedures ..................................... 1-
03 63 00  Concrete Doweling ....................................... 1-
03 64 23  Epoxy Resin Injection Grouting ......................... 1-

### DIVISION 04—MASONRY

04 21 13.13  Masonry Veneer ........................................... 1-
04 22 00  Concrete Unit Masonry ..................................... 1-

### DIVISION 05—METALS

05 05 19  Post-Installed Anchors ..................................... 1-

*Not Included in this Submittal*
DIVISION 11—EQUIPMENT
11 38 00 WaveShapers and Gates .............................................................. 1-

DIVISIONS 12 THROUGH 21—NOT USED

DIVISION 22—PLUMBING
22 47 13 Drinking Fountains, Yard Hydrants, and Showers ..................... 1-

DIVISION 23—HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)
23 05 48 Vibration Isolation for HVAC Piping and Equipment .................... 1-
23 05 93 Testing, Adjusting, and Balancing for HVAC ................................ 1-
23 07 00 HVAC Insulation ........................................................................... 1-
23 31 13 Metal Ducts and Accessories ....................................................... 1-
23 34 00 HVAC Fans .................................................................................. 1-
Supplement:
Fans Schedule ............................................................................................ 1-
23 37 00 Air Outlets and Inlets .................................................................... 1-
23 82 00 Terminal Heating and Cooling Units ............................................ 1-

DIVISIONS 24 AND 25—NOT USED

VOLUME 2

DIVISION 26—ELECTRICAL
26 05 02 Basic Electrical Requirements .................................................... 1-
26 05 04 Basic Electrical Materials and Methods ...................................... 1-
26 05 05 Conductors ................................................................................... 1-
26 05 26 Grounding and Bonding for Electrical Systems ......................... 1-
26 05 33 Raceway and Boxes ...................................................................... 1-
26 05 70 Electrical Systems Analysis ......................................................... 1-
26 08 00 Commissioning of Electrical Systems ....................................... 1-
26 09 13 Power Measurement and Control .............................................. 1-
26 14 13 Low-Voltage Switchboards ........................................................... 1-
26 20 00 Low-Voltage AC Induction Motors ............................................. 1-
26 22 00 Low-Voltage Transformers .......................................................... 1-
26 24 16 Panelboards .................................................................................. 1-
26 24 19 Low-Voltage Motor Control .......................................................... 1-

*Not Included in this Submittal
## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Division</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>Wiring Devices</td>
<td>1</td>
</tr>
<tr>
<td>26</td>
<td>Low-Voltage Adjustable Frequency Drive System</td>
<td>1</td>
</tr>
<tr>
<td>26</td>
<td>Facility Lightning Protection</td>
<td>1</td>
</tr>
<tr>
<td>26</td>
<td>Lighting</td>
<td>1</td>
</tr>
<tr>
<td>26</td>
<td>Exterior Lighting</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>DIVISIONS 27 THROUGH 30—NOT USED</strong></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>EARTHWORK</td>
<td></td>
</tr>
<tr>
<td>31 10</td>
<td>Site Clearing</td>
<td>1</td>
</tr>
<tr>
<td>31 23</td>
<td>Subgrade Preparation</td>
<td>1</td>
</tr>
<tr>
<td>31 23</td>
<td>Excavation</td>
<td>1</td>
</tr>
<tr>
<td>31 23</td>
<td>Dewatering</td>
<td>1</td>
</tr>
<tr>
<td>31 23</td>
<td>Fill and Backfill</td>
<td>1</td>
</tr>
<tr>
<td>31 23</td>
<td>Trench Backfill</td>
<td>1</td>
</tr>
<tr>
<td>31 32</td>
<td>Geotextile</td>
<td>1</td>
</tr>
<tr>
<td>31 37</td>
<td>Start-Up and Tuning</td>
<td>1</td>
</tr>
<tr>
<td>31 38</td>
<td>Riprap</td>
<td>1</td>
</tr>
<tr>
<td>31 41</td>
<td>Rock</td>
<td>1</td>
</tr>
<tr>
<td>31 68</td>
<td>Prestressed Rock Anchors</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>DIVISION 32—EXTERIOR IMPROVEMENTS</strong></td>
<td></td>
</tr>
<tr>
<td>32 13</td>
<td>Exposed Aggregate Concrete Paving</td>
<td>1</td>
</tr>
<tr>
<td>32 31</td>
<td>Fences and Gates</td>
<td>1</td>
</tr>
<tr>
<td>32 84</td>
<td>Landscape Irrigation</td>
<td>1</td>
</tr>
<tr>
<td>32 91</td>
<td>Planting Soil System Procurement</td>
<td>1</td>
</tr>
<tr>
<td>32 91</td>
<td>Planting Soil System Installation</td>
<td>1</td>
</tr>
<tr>
<td>32 92</td>
<td>Prairies, Meadows, and Wetlands</td>
<td>1</td>
</tr>
<tr>
<td>32 93</td>
<td>Planting and Fine Grading</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>DIVISION 33—UTILITIES</strong></td>
<td></td>
</tr>
<tr>
<td>33 05</td>
<td>Water Conveyance Pipe</td>
<td>1</td>
</tr>
<tr>
<td>33 13</td>
<td>Disinfection of Water Utility Distribution Facilities</td>
<td>1</td>
</tr>
<tr>
<td>33 41</td>
<td>Storm Drain Piping</td>
<td>1</td>
</tr>
<tr>
<td>33 41</td>
<td>Reinforced Concrete Data Sheet</td>
<td>1</td>
</tr>
<tr>
<td>33 44</td>
<td>Stormwater Structures</td>
<td>1</td>
</tr>
</tbody>
</table>

*Not Included in this Submittal*
33 46 00  Subsurface Drainage ................................................................. 1-

DIVISION 34—NOT USED

DIVISION 35—WATERWAY AND MARINE CONSTRUCTION

35 20 25  Pneumatic Gate Systems............................................................... 1-
35 31 19.16  Concrete Masonry Unit Revetments........................................ 1-

DIVISIONS 36 THROUGH 39—NOT USED

DIVISION 40—PROCESS INTERCONNECTIONS

40 05 15  Piping Support Systems ............................................................... 1-
Supplement:
   Table 1: Nonchemical Areas................................................................. 1-
40 27 00  Process Piping—General ............................................................... 1-
Supplement:
   Piping Schedule ............................................................................... 1-
40 27 00.08  Stainless Steel Pipe and Fittings—General Service
   Data Sheet ....................................................................................... 1-
40 27 00.10  Polyvinyl Chloride (PVC) Pipe and Fittings Data Sheet............. 1-
40 27 01  Process Piping Specialties ............................................................. 1-
40 80 01  Process Piping Leakage Testing ................................................... 1-
40 90 01  Instrumentation and Control for Process Systems ....................... 1-
Supplements:
   Instrument List ............................................................................... 1-
   Loop Specifications ........................................................................... 1-
   * PLC Input and Output List................................................................. 1-
   Instrument Calibration Sheet ............................................................. 1-
   Performance Acceptance Test Sheet.................................................... 1-
40 91 00  Instrumentation and Control Components ................................... 1-
40 99 90  Package Control Systems............................................................ 1-

DIVISIONS 41 THROUGH 49—NOT USED

VOLUME 3

DRAWINGS

END OF SECTION

*Not Included in this Submittal
PART 1   GENERAL

1.01 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work under this Contract includes modifications to Zink Dam, generally consisting of raising the existing dam, new gates, new whitewater recreational facilities, and a compressor control building. Contractor’s Bid price shall reflect all work necessary to complete the Work described in the Contract Documents. A brief summary of the Work is presented below.

B. Summary of Project:

1. The Project includes the furnishing of labor, materials, and equipment for the construction of the Zink Dam Improvements Project.
2. The following Owner-Furnished Products are included in the Work. See Section 01 64 00, Owner-Furnished Products.
   a. Pneumatic gates and air bladders.
3. Cofferdams.
4. Dam: The Work includes partial demolition of the existing dam, demolition of the existing bascule gates, raising the existing dam, and downstream roller mitigation.
5. East Bank: The Work includes new bank stabilization, underdrains, surface treatments, pathways, and plantings.
7. West Bank: The Work includes new bank stabilization, underdrains, surface treatments, pathways, and plantings.
8. Compressor Building.

PART 2   PRODUCTS (NOT USED)

PART 3   EXECUTION (NOT USED)

END OF SECTION
SECTION 01 29 00
PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:
   1. Schedule of Values: Submit on Contractor’s standard form.
   2. Application for Payment.
   3. Final Application for Payment.

1.02 SCHEDULE OF VALUES

A. Prepare a separate Schedule of Values for each schedule of the Work under the Agreement.

B. Upon request of Engineer, provide documentation to support the accuracy of the Schedule of Values.

C. Unit Price Work:
   1. Reflect specified cash allowances and alternates, as applicable.
   2. List bonds and insurance premiums, mobilization, demobilization, preliminary and detailed progress schedule preparation, equipment testing, facility startup, and Contract closeout separately.
   3. Break down by Division 02 through Division 49 with appropriate subdivision of each Specification.

D. An unbalanced or front-end loaded schedule will not be acceptable.

E. Summation of the complete Schedule of Values representing all the Work shall equal the Contract Price.

F. Submit Schedule of Values on a CD in a spreadsheet format compatible with latest version of Microsoft Excel.

1.03 APPLICATION FOR PAYMENT

A. Transmittal Summary Form: Attach one Summary Form with each detailed Application for Payment for each schedule and include Request for Payment of Materials and Equipment on Hand as applicable. Execute certification by authorized officer of Contractor.
B. Use detailed Application for Payment Form provided by Owner.

C. Provide separate form for each schedule as applicable.

D. Include accepted Schedule of Values for each schedule or portion of lump sum Work and the unit price breakdown for the Work to be paid on a unit priced basis.

E. Include separate line item for each Change Order and Work Change Directive executed prior to date of submission. Provide further breakdown of such as requested by Engineer.

F. Preparation:
   1. Round values to nearest dollar.
   2. Submit Application for Payment, including a Transmittal Summary Form and detailed Application for Payment Form(s) for each schedule as applicable, a listing of materials on hand for each schedule as applicable, and such supporting data as may be requested by Engineer.

1.04 MEASUREMENT—GENERAL

A. Weighing, measuring, and metering devices used to measure quantity of materials for Work shall be suitable for purpose intended and conform to tolerances and specifications as specified in National Institute of Standards and Technology, Handbook 44.

B. Whenever pay quantities of material are determined by weight, weigh material on scales furnished by Contractor and certified accurate by state agency responsible. Obtain weight or load slip from weigher and deliver to Owner’s representative at point of delivery of material.

C. If material is shipped by rail, car weights will be accepted provided that actual weight of material only will be paid for and not minimum car weight used for assessing freight tariff, and provided further that car weights will not be acceptable for material to be passed through mixing plants.

D. Vehicles used to haul material being paid for by weight shall be weighed empty daily and at such additional times as required by Engineer. Each vehicle shall bear a plainly legible identification mark.

E. Haul materials that are specified for measurement by the cubic yard measured in the vehicle in transport vehicles of such type and size that actual contents may be readily and accurately determined. Unless all vehicles are of uniform capacity, each vehicle must bear a plainly legible identification mark indicating its water level capacity. Load vehicles to at least their water level
capacity. Loads hauled in vehicles not meeting above requirements or loads of a quantity less than the capacity of the vehicle, measured after being leveled off as above provided, will be subject to rejection, and no compensation will be allowed for such material.

F. Where measurement of quantities depends on elevation of existing ground, elevations obtained during construction will be compared with those shown on Drawings. Variations of 1 foot or less will be ignored, and profiles shown on Drawings will be used for determining quantities.

G. Units of measure shown on Bid Form shall be as follows, unless specified otherwise.

<table>
<thead>
<tr>
<th>Item</th>
<th>Method of Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>Acre—Field Measure by Engineer</td>
</tr>
<tr>
<td>CY</td>
<td>Cubic Yard—Field Measure by Engineer within limits specified or shown</td>
</tr>
<tr>
<td>CY-VM</td>
<td>Cubic Yard—Measured in Vehicle by Volume</td>
</tr>
<tr>
<td>EA</td>
<td>Each—Field Count by Engineer</td>
</tr>
<tr>
<td>GAL</td>
<td>Gallon—Field Measure by Engineer</td>
</tr>
<tr>
<td>HR</td>
<td>Hour</td>
</tr>
<tr>
<td>LB</td>
<td>Pound(s)—Weight Measure by Scale</td>
</tr>
<tr>
<td>LF</td>
<td>Linear Foot—Field Measure by Engineer</td>
</tr>
<tr>
<td>MFBM</td>
<td>Thousand Foot Board Measure—[Delivery Invoice] [Field Measure by Engineer]</td>
</tr>
<tr>
<td>SF</td>
<td>Square Foot</td>
</tr>
<tr>
<td>SY</td>
<td>Square Yard</td>
</tr>
<tr>
<td>TON</td>
<td>Ton—Weight Measure by Scale (2,000 pounds)</td>
</tr>
</tbody>
</table>
H. Measurement of Linear Items:

1. Where payment will be made based on linear quantities and on parameters other than length, those parameters shall be as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Measurement Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trench Safety System</td>
<td>Depth of Trench: 0 foot to 4 feet; 4 feet to 10 feet; over 10 feet in 2-foot increments. The depth of trench will be measured at intervals of 25 feet along the centerline of the trench. The depth of each measuring point will be the depth from existing at grade surface to bottom of pipe base, [A: ] inches below pipe invert and will used for computing the depth of trench for a distance of 25 feet ahead of the point of measurement. The depth figures indicated in Bid Form are inclusive to nearest 0.1 foot; that is, a trench depth measured as 11.9 feet will be paid for at the unit price for excavation 10 feet to 12 feet deep. A trench depth measured as 12 feet will be paid for at the unit price for excavation 12 feet to 14 feet deep.</td>
</tr>
<tr>
<td>Unclassified Trench Excavation</td>
<td>Depth of Trench: Same as Trench Safety System above.</td>
</tr>
<tr>
<td>Trench Backfill and Compaction</td>
<td>Depth of Trench: Same as Unclassified Trench Excavation above.</td>
</tr>
<tr>
<td>Rock Excavation</td>
<td>Depth: Same as for Unclassified Trench Excavation above except that depth will be measured from surface of rock to bottom of pipe base [A: ] inches below pipe invert.</td>
</tr>
</tbody>
</table>

1.05 PAYMENT

A. General:

1. The following items shall be bid as shown on the Estimate of Quantities of the Bid Proposal. The description below summarizes the elements of the Work that to be included in each item, but they are not intended to represent a complete list of the required work for a completed job. Rather, the descriptions are intended to serve as guidelines for the proper distribution of the Bid price. Any items not specifically described but required by Drawings, Contract Documents, and Specifications shall be included in the appropriate items. The lump sum and appropriate unit price Bid items shall be broken down for the purpose of monthly
progress payment as outlined below. Breakdown of the lump sum and unit quantity Bid items shall be provided by the apparent low Bidder within 48 hours after the Bid opening.

2. The Owner pays vendor invoices directly based upon written documentation submitted to and approved by the Owner.

B. Unit Price:

1. Payment for unit price items covers all the labor, materials, and services necessary to furnish and install the following items:
   a. Mobilization:
      1) This item includes mobilization and demobilization. A maximum of 5 percent of the total base Bid is allowed in the Bid proposal for mobilization and shall be paid for on an each (EA) basis in the following manner:
         a) 50 percent on the first pay estimate.
         b) 35 percent on the pay estimate that shows 50 percent completion of the Work, not included allowances for stored materials.
         c) 15 percent on the final pay estimate.
   b. East Bank.
   c. Recreational Flume.
   d. Dam Modifications.
   e. Installation of Owner-Furnished Products.
   f. West Bank.
   g. Compressor Building Complete:
      1) This item includes all required work associated with the Compressor Building including, but not limited to:
         a) Excavation.
         b) Subgrade preparation.
         c) Foundation.
         d) Building walls.
         e) Building roof.
         f) Installation of doors.
         g) Installation of windows.
         h) Installation of control system.
         i) Installation of pneumatic gate equipment.
         j) Installation of hydraulic gate equipment.
         k) This item includes all work required to make the Control Building operational. This item all includes all required work shown on Drawings, Specifications, or required for the construction of the Compressor Building and not covered by another pay item. This item shall be paid for on a unit basis of each (EA) using a breakdown approved by the Owner. Partial
payment for this item shall be based on percentage of work completed.

C. Allowances: An Owner’s Allowance has been provided in the Contract for various civil, mechanical, electrical, and plumbing and general construction work. The allowance shall be used only at the discretion of the Owner. Any allowance balance remaining at the completion of the Project will be credited back to the Owner on the final Application for Payment submitted by the Contractor. Contractor shall proceed with the work included in the allowance only after receiving a written order from the Owner’s Representative authorizing such work. Proceeding with work in the allowance without a written order from the Owner’s Representative will be at the Contractor’s cost. The allowance shall be used for the cost of materials, labor, installation, and overhead and profit in accordance with GC-26, for additional work that is not identified in Construction Documents/Plan, and not included in the Base Bid sum.

1. Owner’s Allowance: Allowance for various mechanical, electrical, plumbing, or general construction work not included in the Contract Documents.
   a. Allowance $xxx,xxx.

1.06 NONPAYMENT FOR REJECTED OR UNUSED PRODUCTS

A. Payment will not be made for following:

   1. Loading, hauling, and disposing of rejected material.
   2. Quantities of material wasted or disposed of in manner not called for under Contract Documents.
   3. Rejected loads of material, including material rejected after it has been placed by reason of failure of Contractor to conform to provisions of Contract Documents.
   4. Material not unloaded from transporting vehicle.
   5. Defective Work not accepted by Owner.
   6. Material remaining on hand after completion of Work.

1.07 PARTIAL PAYMENT FOR STORED MATERIALS AND EQUIPMENT

A. Partial Payment: No partial payments will be made for materials and equipment delivered or stored unless Shop Drawings and preliminary operation and maintenance data is acceptable to Engineer.

B. Final Payment: Will be made only for products incorporated in Work; remaining products, for which partial payments have been made, shall revert to Contractor unless otherwise agreed, and partial payments made for those items will be deducted from final payment.
1.08 PARTIAL PAYMENT FOR UNDELIVERED, PROJECT-SPECIFIC MANUFACTURED OR FABRICATED EQUIPMENT

A. Notwithstanding above provisions, partial payments for undelivered (not yet delivered to Site or not stored in the vicinity of Site) products specifically manufactured for this Project, excluding off the shelf or catalog items, will be made for products listed below when all following conditions exist:

   1. Partial payment request is supported by written acknowledgment from Suppliers that invoice requirements have been met.
   2. Equipment is adequately insured, maintained, stored, and protected by appropriate security measures.
   3. Each equipment item is clearly marked and segregated from other items to permit inventory and accountability.
   4. Authorization has been provided for access to storage Site for Engineer and Owner.
   5. Equipment meets applicable Specifications of these Contract Documents.

B. Payment of 15 percent of manufacturer’s quoted price for undelivered, Project-specific manufactured equipment will be made following Shop Drawing approval. Thereafter, monthly payments will be made based on progress of fabrication as determined by Engineer, but in no case will total of payments prior to delivery exceed 75 percent of manufacturer’s quoted price.

C. Failure of Contractor to continue compliance with above requirements shall give cause for Owner to withhold payments made for such equipment from future partial payments.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
SECTION 01 31 13
PROJECT COORDINATION

PART 1  GENERAL

1.01  SUBMITTALS

A.  Informational:
   1.  Statement of Qualification (SOQ) for land surveyor or civil engineer.
   2.  Photographs:
        a.  Digital Images: Submit on DVD disc each monthly progress meeting. Each image is to have a minimum file size of 1.4 Mb (1,400 Kb) so viewed resolution is high quality. The production of larger file sizes with higher resolution is encouraged.
        3.  Video Recordings: Submit one copy, including updated copy of project video log each monthly progress meeting.

1.02  OWNER-FURNISHED PRODUCTS

A.  Refer to Section 01 64 00, Owner-Furnished Products.

1.03  UTILITY NOTIFICATION AND COORDINATION

A.  Coordinate the Work with various utilities within Project limits. Notify applicable utilities prior to commencing Work, if damage occurs, or if conflicts or emergencies arise during the Work.

1.04  PROJECT MILESTONES

A.  General: Include the Milestones specified herein as a part of the Progress Schedule required under Section 01 32 00, Construction Progress Documentation.

B.  Project Milestones:

   1.  Generally described in the Agreement Form. Following is a detailed description of each:
        a.  [A:  ]
        b.  [B:  ]
1.05 WORK SEQUENCING/CONSTRAINTS

A. Include the following work sequences in the Progress Schedule:

1. Phase 1: Construct East Bank, Recreational Flume and east half of dam modifications including the 20 feet wide Fixed Crest section.
2. Phase 2: Construct West Bank, Waveshaper Area, and west half of dam modifications up to the 20 feet wide Fixed Crest section completed in Phase 1.

1.06 FACILITY OPERATIONS

A. Continuous operation of Owner’s facilities is of critical importance. Schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified.

B. Perform Work continuously during critical connections and changeovers, and as required to prevent interruption of Owner’s operations.

C. When necessary, plan, design, and provide various temporary services, utilities, connections, temporary piping and heating, access, and similar items to maintain continuous operations of Owner’s facility.

D. Do not close lines, open or close valves, or take other action which would affect the operation of existing systems, except as specifically required by the Contract Documents and after authorization by Owner and Engineer. Such authorization will be considered within 48 hours after receipt of Contractor’s written request.

E. Install and maintain bypass facilities and temporary connections required to keep PSO upstream and downstream water intake operations on line. Sequences other than those specified will be considered upon written request to Owner and Engineer, provided they afford equivalent continuity of operations.

F. Do not proceed with Work affecting a facility’s operation without obtaining Owner’s and Engineer’s advance approval of the need for and duration of such Work.

G. Relocation of Existing Facilities:

1. During construction, it is expected that minor relocations of Work will be necessary.
2. Provide complete relocation of existing structures and Underground Facilities, including piping, utilities, equipment, structures, electrical conduit wiring, electrical duct bank, and other necessary items.
3. Use only new materials for relocated facility. Match materials of existing facility, unless otherwise shown or specified.
4. Perform relocations to minimize downtime of existing facilities.
5. Install new portions of existing facilities in their relocated position prior to removal of existing facilities, unless otherwise accepted by Engineer.

1.07 ADJACENT FACILITIES AND PROPERTIES

A. Examination:

1. After Effective Date of the Agreement and before Work at Site is started, Contractor, Engineer, and affected property owners and utility owners shall make a thorough examination of pre-existing conditions including existing buildings, structures, and other improvements in vicinity of Work, as applicable, which could be damaged by construction operations.
2. Periodic reexamination shall be jointly performed to include, but not limited to, cracks in structures, settlement, leakage, and similar conditions.

B. Documentation:

1. Record and submit documentation of observations made on examination inspections in accordance with Article Construction Photographs and Article Audio-Video Recordings.
2. Such documentation shall be used as indisputable evidence in ascertaining whether and to what extent damage occurred as a result of Contractor’s operations, and is for the protection of adjacent property owners, Contractor, and Owner.

1.08 CONSTRUCTION PHOTOGRAPHS

A. General:

1. Photographically document all phases of the Project including preconstruction, construction progress, and post-construction.
2. Engineer shall have right to select subject matter and vantage point from which photographs are to be taken.
3. Digital Images: No post-session electronic editing of images is allowed. Stored image shall be actual image as captured without cropping or other edits.
ZINK DAM IMPROVEMENTS

B. Preconstruction and Post-Construction:
   1. After Effective Date of the Agreement and before Work at Site is started, and again upon issuance of Substantial Completion, take a minimum of 100 photographs of Site and property adjacent to perimeter of Site.
   2. Particular emphasis shall be directed to structures both inside and outside the Site.
   3. Format: Digital, minimum resolution of 1,832 pixels by 3,264 pixels and 24-bit, millions of colors.

C. Construction Progress Photos:
   1. Photographically demonstrate progress of construction, showing every aspect of Site and adjacent properties as well as interior and exterior of new or impacted structures.
   2. Weekly: Take 50 photographs using digital, minimum resolution of 1,832 pixels by 3,264 pixels and 24-bit, millions of colors.

D. Documentation:
   1. Digital Images:
      a. Electronic image shall have date taken embedded into image.
      b. Archive using a commercially available photo management system that provides listing of photographs, including date, keyword description, and direction of photograph.
      c. Label each disk with Project and Owner’s name, and month and year images were produced.

1.09 AUDIO-VIDEO RECORDINGS

A. Prior to beginning the Work on Site or of a particular area of the Work, and again within 10 days following date of Substantial Completion, videograph Site and property adjacent to Site.

B. In the case of preconstruction recording, no work shall begin in the area prior to Engineer’s review and approval of content and quality of video for that area.

C. Particular emphasis shall be directed to physical condition of existing vegetation, structures, and pavements within and areas adjacent to and within the right-of-way or easement, and on Contractor storage and staging areas.

D. Engineer shall have right to select subject matter and vantage point from which videos are to be taken.
E. Video Format and Quality:

1. DVD format, with sound.
2. Video:
   a. Produce bright, sharp, and clear images with accurate colors, free of distortion and other forms of picture imperfections.
   b. Electronically, and accurately display the month, day, year, and time of day of the recording.
3. Audio:
   a. Audio documentation shall be done clearly, precisely, and at a moderate pace.
   b. Indicate date, project name, and a brief description of the location of recording, including:
      1) Facility name.
      2) Street names or easements.
      3) Addresses of private property.
      4) Direction of coverage, including engineering stationing, if applicable.

F. Documentation:

1. DVD Label:
   a. DVD number (numbered sequentially, beginning with 001).
   b. Project name.
   c. Date and time of coverage.
2. Project Video Log: Maintain an ongoing log that incorporates above noted label information for DVDs on Project.

1.10 REFERENCE POINTS AND SURVEYS

A. Location and elevation of bench marks are shown on Drawings.

B. Contractor’s Responsibilities:

1. Provide additional survey and layout required to layout the Work.
2. Notify Engineer at least 3 working days in advance of time when grade and line to be provided by Owner will be needed.
3. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
4. In event of discrepancy in data or staking provided by Owner, request clarification before proceeding with Work.
5. Retain professional land surveyor or civil engineer registered in state of Project who shall perform or supervise engineering surveying necessary for additional construction staking and layout.
6. Maintain complete accurate log of survey work as it progresses as a Record Document.
7. On request of Engineer, submit documentation.
8. Provide competent employee(s), tools, stakes, and other equipment and materials as Engineer may require to:
   a. Establish control points, lines, and easement boundaries.
   b. Check layout, survey, and measurement work performed by others.
   c. Measure quantities for payment purposes.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CUTTING, FITTING, AND PATCHING

A. Cut, fit, adjust, or patch Work and work of others, including excavation and backfill as required, to make Work complete.

B. Obtain prior written authorization of Engineer before commencing Work to cut or otherwise alter:
   1. Structural or reinforcing steel, structural column or beam, elevated slab, trusses, or other structural member.
   2. Weather-resistant or moisture-resistant elements.
   3. Efficiency, maintenance, or safety of element.
   4. Work of others.

C. Refinish surfaces to provide an even finish.
   1. Refinish continuous surfaces to nearest intersection.
   2. Refinish entire assemblies.
   3. Finish restored surfaces to such planes, shapes, and textures that no transition between existing work and the Work is evident in finished surfaces.

D. Restore existing work, underground facilities, and surfaces that are to remain in completed Work including concrete-embedded piping, conduit, and other utilities as specified and as shown on Drawings.

E. Make restorations with new materials and appropriate methods as specified for new Work of similar nature; if not specified, use recommended practice of manufacturer or appropriate trade association.

F. Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces and fill voids.
G. Remove specimens of installed Work for testing when requested by Engineer.

END OF SECTION
PART 1 GENERAL

1.01 GENERAL

A. Engineer will schedule physical arrangements for meetings throughout progress of the Work, prepare meeting agenda with regular participant input and distribute with written notice of each meeting, preside at meetings, record minutes to include significant proceedings and decisions, and reproduce and distribute copies of minutes within 7 days after each meeting to participants and parties affected by meeting decisions.

1.02 PRECONSTRUCTION CONFERENCE

A. Contractor shall be prepared to discuss the following subjects, as a minimum:

1. Required schedules.
2. Status of Bonds and insurance.
3. Sequencing of critical path work items.
4. Progress payment procedures.
5. Project changes and clarification procedures.
6. Use of Site, access, office and storage areas, security and temporary facilities.
7. Major product delivery and priorities.
8. Contractor’s safety plan and representative.

B. Attendees will include:

1. Owner’s representatives.
2. Contractor’s office representative.
3. Contractor’s resident superintendent.
4. Contractor’s quality control representative.
5. Subcontractors’ representatives whom Contractor may desire or Engineer may request to attend.
6. Engineer’s representatives.
7. Others as appropriate.

1.03 PRELIMINARY SCHEDULES REVIEW MEETING

A. As set forth in General Conditions and Section 01 32 00, Construction Progress Documentation.
1.04 PROGRESS MEETINGS

A. Engineer will schedule regular progress meetings at Site, conducted monthly to review the Work progress, Progress Schedule, Schedule of Submittals, Application for Payment, contract modifications, and other matters needing discussion and resolution.

B. Attendees will include:
   1. Owner’s representative(s), as appropriate.
   2. Contractor, Subcontractors, and Suppliers, as appropriate.
   3. Engineer’s representative(s).
   4. Others as appropriate.

1.05 QUALITY CONTROL MEETINGS

A. In accordance with Section 01 45 16.13, Contractor Quality Control.

B. Attendees will include:
   1. Contractor.
   2. Contractor’s designated quality control representative.
   3. Subcontractors and Suppliers, as necessary.
   4. Engineer’s representatives.

1.06 PREINSTALLATION MEETINGS

A. When required in individual Specification sections, convene at Site prior to commencing the Work of that section.

B. Require attendance of entities directly affecting, or affected by, the Work of that section.

C. Notify Engineer days in advance of meeting date.

D. Provide suggested agenda to Engineer to include reviewing conditions of installation, preparation and installation or application procedures, and coordination with related Work and work of others.

1.07 FACILITY STARTUP MEETINGS

A. Schedule and attend a minimum of two facility startup meetings. The first of such meetings shall be held prior to submitting Facility Startup Plan, as specified in Section 01 91 14, Equipment Testing and Facility Startup, and shall include preliminary discussions regarding such plan.
B. Agenda items shall include, but not be limited to, content of Facility Startup Plan, coordination needed between various parties in attendance, and potential problems associated with startup.

C. Attendees will include:

1. Contractor.
2. Contractor’s designated quality control representative.
3. Subcontractors and equipment manufacturer’s representatives whom Contractor deems to be directly involved in facility startup.
4. Engineer’s representatives.
5. Owner’s operations personnel.
6. Others as required by Contract Documents or as deemed necessary by Contractor.

1.08 OTHER MEETINGS

A. In accordance with Contract Documents and as may be required by Owner and Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
SECTION 01 32 00
CONSTRUCTION PROGRESS DOCUMENTATION

PART 1  GENERAL

1.01  SUBMITTALS

A.  Informational Submittals:

1.  Preliminary Progress Schedule: Submit at least 7 days prior to preconstruction conference.

2.  Detailed Progress Schedule:
   a.  Submit initial Detailed Progress Schedule within 30 days after Effective Date of the Agreement.
   b.  Submit an Updated Progress Schedule at each update, in accordance with Article Detailed Progress Schedule.

3.  Submit with Each Progress Schedule Submission:
   a.  Contractor’s certification that Progress Schedule submission is actual schedule being used for execution of the Work.
   b.  Electronic file compatible with latest version of Project Planner (P6) by Primavera Systems, Inc.
   c.  Progress Schedule: Four legible copies.
   d.  Narrative Progress Report: Same number of copies as specified for Progress Schedule.

4.  Prior to final payment, submit a final Updated Progress Schedule.

1.02  PRELIMINARY PROGRESS SCHEDULE

A.  In addition to basic requirements outlined in General Conditions, show a detailed schedule, beginning with Notice to Proceed, for minimum duration of 90 days, and a summary of balance of Project through Final Completion.

B.  Show activities including, but not limited to, the following:

1.  Notice to Proceed.
2.  Permits.
3.  Submittals, with review time. Contractor may use Schedule of Submittals specified in Section 01 33 00, Submittal Procedures.
4.  Early procurement activities for long lead equipment and materials.
5.  Initial Site work.
7.  Specified Work sequences and construction constraints.
9.  Owner-furnished products delivery dates or ranges of dates.
10. Major structural, mechanical, equipment, electrical, architectural, and instrumentation and control Work.
11. System startup summary.
12. Project close-out summary.

C. Update Preliminary Progress Schedule monthly as part of progress payment process. Failure to do so may result in the Owner withholding all or part of the monthly progress payment until the Preliminary Progress Schedule is updated in a manner acceptable to Engineer.

D. Format: In accordance with Article Progress Schedule—Bar Chart.

1.03 DETAILED PROGRESS SCHEDULE

A. In addition to requirements of General Conditions, submit Detailed Progress Schedule beginning with Notice to Proceed and continuing through Final Completion.

B. Show the duration and sequences of activities required for complete performance of the Work reflecting means and methods chosen by Contractor.

C. When accepted by Engineer, Detailed Progress Schedule will replace Preliminary Progress Schedule and become Baseline Schedule. Subsequent revisions will be considered as Updated Progress Schedules.

D. Format: In accordance with Article Progress Schedule—Bar Chart.

E. Update monthly to reflect actual progress and occurrences to date, including weather delays.

1.04 PROGRESS SCHEDULE—BAR CHART

A. General: Comprehensive bar chart schedule, generally as outlined in Associated General Contractors of America (AGC) 580, “Construction Project Planning and Scheduling Guidelines.” If a conflict occurs between the AGC publication and this Specification, this Specification shall govern.

B. Format:

1. Unless otherwise approved, white paper, 11-inch by 17-inch sheet size.
2. Title Block: Show name of Project and Owner, date submitted, revision or update number, and name of scheduler.
3. Identify horizontally, across the top of the schedule, the time frame by year, month, and day.
4. Identify each activity with a unique number and a brief description of the Work associated with that activity.

5. Legend: Describe standard and special symbols used.

C. Contents:

1. Identify, in chronological order, those activities reasonably required to complete the Work, including as applicable, but not limited to:
   a. Obtaining permits, submittals for early product procurement, and long lead time items.
   b. Mobilization and other preliminary activities.
   c. Initial Site work.
   d. Specified Work sequences, constraints, and Milestones, including Substantial Completion date(s).
   e. Subcontract Work.
   f. Major equipment design, fabrication, factory testing, and delivery dates.
   g. Delivery dates for Owner-furnished products, as specified in Section 01 11 00, Summary of Work.
   h. Sitework.
   i. Concrete Work.
   j. Structural steel Work.
   k. Architectural features Work.
   l. Conveying systems Work.
   m. Equipment Work.
   n. Mechanical Work.
   o. Electrical Work.
   p. Instrumentation and control Work.
   q. Interfaces with Owner-furnished equipment.
   r. Other important Work for each major facility.
   s. Equipment and system startup and test activities.
   t. Project closeout and cleanup.
   u. Demobilization.

1.05 PROGRESS OF THE WORK

A. Updated Progress Schedule shall reflect:

1. Progress of Work to within 5 working days prior to submission.
2. Approved changes in Work scope and activities modified since submission.
3. Delays in Submittals or resubmittals, deliveries, or Work.
4. Adjusted or modified sequences of Work.
5. Other identifiable changes.
6. Revised projections of progress and completion.

B. Produce detailed subschedules during Project, upon request of Owner or Engineer, to further define critical portions of the Work such as facility shutdowns.

C. If an activity is not completed by its latest scheduled completion date and this failure is anticipated to extend Contract Times (or Milestones), submit, within 7 days of such failure, a written statement as to how nonperformance will be corrected to return Project to acceptable current Progress Schedule. Actions by Contractor to complete the Work within Contract Times (or Milestones) will not be justification for adjustment to Contract Price or Contract Times.

D. Owner may order Contractor to increase plant, equipment, labor force, or working hours if Contractor fails to:
   1. Complete a Milestone activity by its completion date.
   2. Satisfactorily execute Work as necessary to prevent delay to overall completion of Project, at no additional cost to Owner.

1.06 NARRATIVE PROGRESS REPORT

A. Format:
   1. Organize same as Progress Schedule.
   2. Identify, on a cover letter, reporting period, date submitted, and name of author of report.

B. Contents:
   1. Number of days worked over the period, work force on hand, construction equipment on hand (including utility vehicles such as pickup trucks, maintenance vehicles, stake trucks).
   2. General progress of Work, including a listing of activities started and completed over the reporting period, mobilization/demobilization of subcontractors, and major milestones achieved.
   3. Contractor’s plan for management of Site (for example, lay down and staging areas, construction traffic), use of construction equipment, buildup of trade labor, and identification of potential Contract changes.
   4. Identification of new activities and sequences as a result of executed Contract changes.
   5. Documentation of weather conditions over the reporting period, and any resulting impacts to the work.
   6. Description of actual or potential delays, including related causes, and the steps taken or anticipated to mitigate their impact.
7. Changes to activity logic.
8. Changes to the critical path.
9. Identification of, and accompanying reason for, any activities added or deleted since the last report.
10. Steps taken to recover the schedule from Contractor-caused delays.

1.07 SCHEDULE ACCEPTANCE

A. Engineer’s acceptance will demonstrate agreement that:

1. Proposed schedule is accepted with respect to:
   a. Contract Times, including Final Completion and all intermediate Milestones, are within the specified times.
   b. Specified Work sequences and constraints are shown as specified.
   c. Specified Owner-furnished equipment or material arrival dates, or range of dates, are included.
   d. Access restrictions are accurately reflected.
   e. Startup and testing times are as specified.
   f. Submittal review times are as specified.
   g. Startup testing duration is as specified and timing is acceptable.

2. In all other respects, Engineer’s acceptance of Contractor’s schedule indicates that, in Engineer’s judgment, schedule represents reasonable plan for constructing Project in accordance with the Contract Documents. Engineer’s review will not make any change in Contract requirements. Lack of comment on any aspect of schedule that is not in accordance with the Contract Documents will not thereby indicate acceptance of that change, unless Contractor has explicitly called the nonconformance to Engineer’s attention in submittal. Schedule remains Contractor’s responsibility and Contractor retains responsibility for performing all activities, for activity durations, and for activity sequences required to construct Project in accordance with the Contract Documents.

B. Unacceptable Preliminary Progress Schedule:

1. Make requested corrections; resubmit within 10 days.
2. Until acceptable to Engineer as Baseline Progress Schedule, continue review and revision process, including updating schedule on a monthly basis to reflect actual progress and occurrences to date.

C. Unacceptable Detailed Progress Schedule:

1. Make requested corrections; resubmit within 10 days.
2. Until acceptable to Engineer as Baseline Progress Schedule, continue review and revision process.
D. Narrative Report: All changes to activity duration and sequences, including addition or deletion of activities subsequent to Engineer’s acceptance of Baseline Progress Schedule, shall be delineated in Narrative Report current with proposed Updated Progress Schedule.

1.08 ADJUSTMENT OF CONTRACT TIMES

A. Reference General Conditions.

B. Evaluation and reconciliation of Adjustments of Contract Times shall be based on the Updated Progress Schedule at the time of proposed adjustment or claimed delay.

C. Schedule Contingency:

1. Contingency, when used in the context of the Progress Schedule, is time between Contractor’s proposed Completion Time and Contract Completion Time.

2. Contingency included in Progress Schedule is a Project resource available to both Contractor and Owner to meet Contract Milestones and Contract Times. Use of Schedule contingency shall be shared to the proportionate benefit of both parties.

3. Use of schedule contingency suppression techniques such as preferential sequencing and extended activity times is prohibited.

4. Pursuant to Contingency sharing provisions of this Specification, no time extensions will be granted, nor will delay damages be paid until a delay occurs which (i) consumes all available contingency time, and (ii) extends Work beyond the Contract Completion date.

D. Claims Based on Contract Times:

1. Where Engineer has not yet rendered formal decision on Contractor’s Claim for adjustment of Contract Times, and parties are unable to agree as to amount of adjustment to be reflected in Progress Schedule, reflect an interim adjustment in the Progress Schedule as acceptable to Engineer.

2. It is understood and agreed that such interim acceptance will not be binding on either Contractor or Owner, and will be made only for the purpose of continuing to schedule Work until such time as formal decision has been rendered as to an adjustment, if any, of the Contract Times.

3. Revise Progress Schedule prepared thereafter in accordance with Engineer’s formal decision.
PART 1 GENERAL

1.01 DEFINITIONS

A. Action Submittal: Written and graphic information submitted by Contractor that requires Engineer’s approval.

B. Deferred Submittal: Information in accordance with 2015 IBC submitted by Contractor for portions of design that are to be submitted to permitting agency for approval prior to installation of that portion of the Work, along with Engineer’s review documentation that submittal has been found to be in general conformance with Project’s design.

C. Informational Submittal: Information submitted by Contractor that requires Engineer’s review and determination that submitted information is in accordance with the Conditions of the Contract.

1.02 PROCEDURES

A. Direct submittals to Owner and Engineer, unless specified otherwise.

B. Electronic Submittals: Submittals shall, unless specifically accepted, be made in electronic format.

1. Each submittal shall be an electronic file in Adobe Acrobat Portable Document Format (PDF). Use the latest version available at time of execution of the Agreement.

2. Electronic files that contain more than 10 pages in PDF format shall contain internal bookmarking from an index page to major sections of the document.

3. PDF files shall be set to open “Bookmarks and Page” view.

4. Add general information to each PDF file, including title, subject, author, and keywords.

5. PDF files shall be set up to print legibly at 8.5-inch by 11-inch, 11-inch by 17-inch, or 22-inch by 34-inch. No other paper sizes will be accepted.


7. Include a copy of the Transmittal of Contractor’s Submittal form, located at end of section, with each electronic file.

8. Engineer will reject submittal that is not electronically submitted, unless specifically accepted.
9. Provide Engineer with authorization to reproduce and distribute each file as many times as necessary for Project documentation.

10. Detailed procedures for handling electronic submittals will be discussed at the preconstruction conference.

C. Transmittal of Submittal:

1. Contractor shall:
   a. Review each submittal and check for compliance with Contract Documents.
   b. Stamp each submittal with uniform approval stamp before submitting to Engineer.
      1) Stamp to include Project name, submittal number, Specification number, Contractor’s reviewer name, date of Contractor’s approval, and statement certifying submittal has been reviewed, checked, and approved for compliance with Contract Documents.
      2) Engineer will not review submittals that do not bear Contractor’s approval stamp and will return them without action.

2. Complete, sign, and transmit with each submittal package, one Transmittal of Contractor’s Submittal form in format approved by Engineer.

3. Identify each submittal with the following:
   a. Numbering and Tracking System:
      1) Sequentially number each submittal.
      2) Resubmission of submittal shall have original number with sequential alphabetic suffix.
   b. Specification section and paragraph to which submittal applies.
   c. Project title and Engineer’s project number.
   d. Date of transmittal.
   e. Names of Contractor, Subcontractor or Supplier, and manufacturer as appropriate.

4. Identify and describe each deviation or variation from Contract Documents.

D. Format:

1. Do not base Shop Drawings on reproductions of Contract Documents.

2. Package submittal information by individual specification section. Do not combine different specification sections together in submittal package, unless otherwise directed in Specification.

3. Present in a clear and thorough manner and in sufficient detail to show kind, size, arrangement, and function of components, materials, and devices, and compliance with Contract Documents.
4. Index with labeled tab dividers in orderly manner.

E. Timeliness: Schedule and submit in accordance Schedule of Submittals and requirements of individual specification sections.

F. Processing Time:

1. Time for review shall commence on Engineer’s receipt of submittal.
2. Engineer will act upon Contractor’s submittal and transmit response to Contractor not later than 30 days after receipt, unless otherwise specified.
3. Resubmittals will be subject to same review time.
4. No adjustment of Contract Times or Price will be allowed as a result of delays in progress of Work caused by rejection and subsequent resubmittals.

G. Resubmittals: Clearly identify each correction or change made.

H. Incomplete Submittals:

1. Engineer will return entire submittal for Contractor’s revision if preliminary review deems it incomplete.
2. When any of the following are missing, submittal will be deemed incomplete:
   a. Contractor’s review stamp; completed and signed.
   b. Transmittal of Contractor’s Submittal; completed and signed.
   c. Insufficient number of copies.

I. Submittals not required by Contract Documents:

1. Will not be reviewed and will be returned stamped “Not Subject to Review.”
2. Engineer will keep one copy and return submittal to Contractor.

1.03 ACTION SUBMITTALS

A. Prepare and submit Action Submittals required by individual specification sections.

B. Shop Drawings:

2. Identify and Indicate:
   a. Applicable Contract Drawing and Detail number, products, units and assemblies, and system or equipment identification or tag numbers.
b. Equipment and Component Title: Identical to title shown on Drawings.
c. Critical field dimensions and relationships to other critical features of Work. Note dimensions established by field measurement.
d. Project-specific information drawn accurately to scale.

3. Manufacturer’s standard schematic drawings and diagrams as follows:
   a. Modify to delete information that is not applicable to the Work.
   b. Supplement standard information to provide information specifically applicable to the Work.

4. Product Data: Provide as specified in individual specifications.

5. Deferred Submittal: See Drawings for list of deferred submittals.
   a. Contractor-design drawings and product data related to permanent construction.
      1) Written and graphic information.
      2) Drawings.
      3) Cut sheets.
      4) Data sheets.
      5) Action item submittals requested in individual specification section.
   b. Prior to installation of indicated structural or nonstructural element, equipment, distribution system, or component or its anchorage, submit required supporting data and drawings for review and acceptance by Engineer. Documentation of review and approval provided on Engineer’s comment form, along with completed submittal, shall be filed with permitting agency by Contractor and approved by permitting agency prior to installation.

6. Foreign Manufacturers: When proposed, include names and addresses of at least two companies that maintain technical service representatives close to Project.

C. Samples:

1. Copies: Two, unless otherwise specified in individual specifications.
2. Preparation:
   a. Mount, display, or package Samples in manner specified to facilitate review of quality. Attach label on unexposed side that includes the following:
      1) Manufacturer name.
      2) Model number.
      3) Material.
      4) Sample source.
3. Manufacturer’s Color Chart: Units or sections of units showing full range of colors, textures, and patterns available.

4. Full-size Samples:
   a. Size as indicated in individual specification section.
   b. Prepared from same materials to be used for the Work.
   c. Cured and finished in manner specified.
   d. Physically identical with product proposed for use.

D. Action Submittal Dispositions: Engineer will review, comment, stamp, and distribute as noted.

1. Approved:
   a. Contractor may incorporate product(s) or implement Work covered by submittal.
   b. Distribution: Electronic.

2. Approved as Noted:
   a. Contractor may incorporate product(s) or implement Work covered by submittal, in accordance with Engineer’s notations.
   b. Distribution: Electronic.

3. Partial Approval, Resubmit as Noted:
   a. Make corrections or obtain missing portions, and resubmit.
   b. Except for portions indicated, Contractor may begin to incorporate product(s) or implement Work covered by submittal, in accordance with Engineer’s notations.
   c. Distribution: Electronic.

4. Revise and Resubmit:
   a. Contractor may not incorporate product(s) or implement Work covered by submittal.
   b. Distribution: Electronic.

1.04 INFORMATIONAL SUBMITTALS

A. General:

1. Copies: Electronic, unless otherwise indicated in individual specification section.

2. Refer to individual specification sections for specific submittal requirements.

3. Engineer will review each submittal. If submittal meets conditions of the Contract, Engineer will forward copy to appropriate parties. If Engineer determines submittal does not meet conditions of the Contract and is therefore considered unacceptable, Engineer will retain one copy and return remaining copy with review comments to Contractor, and require that submittal be corrected and resubmitted.
B. Certificates:

1. General:
   a. Provide notarized statement that includes signature of entity responsible for preparing certification.
   b. Signed by officer or other individual authorized to sign documents on behalf of that entity.
2. Welding: In accordance with individual specification sections.
3. Installer: Prepare written statements on manufacturer’s letterhead certifying installer complies with requirements as specified in individual specification section.
4. Material Test: Prepared by qualified testing agency, on testing agency’s standard form, indicating and interpreting test results of material for compliance with requirements.
5. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in individual specification sections.
6. Manufacturer’s Certificate of Compliance: In accordance with Section 01 61 00, Common Product Requirements.
7. Manufacturer’s Certificate of Proper Installation: In accordance with Section 01 43 33, Manufacturers’ Field Services.

C. Construction Photographs and Video: In accordance with Section 01 31 13, Project Coordination, and as may otherwise be required in Contract Documents.

D. Closeout Submittals: In accordance with Section 01 77 00, Closeout Procedures.

E. Contractor-design Data (related to temporary construction):

   1. Written and graphic information.
   2. List of assumptions.
   3. List of performance and design criteria.
   4. Summary of loads or load diagram, if applicable.
   5. Calculations.
   6. List of applicable codes and regulations.
   7. Name and version of software.
   8. Information requested in individual specification section.

F. Deferred Submittals: See Drawings for list of deferred submittals.

   1. Contractor-design data related to permanent construction:
      a. List of assumptions.
      b. List of performance and design criteria.
c. Summary of loads or load diagram, if applicable.
d. Calculations.
e. List of applicable codes and regulations.
f. Name and version of design software.
g. Factory test results.
h. Informational submittals requested in individual specification section.

2. Prior to installation of indicated structural or nonstructural element, equipment, distribution system, or component or its anchorage, submit calculations and test results of Contractor-designed components for review by Engineer. Documentation of review and indication of compliance with general design intent and project criteria provided on Engineer’s comment form as meets conditions of the Contract, along with completed submittal, shall be filed with permitting agency by Contractor and approved by permitting agency prior to installation.

G. Manufacturer’s Instructions: Written or published information that documents manufacturer’s recommendations, guidelines, and procedures in accordance with individual specification section.

H. Operation and Maintenance Data: As required in Section 01 78 23, Operation and Maintenance Data.

I. Payment:

1. Application for Payment: In accordance with Section 01 29 00, Payment Procedures.
2. Schedule of Values: In accordance with Section 01 29 00, Payment Procedures.

J. Quality Control Documentation: As required in Section 01 45 16.13, Contractor Quality Control.

K. Schedules:

1. Schedule of Submittals: Prepare separately or in combination with Progress Schedule as specified in Section 01 32 00, Construction Progress Documentation.
   a. Show for each, at a minimum, the following:
      1) Specification section number.
      2) Identification by numbering and tracking system as specified under Paragraph Transmittal of Submittal.
      3) Estimated date of submission to Engineer, including reviewing and processing time.
b. On a monthly basis, submit updated Schedule of Submittals to Engineer if changes have occurred or resubmittals are required.

2. Progress Schedules: In accordance with Section 01 32 00, Construction Progress Documentation.

L. Special Guarantee: Supplier’s written guarantee as required in individual specification sections.

M. Statement of Qualification: Evidence of qualification, certification, or registration as required in Contract Documents to verify qualifications of professional land surveyor, engineer, materials testing laboratory, specialty Subcontractor, trade, Specialist, consultant, installer, and other professionals.

N. Submittals Required by Laws, Regulations, and Governing Agencies:
   1. Promptly submit promptly notifications, reports, certifications, payrolls, and otherwise as may be required, directly to the applicable federal, state, or local governing agency or their representative.
   2. Transmit to Engineer for Owner’s records one copy of correspondence and transmittals (to include enclosures and attachments) between Contractor and governing agency.

O. Test, Evaluation, and Inspection Reports:
   1. General: Shall contain signature of person responsible for test or report.
   2. Factory:
      a. Identification of product and specification section, type of inspection or test with referenced standard or code.
      b. Date of test, Project title and number, and name and signature of authorized person.
      c. Test results.
      d. If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
      e. Provide interpretation of test results, when requested by Engineer.
      f. Other items as identified in individual specification sections.
   3. Field:
      a. As a minimum, include the following:
         1) Project title and number.
         2) Date and time.
         3) Record of temperature and weather conditions.
         4) Identification of product and specification section.
         5) Type and location of test, Sample, or inspection, including referenced standard or code.
6) Date issued, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.
7) If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
8) Provide interpretation of test results, when requested by Engineer.
9) Other items as identified in individual specification sections.

P. Testing and Startup Data: In accordance with Section 01 91 14, Equipment Testing and Facility Startup.

Q. Training Data: In accordance with Section 01 43 33, Manufacturers’ Field Services.

1.05 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is part of this Specification.

1. Transmittal of Contractor’s Submittal.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION
## TRANSMITTAL OF CONTRACTOR’S SUBMITTAL

(ATTACH TO EACH SUBMITTAL)

<table>
<thead>
<tr>
<th>DATE:</th>
<th>Submittal No.:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>TO:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>FROM:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Contractor</td>
<td></td>
</tr>
</tbody>
</table>

### SUBMITTAL TYPE:
- [x] Shop Drawing
- [ ] Sample
- [ ] Informational
- [ ] Deferred

### The following items are hereby submitted:

<table>
<thead>
<tr>
<th>Number of Copies</th>
<th>Description of Item Submitted (Type, Size, Model Number, Etc.)</th>
<th>Spec. and Para. No.</th>
<th>Drawing or Brochure Number</th>
<th>Contains Variation to Contract</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No</td>
</tr>
</tbody>
</table>

Contractor hereby certifies that (i) Contractor has complied with the requirements of Contract Documents in preparation, review, and submission of designated Submittal and (ii) the Submittal is complete and in accordance with the Contract Documents and requirements of laws and regulations and governing agencies.

By: _____________________________________

Contractor (Authorized Signature)
SECTION 01 43 33
MANUFACTURERS’ FIELD SERVICES

PART 1  GENERAL

1.01  DEFINITIONS
A. Person-Day: One person for 8 hours within regular Contractor working hours.

1.02  SUBMITTALS
A. Informational Submittals:
   1. Training Schedule: Submit, in accordance with requirements of this Specification, not less than 21 days prior to start of equipment installation and revise as necessary for acceptance.
   2. Lesson Plan: Submit, in accordance with requirements of this Specification, proposed lesson plan not less than 21 days prior to scheduled training and revise as necessary for acceptance.
   3. Training Session Recordings: Furnish Owner with two complete sets of recordings fully indexed and cataloged with printed label stating session and date recorded.

1.03  QUALIFICATION OF MANUFACTURER’S REPRESENTATIVE
A. Authorized representative of the manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system, with full authority by the equipment manufacturer to issue the certifications required of the manufacturer. Additional qualifications may be specified in the individual specification section.

B. Representative subject to acceptance by Owner and Engineer. No substitute representatives will be allowed unless prior written approval by such has been given.

PART 2  PRODUCTS (NOT USED)

PART 3  EXECUTION

3.01  FULFILLMENT OF SPECIFIED MINIMUM SERVICES
A. Furnish manufacturers’ services, when required by an individual specification section, to meet the requirements of this section.
B. Where time is necessary in excess of that stated in the Specifications for manufacturers’ services, or when a minimum time is not specified, time required to perform specified services shall be considered incidental.

C. Schedule manufacturer’s services to avoid conflict with other onsite testing or other manufacturers’ onsite services.

D. Determine, before scheduling services, that conditions necessary to allow successful testing have been met.

E. Only those days of service approved by Engineer will be credited to fulfill specified minimum services.

F. When specified in individual specification sections, manufacturer’s onsite services shall include:

1. Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction of Contractor’s assembly, erection, installation or application procedures.
2. Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by manufacturer and necessary to furnish Manufacturer’s Certificate of Proper Installation.
3. Providing, on a daily basis, copies of manufacturers’ representatives field notes and data to Engineer Owner.
4. Revisiting the Site as required to correct problems and until installation and operation are acceptable to Engineer.
5. Resolution of assembly or installation problems attributable to or associated with respective manufacturer’s products and systems.
6. Assistance during functional and performance testing, and facility startup and evaluation.
7. Training of Owner’s personnel in the operation and maintenance of respective product as required.

3.02 MANUFACTURER’S CERTIFICATE OF PROPER INSTALLATION

A. When so specified, a Manufacturer’s Certificate of Proper Installation form, a copy of which is attached to this section, shall be completed and signed by equipment manufacturer’s representative.

B. Such form shall certify signing party is a duly authorized representative of manufacturer, is empowered by manufacturer to inspect, approve, and operate their equipment and is authorized to make recommendations required to ensure equipment is complete and operational.
3.03 TRAINING

A. General:

1. Furnish manufacturers’ representatives for detailed classroom and hands-on training to Owner’s personnel on operation and maintenance of specified product (system, subsystem, component) and as may be required in applicable Specifications.
2. Furnish trained, articulate personnel to coordinate and expedite training, to be present during training coordination meetings with Owner, and familiar with operation and maintenance manual information specified in Section 01 78 23, Operation and Maintenance Data.
3. Manufacturer’s representative shall be familiar with facility operation and maintenance requirements as well as with specified equipment.
4. Furnish complete training materials, to include operation and maintenance data, to be retained by each trainee.

B. Training Schedule:

1. List specified equipment and systems that require training services and show:
   a. Respective manufacturer.
   b. Estimated dates for installation completion.
   c. Estimated training dates.
2. Allow for multiple sessions when several shifts are involved.
3. Adjust schedule to ensure training of appropriate personnel as deemed necessary by Owner, and to allow full participation by manufacturers’ representatives. Adjust schedule for interruptions in operability of equipment.
4. Coordinate with Section 01 32 00, Construction Progress Documentation, and Section 01 91 14, Equipment Testing and Facility Startup.

C. Lesson Plan:

1. When manufacturer or vendor training of Owner personnel is specified, prepare a lesson plan for each required course containing the following minimum information:
   a. Title and objectives.
   b. Recommended attendees (such as, managers, engineers, operators, maintenance).
   c. Course description, outline of course content, and estimated class duration.
   d. Format (such as, lecture, self-study, demonstration, hands-on).
e. Instruction materials and equipment requirements.
f. Resumes of instructors providing training.

D. Prestartup Training:

1. Coordinate training sessions with Owner’s operating personnel and manufacturers’ representatives, and with submission of operation and maintenance manuals in accordance with Contract Documents.
2. Complete at least 14 days prior to beginning of facility startup.

E. Post-startup Training: If required in Specifications, furnish and coordinate training of Owner’s operating personnel by respective manufacturer’s representatives.

F. Recording of Training Sessions:

1. Furnish audio and color recording of prestartup and post-startup instruction sessions, including manufacturers’ representatives’ hands-on equipment instruction and classroom sessions.
2. Use DVD format suitable for playback on standard equipment available commercially in the United States. Blu-ray® DVD format is not acceptable without Engineer’s prior approval.
3. Include one training session on each DVD. DVD may contain multiple training sessions. If multiple training sessions included on a DVD, provide with on-screen menu for playback selection.

3.04 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is part of this Specification.

1. Manufacturer’s Certificate of Proper Installation.

END OF SECTION
MANUFACTURER’S CERTIFICATE OF PROPER INSTALLATION

OWNER ___________________________ EQPT SERIAL NO: ________________

EQPT TAG NO: ________________ EQPT/SYSTEM: ________________

PROJECT NO: ________________ SPEC. SECTION: ________________

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer’s recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: ____________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

I, the undersigned Manufacturer’s Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: ___________________________ 20___

Manufacturer: ____________________________

By Manufacturer’s Authorized Representative: ____________________________

(Authorized Signature)
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):

1.02 DEFINITIONS

A. Contractor Quality Control (CQC): The means by which Contractor ensures that the construction, to include that performed by subcontractors and suppliers, complies with the requirements of the Contract.

1.03 SUBMITTALS

A. Informational Submittals:

1. CQC Plan: Submit, not later than 30 days after receipt of Notice to Proceed.
2. CQC Report: Submit, weekly, an original and one copy in report form.

1.04 OWNER’S QUALITY ASSURANCE

A. All Work is subject to Owner’s quality assurance inspection and testing at all locations and at all reasonable times before acceptance to ensure strict compliance with the terms of the Contract Documents.

B. Owner’s quality assurance inspections and tests are for the sole benefit of Owner and do not:

1. Relieve Contractor of responsibility for providing adequate quality control measures;
2. Relieve Contractor of responsibility for damage to or loss of the material before acceptance;
3. Constitute or imply acceptance; or
4. Affect the continuing rights of Owner after acceptance of the completed Work.
C. The presence or absence of a quality assurance inspector does not relieve Contractor from any Contract requirement.

D. Promptly furnish all facilities, labor, and material reasonably needed for performing such safe and convenient inspections and tests as may be required by Engineer.

E. Owner may charge Contractor for any additional cost of inspection or test when Work is not ready at the time specified by Contractor for inspection or test, or when prior rejection makes re-inspection or retest necessary. Quality assurance inspections and tests will be performed in a manner that will not unnecessarily delay the Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Maintain an adequate inspection system and perform such inspections as will ensure that the Work conforms to the Contract Documents.

B. Maintain complete inspection records and make them available at all times to Owner and Engineer.

C. The quality control system shall consist of plans, procedures, and organization necessary to produce an end product that complies with the Contract Documents. The system shall cover all construction and demolition operations, both onsite and offsite, including Work by subcontractors, fabricators, suppliers and purchasing agents, and shall be keyed to the proposed construction sequence.

3.02 COORDINATION MEETING

A. After the Preconstruction Conference, but before start of construction, and prior to acceptance of the CQC Plan, schedule a meeting with Engineer and Owner to discuss the quality control system.

B. Develop a mutual understanding of the system details, including the forms for recording the CQC operations, control activities, testing, administration of the system for both onsite and offsite Work, and the interrelationship of Contractor’s management and control with the Owner’s Quality Assurance.

C. There may be occasions when subsequent conferences may be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures that may require corrective action by Contractor.
3.03 QUALITY CONTROL ORGANIZATION

A. CQC System Manager:

1. Designate an individual within Contractor’s organization who will be responsible for overall management of CQC and have the authority to act in CQC matters for the Contractor.
2. CQC System Manager may perform other duties on the Project.
3. CQC System Manager shall be an experienced construction person, with a minimum of 3 years construction experience on similar type Work.
4. CQC System Manager shall report to the Contractor’s project manager or someone higher in the organization. Project manager in this context shall mean the individual with responsibility for the overall quality and production management of the Project.
5. CQC System Manager shall be onsite during construction; periods of absence may not exceed 2 weeks at any one time.
6. Identify an alternate for CQC System Manager to serve with full authority during the System Manager’s absence. The requirements for the alternate will be the same as for designated CQC System Manager.

B. CQC Staff:

1. Designate a CQC staff, available at the Site at all times during progress, with complete authority to take any action necessary to ensure compliance with the Contract. CQC staff members shall be subject to acceptance by Engineer.
2. CQC staff shall take direction from CQC System Manager in matters pertaining to QC.
3. CQC staff must be of sufficient size to ensure adequate QC coverage of Work phases, work shifts, and work crews involved in the construction. These personnel may perform other duties, but must be fully qualified by experience and technical training to perform their assigned QC responsibilities and must be allowed sufficient time to carry out these responsibilities.
4. The actual strength of the CQC staff may vary during any specific Work period to cover the needs of the Project. Add additional staff when necessary for a proper CQC organization.

C. Organizational Changes: Obtain Engineer’s acceptance before replacing any member of the CQC staff. Requests for changes shall include name, qualifications, duties, and responsibilities of the proposed replacement.
3.04 QUALITY CONTROL PHASING

A. CQC shall include at least three phases of control to be conducted by CQC System Manager for all definable features of Work, as follows:

1. Preparatory Phase:
   a. Notify Owner at least 48 hours in advance of beginning any of the required action of the preparatory phase.
   b. This phase shall include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The CQC System Manager shall instruct applicable CQC staff as to the acceptable level of workmanship required in order to meet Contract requirements.
   c. Document the results of the preparatory phase meeting by separate minutes prepared by the CQC System Manager and attached to the QC report.
   d. Perform prior to beginning Work on each definable feature of Work:
      1) Review applicable Contract Specifications.
      2) Review applicable Contract Drawings.
      3) Verify that all materials and/or equipment have been tested, submitted, and approved.
      4) Verify that provisions have been made to provide required control inspection and testing.
      5) Examine the Work area to verify that all required preliminary Work has been completed and is in compliance with the Contract.
      6) Perform a physical examination of required materials, equipment, and sample Work to verify that they are on hand, conform to approved Shop Drawing or submitted data, and are properly stored.
      7) Review the appropriate activity hazard analysis to verify safety requirements are met.
      8) Review procedures for constructing the Work, including repetitive deficiencies.
      9) Document construction tolerances and workmanship standards for that phase of the Work.
      10) Check to verify that the plan for the Work to be performed, if so required, has been accepted by Engineer.

2. Initial Phase:
   a. Accomplish at the beginning of a definable feature of Work:
      1) Notify Owner at least 48 hours in advance of beginning the initial phase.
2) Perform prior to beginning Work on each definable feature of Work:
   a) Review minutes of the preparatory meeting.
   b) Check preliminary Work to verify compliance with Contract requirements.
   c) Verify required control inspection and testing.
   d) Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Comparison with sample panels is appropriate.
   e) Resolve all differences.
   f) Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.

3) Separate minutes of this phase shall be prepared by the CQC System Manager and attached to the QC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.

4) The initial phase should be repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.

3. Follow-up Phase:
   a. Perform daily checks to verify continuing compliance with Contract requirements, including control testing, until completion of the particular feature of Work.
   b. Daily checks shall be made a matter of record in the CQC documentation and shall document specific results of inspections for all features of Work for the day or shift.
   c. Conduct final follow-up checks and correct all deficiencies prior to the start of additional features of Work that will be affected by the deficient Work. Constructing upon or concealing nonconforming Work will not be allowed.

4. Additional Preparatory and Initial Phases: Additional preparatory and initial phases may be conducted on the same definable features of Work as determined by Owner if the quality of ongoing Work is unacceptable; or if there are changes in the applicable QC staff or in the onsite production supervision or work crew; or if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.
3.05 CONTRACTOR QUALITY CONTROL PLAN

A. General:

1. Plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used.
2. An interim plan for the first 30 days of operation will be considered.
3. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of Work to be started.
4. Work outside of the features of Work included in an accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional features of Work to be started.

B. Content:

1. Plan shall cover the intended CQC organization for the entire Contract and shall include the following, as a minimum:
   a. Organization: Description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff will implement the three-phase control system (see Paragraph QC Phasing) for all aspects of the Work specified.
   b. CQC Staff: The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a QC function.
   c. Letters of Authority: A copy of a letter to the CQC System Manager signed by an authorized official of the firm, describing the responsibilities and delegating sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop Work which is not in compliance with the Contract. The CQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities and responsibilities. Copies of these letters will also be furnished to Owner.
   d. Submittals: Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers, and purchasing agents.
   e. Testing: Control, verification and acceptance testing procedures for each specific test to include the test name, frequency, specification paragraph containing the test requirements, the personnel and laboratory responsible for each type of test, and an estimate of the number of tests required.
f. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests, including documentation.

g. Procedures for tracking deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.

h. Reporting procedures, including proposed reporting formats; include a copy of the CQC report form.

C. Acceptance of Plans: Acceptance of the Contractor’s basic and addendum CQC plans is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. Owner reserves the right to require Contractor to make changes in the CQC plan and operations including removal of personnel, as necessary, to obtain the quality specified.

D. Notification of Changes: After acceptance of the CQC plan, Contractor shall notify Engineer, in writing, a minimum of 7 calendar days prior to any proposed change. Proposed changes are subject to acceptance by Engineer.

3.06 CONTRACTOR QUALITY CONTROL REPORT

A. As a minimum, prepare a CQC report for every 7 calendar days. Account for all days throughout the life of the Contract. Reports shall be signed and dated by CQC System Manager. Include copies of test reports and copies of reports prepared by QC staff.

B. Maintain current records of quality control operations, activities, and tests performed, including the Work of subcontractors and suppliers.

C. Records shall be on an acceptable form and shall be a complete description of inspections, the results of inspections, daily activities, tests, and other items, including but not limited to the following:

1. Contractor/subcontractor and their areas of responsibility.
2. Operating plant/equipment with hours worked, idle, or down for repair.
3. Work performed today, giving location, description, and by whom. When a network schedule is used, identify each phase of Work performed each day by activity number.
4. Test and/or control activities performed with results and references to specifications/plan requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.
5. Material received with statement as to its acceptability and storage.
6. Identify submittals reviewed, with Contract reference, by whom, and action taken.
7. Offsite surveillance activities, including actions taken.
8. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
9. List instructions given/received and conflicts in Drawings and/or Specifications.
10. Contractor’s verification statement.
11. Indicate a description of trades working on the Project; the number of personnel working; weather conditions encountered; and any delays encountered.
12. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in file work and workmanship comply with the Contract.

3.07 SUBMITTAL QUALITY CONTROL

A. Submittals shall be as specified in Section 01 33 00, Submittal Procedures. The CQC organization shall be responsible for certifying that all submittals are in compliance with the Contract requirements. Owner will furnish copies of test report forms upon request by Contractor. Contractor may use other forms as approved.

3.08 TESTING QUALITY CONTROL

A. Testing Procedure:

1. Perform tests specified or required to verify that control measures are adequate to provide a product which conforms to Contract requirements. Procure services of a licensed testing laboratory. Perform the following activities and record the following data:
   a. Verify testing procedures comply with contract requirements.
   b. Verify facilities and testing equipment are available and comply with testing standards.
   c. Check test instrument calibration data against certified standards.
   d. Verify recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
   e. Documentation:
      1) Record results of all tests taken, both passing and failing, on the CQC report for the date taken.
      2) Include specification paragraph reference, location where tests were taken, and the sequential control number identifying the test.
      3) Actual test reports may be submitted later, if approved by Engineer, with a reference to the test number and date taken.
4) Provide directly to Engineer an information copy of tests performed by an offsite or commercial test facility. Test results shall be signed by an engineer registered in the state where the tests are performed.

5) Failure to submit timely test reports, as stated, may result in nonpayment for related Work performed and disapproval of the test facility for this Contract.

B. Testing Laboratories: Laboratory facilities, including personnel and equipment, utilized for testing soils, concrete, asphalt and steel shall meet criteria detailed in ASTM D3740 and ASTM E329, and be accredited by the American Association of Laboratory Accreditation (AALA), National Institute of Standards and Technology (NIST), National Voluntary Laboratory Accreditation Program (NVLAP), the American Association of State Highway and Transportation Officials (AASHTO), or other approved national accreditation authority. Personnel performing concrete testing shall be certified by the American Concrete Institute (ACI).

3.09 COMPLETION INSPECTION

A. CQC System Manager shall conduct an inspection of the Work at the completion of all Work or any milestone established by a completion time stated in the Contract.

B. Punchlist:

1. CQC System Manager shall develop a punchlist of items which do not conform to the Contract requirements.
2. Include punchlist in the CQC report, indicating the estimated date by which the deficiencies will be corrected.
3. CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected and so notify the Owner.
4. These inspections and any deficiency corrections required will be accomplished within the time stated for completion of the entire Work or any particular increment thereof if the Project is divided into increments by separate completion dates.

END OF SECTION
PART 1 GENERAL

1.01 SUMMARY

A. This section covers requirements for Special Inspection, Observation, and Testing required in accordance with Chapter 17 of the 2015 IBC and is in addition to and supplements requirements included in Statement of Special Inspections shown in supplement located at end of this section.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

2. International Code Council (ICC):
   b. Evaluation Service (ICC-ES) Reports and Legacy Reports.

1.03 DEFINITIONS

A. Agencies and Personnel:

1. Agency Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be Owner when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.
2. Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved.
3. Registered Design Professional in Responsible Charge: An individual who is registered or licensed to practice their respective design profession as defined by statutory requirements of professional registration laws of state or jurisdiction in which Project is to be constructed.
4. Special Inspector: Qualified person employed by Owner who will demonstrate competence to the satisfaction of AHJ for inspection of a particular type of construction or operation requiring Special Inspection.
B. Statement of Special Inspections: Detailed written procedure contained in supplement located at end of this section establishing systems and components subject to Special Inspection, Observation, and Testing during construction, type and frequency of testing, extent and duration of Special Inspection, and reports to be completed and distributed by Special Inspector.

C. Special Inspection:

1. Special Inspection: Inspection required of materials, installation, fabrication, erection, or placement of components and connections requiring special expertise to ensure compliance with approved Contract Documents and referenced standards.
2. Special Inspection, Continuous: Full-time observation of work requiring Special Inspection by an approved Special Inspector who is present in area where the Work is being performed.
3. Special Inspection, Periodic: Part-time or intermittent observation of the Work requiring Special Inspection by an approved Special Inspector who is present in area where the Work has been or is being performed, and at completion of the Work.

D. Structural Systems and Components:

1. Diaphragm: Component of structural lateral load resisting system consisting of roof, floor, or other membrane or bracing system acting to transfer lateral forces to vertical resisting elements of structure.
2. Drag Strut or Collector: Component of structural lateral load resisting system consisting of diaphragm or shear wall element that collects and transfers diaphragm shear forces to vertical force-resisting elements or distributes forces within diaphragm or shear wall.
3. Seismic-Force-Resisting System: That part of structural lateral load resisting system that has been considered in the design to provide required resistance to seismic forces identified on Drawings.
4. Shear Wall: Component of structural lateral load resisting system consisting of a wall designed to resist lateral forces parallel to plane of the wall. Unless noted otherwise on Drawings, load-bearing walls with direct in-plane connections to roof and floors shall be considered to be shear walls.
5. Wind Force Resisting System: That part of the structural system that has been considered in the design to provide required resistance to wind forces identified on Drawings.

E. Nonstructural Components:

1. Architectural Component Supports: Structural members or assemblies of members which transmit loads and forces from architectural systems
or components to structure, including braces, frames, struts, and attachments.

2. Electrical Component Supports: Structural members or assemblies which transmit loads and forces from electrical equipment to structure, including braces, frames, legs, pedestals, and tethers, as well as elements forged or cast as part of component for anchorage.

3. Mechanical and Plumbing Component Supports: Structural members or assemblies which transmit loads and forces from mechanical or plumbing equipment to structure, including braces, frames, skirts, legs, saddles, pedestals, snubbers, and tethers, as well as elements forged or cast as part of component for anchorage.

F. Professional Observation:

1. Does not include or waive responsibility for required Special Inspection or inspections by building official.

2. Requirements are indicated on Statement of Special Inspections provided in supplement located at the end of this section.


4. Structural Observation: Visual observation of structural system(s) by a registered design professional for general conformance to Contract Documents.

1.04 SUBMITTALS

A. Informational Submittals:

1. Contractor’s Statement of Responsibility: Form shall be completed by entity responsible for construction of main wind-force-resisting system, and main seismic-force-resisting system listed in Statement of Special Inspections. Refer to Article Supplements located at end of section.

1.05 STATEMENT OF SPECIAL INSPECTIONS REQUIREMENTS

A. Designated Systems for Inspection:

1. Seismic-force-resisting systems designated under IBC Section 1705 and subject to Special Inspection under Section 1705. See Drawings for basic lateral load resisting systems for each structure and other designated seismic systems.

2. Wind-force-resisting systems designated under IBC Section 1705. See Drawings for basic lateral load resisting systems for each structure and other designated wind-resisting components.
3. Architectural, Plumbing, Mechanical, and Electrical Components subject to Special Inspection under IBC Section 1705.12.5 and 1705.12.6 for Seismic Resistance, none required.

B. Statement of Special Inspections:

1. As included in supplement located at the end of this section and in support of building permit application, Project-specific requirements were prepared by Registered Design Professional in Responsible Charge. The following identifies elements of inspection, observation, and testing program to be followed in construction of the Work:
   a. Designated wind-force-resisting systems and components that are subject to Special Inspection and Structural Observation for lateral load resistance.
   b. Special Inspection and testing required by IBC Section 1705 and other applicable sections and referenced standards therein.
   c. Type and frequency of Special Inspection required.
   d. Type and frequency of testing required.
   e. Required frequency and distribution of testing and Special Inspection reports to be distributed by Special Inspector to Engineer, Contractor, building official, and Owner.
   f. Geotechnical Observation to be Performed: Required frequency and distribution of Geotechnical Observation reports by registered design professional to Contractor, building official, and Owner.
   g. Structural Observations to be Performed: Not required for this Project.

C. Special Inspection and associated testing of shop fabrication and field construction will be performed by an approved accredited independent agency or by Authority Having Jurisdiction’s (AHJ) approved, qualified inspection staff. Owner will secure and pay for services of agency to perform Special Inspection and associated testing.

D. Code required Special Inspection with associated testing and Professional Observation, as provided in Statement of Special Inspections in supplement located at the end of this section and further provided in this section, is for benefit of Owner and does not:

1. Relieve Contractor of responsibility for providing adequate quality control measures.
2. Relieve Contractor of responsibility for damage to or loss of material before acceptance.
3. Constitute or imply acceptance.
E. The presence or absence of code required Special Inspector and Professional Observer does not relieve Contractor from Contract requirements.

F. Contractor is responsible for additional costs associated with Special Inspection and Testing and Observation when Work is not ready at time identified by Contractor and Special Inspectors and Professional Observer are onsite, but not able to provide contracted services.

G. Contractor is responsible for associated costs for additional Special Inspection and Testing and Professional Observation by Special Inspectors and Professional Observers required because of rejection of materials of in-place Work that cannot be made compliant to Contract Document without additional inspections and observation and testing.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Requirements of the Statement of Special Inspections are provided by the Owner. All other testing and inspections, unless noted otherwise, are provided by Contractor.

B. Provide access to shop or Site for Special Inspection and Testing and Professional Observation requirements.

C. Notify Engineer in advance of required Special Inspection and Professional Observation no later than 48 hours prior to date of Special Inspection and Professional Observation.

D. Provide access for Special Inspector to construction documents.

E. Retain special inspection records onsite to be readily available for review.

F. Cooperate with Special Inspector and provide safe access to the Work to be inspected.

G. Submit Fabricator’s Certificates of Compliance for approved fabricators.

H. Provide reasonable auxiliary services as requested by the Special Inspector. Auxiliary services required include, but not limited to:

1. Providing access to the Work and furnishing incidental labor and facilities necessary to facilitate inspections and tests to assist the Special Inspector in performing test/inspections.
2. Providing storage space for the Special Inspector’s exclusive use, such as for storing and curing concrete test samples and delivery of samples to testing laboratories.
3. Providing the Special Inspector with access to all approved submittals.
4. Providing security and protection of samples and test equipment at the Project Site.
5. Provide samples of materials to be tested in required quantities.

I. Materials and systems shall be inspected during placement where Continuous Special Inspection is required.

J. Where Periodic Special Inspection is indicated in the Statement of Special Inspections:
   1. Schedule inspections for either during or at completion of their placement or a combination or both.
   2. Schedule periodically inspected Work (either inspected during or after its placement) so that corrections can be completed and re-inspected before Work is inaccessible.
   3. Sampling a portion of the Work is not allowed. Schedules shall provide for inspection of all Work requiring periodic inspection.

3.02 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification:
   1. Contractor’s Statement of Responsibility.
   2. Fabricator’s Certificate of Compliance.
   3. Statement of Special Inspections.

END OF SECTION
CONTRACTOR’S STATEMENT OF RESPONSIBILITY

(Project)

[Name of Contracting Company]

(Business Address)

(Telephone)  (Fax)

1. I, (We) hereby certify that I am (we are) aware of the Special Inspection and Testing and Professional Observation and component certification requirements contained in Contract Documents for this Project for components including architectural, mechanical, and electrical components, as listed in Statement of Special Inspections in supplement located at the end of this section, Contractor’s Statement of Responsibility, and that:

2. I, (We) aware of the systems and the requirements of the special inspection and acknowledge our responsibility in the implementation of the Statement of Special Inspections for the construction of the following systems:

<table>
<thead>
<tr>
<th>Facility</th>
<th>Specification</th>
<th>Lateral Force-Resisting System</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-Compressor and Control Building</td>
<td>04 22 00</td>
<td>Ordinary reinforced masonry shear wall</td>
</tr>
</tbody>
</table>

3. and I, (We) are responsible for construction of the following components:

<table>
<thead>
<tr>
<th>Facility</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>09–Electrical Site Work</td>
<td>Standby Engine Generators</td>
</tr>
<tr>
<td>09–Electrical Site Work</td>
<td>Switchgear</td>
</tr>
</tbody>
</table>

4. Control of this Work will be exercised to obtain conformance with Contract Documents approved by building official.

5. Procedures within the Contractor’s organization to be used for exercising control of the Work, method and frequency of reporting, and distribution of reports required under Statement of Special Inspections for Project are attached to this statement.
6. I, (We) will provide 48-hour notification to Engineer and approved inspection agency as required for structural tests and Special Inspection for Project.

7. The following person is hereby identified as exercising control over requirements of this section for the Work designated above:

   Name: _____________________________________________

   Qualifications: ______________________________________
   ______________________________________________________
   ______________________________________________________
   ______________________________________________________

   (Print name and official title of person signing this form)

   Signed by: ___________________________________________

   Date: ________________________________________________

   Project Name: ________________________________________
FABRICATOR’S CERTIFICATE OF COMPLIANCE

Each approved fabricator that is exempt from Special Inspection of shop fabrication and implementation procedures per Section 1704.2.5 of 2015 IBC must submit Fabricator’s Certificate of Compliance at the completion of fabrication.

(P) (Project)

(F) (Fabricator’s Name)

(B) (Business Address)

(C) (Certification or Approval Agency)

(C) (Certification Number)

(D) (Date of Last Audit or Approval)

Description of structural members and assemblies that have been fabricated:

I hereby certify that items described above were fabricated in strict accordance with approved construction documents.

(N and T) (Name and Title) type or print

(S and D) (Signature and Date)

Attach copies of fabricator’s certification or building code evaluation service report and fabricator’s quality control manual.
STATEMENT OF SPECIAL INSPECTIONS

GENERAL NOTES

1. THE STATEMENT OF SPECIAL INSPECTIONS PROVIDE PROJECT COMPLIANCE WITH THE PROVISIONS OF THE 2015 INTERNATIONAL BUILDING CODE (IBC) CHAPTER 17 FOR SPECIAL INSPECTION, STRUCTURAL OBSERVATION, AND TESTING FOR WIND AND SEISMIC RESISTANCE AS APPLICABLE. EXCEPT WHERE OTHERWISE NOTED, THIS INSPECTION IS OWNER FURNISHED.

2. STANDARD SPECIAL INSPECTION REQUIREMENTS FOR NONSTRUCTURAL COMPONENTS ARE CONTAINED IN TABLE 1.

3. STANDARD SPECIAL INSPECTION REQUIREMENTS FOR STRUCTURAL COMPONENTS, REGARDLESS OF WIND OR SEISMIC DESIGN CATEGORIES, ARE CONTAINED IN TABLE 2. STANDARD TESTING REQUIREMENTS FOR STRUCTURAL COMPONENTS ARE CONTAINED IN TABLE 3.

4. PROJECT SPECIFIC REQUIREMENTS FOR STRUCTURES ASSIGNED TO SEISMIC DESIGN CATEGORIES C, D, E, OR F ARE CONTAINED IN TABLE 4. ADDITIONAL TESTING REQUIREMENTS FOR STRUCTURAL RESISTANCE ARE CONTAINED IN TABLE 6.

5. PROJECT SPECIFIC REQUIREMENTS FOR STRUCTURES SUBJECT TO BASIC WIND SPEEDS [(V asd)] IN EXCESS OF 110 MPH ARE CONTAINED IN TABLE 5.

6. FOR ADDITIONAL REQUIREMENTS, REFER TO SPECIFICATION SECTION 01 45 33, SPECIAL INSPECTION, OBSERVATION, AND TESTING. THESE INCLUDE:
   A. CONTRACTOR’S REQUIREMENTS TO PROVIDE ACCESS TO THE WORK FOR REQUIRED INSPECTIONS, AND TO PROVIDE NOTICE OF REQUIRED INSPECTIONS AND STRUCTURAL OBSERVATION.
   B. CONTRACTOR’S STATEMENT OF RESPONSIBILITY FOR WORK TO BE PERFORMED ON SYSTEMS DESIGNATED UNDER THE STATEMENT OF SPECIAL INSPECTIONS FOR WIND OR SEISMIC RESISTANCE.
   C. DEFINITIONS AND TERMINOLOGY USED IN THIS STATEMENT OF SPECIAL INSPECTIONS.

SPECIAL INSPECTION

1. SPECIAL INSPECTION WILL BE IN ACCORDANCE WITH IBC SECTIONS 1704 AND 1705 TOGETHER WITH LOCAL AND STATE AMENDMENTS. REFER TO THE FOLLOWING TABLES FOR PROJECT SPECIFIC INSPECTION TYPES AND FREQUENCIES.

2. SPECIAL INSPECTIONS WILL BE PROVIDED BY A CERTIFIED OR QUALIFIED INSPECTOR AND ASSOCIATED TESTING WILL BE PERFORMED BY AN
APPROVED ACCREDITED INDEPENDENT AGENCY. THE OWNER WILL SECURE AND PAY FOR THE SERVICES OF THE AGENCY TO PERFORM ALL SPECIAL INSPECTION AND ASSOCIATED TESTS. INSPECTORS FOR EACH SYSTEM AND MATERIAL WILL BE INTERNATIONAL CODE COUNCIL (ICC) CERTIFIED OR OTHERWISE APPROVED BY THE BUILDING OFFICIAL.

3. THE SPECIAL INSPECTOR WILL OBSERVE THE INDICATED WORK FOR COMPLIANCE WITH THE APPROVED CONTRACT DOCUMENTS AND SUBMIT RECORDS OF INSPECTION. ALL DISCREPANCIES WILL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE CONTRACTOR FOR CORRECTION.

4. SPECIAL INSPECTION AND ASSOCIATED TESTING REPORTS WILL BE SUBMITTED TO THE ENGINEER, CONTRACTOR, BUILDING OFFICIAL, AND OWNER WITHIN ONE WEEK OF INSPECTION OR WITHIN ONE WEEK OF TEST COMPLETION. INSPECTIONS FOR WHICH REPORTING WILL BE REQUIRED ARE NOTED IN THE FOLLOWING TABLES.

5. AT THE CONCLUSION OF CONSTRUCTION, A FINAL REPORT DOCUMENTING REQUIRED SPECIAL INSPECTIONS AND CORRECTION OF PREVIOUSLY NOTED DISCREPANCIES WILL BE SUBMITTED.

GEOTECHNICAL OBSERVATION

1. ALL FOUNDATION BEARING SURFACES SHALL BE INSPECTED BY GEOTECHNICAL ENGINEER PRIOR TO PLACEMENT OF REINFORCING STEEL. ADDITIONAL SPECIAL INSPECTION REQUIREMENTS ARE LISTED IN TABLE 1.

2. GEOTECHNICAL TESTING REQUIREMENTS ARE LISTED IN TABLE 3.

STRUCTURAL OBSERVATION

1. STRUCTURAL OBSERVATION IN ACCORDANCE WITH IBC SECTION 1704.6 IS NOT REQUIRED.

SPECIAL INSPECTIONS FOR WIND RESISTANCE

1. SPECIAL INSPECTIONS REQUIREMENTS FOR WIND RESISTANCE IN ACCORDANCE WITH IBC SECTION 1705.11 ARE NOT APPLICABLE TO THIS PROJECT.

SPECIAL INSPECTIONS FOR SEISMIC RESISTANCE

1. SPECIAL INSPECTIONS REQUIREMENTS FOR SEISMIC RESISTANCE IN ACCORDANCE WITH IBC SECTION 1705.12 ARE NOT APPLICABLE TO THIS PROJECT.
ZINK DAM IMPROVEMENTS

Statement of Special Inspections Prepared by:

____________________
Type or Print Name

____________________
Signature

____________________
Date

Preparer’s Seal
<table>
<thead>
<tr>
<th>SYSTEM FOR FACILITY xxxxxxxx</th>
<th>STAGE</th>
<th>ITEMS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. FOUNDATION SLAB OF STRUCTURE</td>
<td>PRIOR TO FIRST CONCRETE PLACEMENT OF FIRST SECTION WHEN ITEMS CAN STILL BE REVISED</td>
<td>REINFORCING STEEL, CONCRETE AND MASONRY WALL DOWELS, WATERSTOPS, EMBEDS, AND SIMILAR ITEMS</td>
<td>NOTE 1</td>
</tr>
<tr>
<td>2. CONCRETE WALLS OF STRUCTURE</td>
<td>PRIOR TO FIRST CONCRETE PLACEMENT OF FIRST SECTION WHEN ITEMS CAN STILL BE REVISED</td>
<td>REINFORCING STEEL, WALL DOWELS, WATERSTOPS, EMBEDS, AND SIMILAR ITEMS</td>
<td>NOTE 1</td>
</tr>
<tr>
<td>3. WALL TO FOUNDATION CONNECTIONS PRIOR TO FORM CLOSURE</td>
<td>PRIOR TO FIRST CONCRETE PLACEMENT OF FIRST SECTION WHEN ITEMS CAN STILL BE REVISED</td>
<td>REINFORCING STEEL, WALL DOWELS, WATERSTOPS, EMBEDS, AND SIMILAR ITEMS</td>
<td>NOTE 1</td>
</tr>
<tr>
<td>4. ELEVATED CONCRETE SLABS AND BEAMS PRIOR TO CONCRETE PLACEMENT</td>
<td>PRIOR TO FIRST CONCRETE PLACEMENT OF FIRST SECTION WHEN ITEMS CAN STILL BE REVISED</td>
<td>REINFORCING STEEL, WALL DOWELS, WATERSTOPS, EMBEDS, AND SIMILAR ITEMS</td>
<td>NOTE 1</td>
</tr>
<tr>
<td>5. CONCRETE STRUCTURES</td>
<td>PRIOR TO FIRST CONCRETE PLACEMENT ON FIRST LIQUID HOLDING STRUCTURE WHEN ITEMS CAN STILL BE REVISED</td>
<td>REINFORCING STEEL, WALL DOWELS, WATERSTOPS, EMBEDS, AND SIMILAR ITEMS</td>
<td>NOTE 1</td>
</tr>
<tr>
<td>6. CONCRETE STRUCTURES</td>
<td>AT COMPLETION OF PLACEMENT OF ALL CONCRETE COMPONENTS FOR THE FIRST LIQUID HOLDING STRUCTURE</td>
<td>CONCRETE TOLERANCES, FINISHING, LIQUID TIGHTNESS, AND SIMILAR ITEMS</td>
<td>NOTE 1</td>
</tr>
<tr>
<td>7. MASONRY WALL, BEAM, PIER, AND COLUMN REINFORCING STEEL</td>
<td>[PRIOR TO GROUTING AND PRIOR TO CLOSING OF CLEANOUTS] [DURING THE INITIAL CONSTRUCTION OF THE FIRST MASONRY STRUCTURE WHEN ITEMS CAN STILL BE REVISED]</td>
<td>REINFORCING STEEL, GROUTED CELLS, EMBEDS, COURSE PREPARATION AND SIMILAR ITEMS</td>
<td>NOTE 1</td>
</tr>
<tr>
<td>SYSTEM FOR FACILITY</td>
<td>STAGE</td>
<td>ITEMS</td>
<td>COMMENTS</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------</td>
<td>-------</td>
<td>----------</td>
</tr>
<tr>
<td>8. SYSTEM CONNECTION EMBEDS</td>
<td>PRIOR TO GROUT OR CONCRETE PLACEMENT</td>
<td></td>
<td>NOTE 1</td>
</tr>
<tr>
<td>9. CONCRETE WALL TO FLOOR AND ROOF CONNECTIONS</td>
<td>PRIOR TO FORM CLOSURE [OR CLADDING INSTALLATION] OR OTHER COVER</td>
<td></td>
<td>NOTE 1</td>
</tr>
<tr>
<td>10. PLYWOOD ROOF DIAPHRAGM</td>
<td>PRIOR TO STANDING SEAM ROOF COVER WHEN ITEMS CAN STILL BE REVISED</td>
<td>NAILING PATTERNS, FASTENER TYPE, REQUIRED BLOCKING, STRAP TIES, AND SIMILAR ITEMS</td>
<td>NOTE 1</td>
</tr>
<tr>
<td>11. STRUCTURAL STEEL FRAMING</td>
<td>DURING INITIAL CONSTRUCTION OF STEEL FRAMING AT FIRST STEEL FRAMED BUILDING PRIOR TO ENCLOSURE OF FRAMING BEHIND FINAL FINISHES</td>
<td>MEMBER LOCATIONS AND CONFIGURATIONS, BOLTED AND WELDED CONNECTIONS, AND SIMILAR ITEMS</td>
<td>NOTE 1</td>
</tr>
<tr>
<td>12. TANK SHELL</td>
<td>INITIAL WELDING OF VERTICAL CJP JOINTS</td>
<td>JOINT PREPARATION, WELDING PROCEDURES, AND ENVIRONMENTAL CONTROLS</td>
<td>NOTE 1</td>
</tr>
<tr>
<td>13. TANK SHELL</td>
<td>INITIAL WELDING OF HORIZONTAL CJP JOINTS</td>
<td>JOINT PREPARATION, WELDING PROCEDURES, AND ENVIRONMENTAL CONTROLS</td>
<td>NOTE 1</td>
</tr>
<tr>
<td>SYSTEM FOR FACILITY</td>
<td>STAGE</td>
<td>ITEMS</td>
<td>COMMENTS</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------</td>
<td>-------</td>
<td>----------</td>
</tr>
<tr>
<td>xxxxxxxx</td>
<td>14</td>
<td>AT ADDITIONAL TIMES DURING CONSTRUCTION AT WHICH THE ENGINEER OF RECORD OR OWNER DEEM THE NEED FOR ADDITIONAL STRUCTURAL OBSERVATION</td>
<td>NOTE 1</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>AT SUBSTANTIAL COMPLETION OF PRIMARY STRUCTURAL SYSTEM FOR DETERMINATION OF FINAL CONDITION OF STRUCTURE</td>
<td>NOTE 1</td>
</tr>
</tbody>
</table>

NOTES:
1. STRUCTURAL OBSERVER TO DISCUSS ITEMS AND SITE SPECIFIC CONDITIONS WITH SPECIAL INSPECTOR AND FIELD INSPECTION STAFF DURING OBSERVATION.
### TABLE 1
**REQUIRED NON-STRUCTURAL SPECIAL INSPECTION**
**REFER TO SPECIFICATION SECTION 01 45 33**

<table>
<thead>
<tr>
<th>SYSTEM OR MATERIAL</th>
<th>2015 IBC CODE REFERENCE</th>
<th>REFERENCED STANDARD</th>
<th>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</th>
<th>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</th>
<th>COMMENTS</th>
<th>TESTING FOR SPECIAL INSPECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SOILS:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. VERIFY MATERIALS BELOW SHALLOW FOUNDATIONS ARE ADEQUATE TO ACHIEVE THE DESIGN BEARING CAPACITY</td>
<td>1705.6, 1803.5.8, 1803.5.9, 1804.6</td>
<td>SECTION 31 23 13, SUBGRADE PREPARATION</td>
<td>X</td>
<td></td>
<td>PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER</td>
<td></td>
</tr>
<tr>
<td>B. VERIFY EXCAVATIONS ARE EXTENDED TO PROPER DEPTH AND HAVE REACHED PROPER MATERIAL</td>
<td>1705.6</td>
<td>SECTION 31 23 16, EXCAVATION</td>
<td>X</td>
<td></td>
<td>PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER</td>
<td></td>
</tr>
<tr>
<td>C. PERFORM CLASSIFICATION AND TESTING OF COMPACTED FILL MATERIALS</td>
<td>1705.6</td>
<td>SECTION 31 23 23, FILL AND BACKFILL</td>
<td>X</td>
<td></td>
<td>SEE TABLE 3 FOR GRADATION TEST REQUIREMENTS</td>
<td></td>
</tr>
<tr>
<td>D. VERIFY USE OF PROPER MATERIALS, DENSITIES, AND LIFT THICKNESSES DURING PLACEMENT AND COMPACTION OF COMPACTED FILL</td>
<td>1705.6, 1803.5.8</td>
<td>SECTION 31 23 23, FILL AND BACKFILL</td>
<td>X</td>
<td></td>
<td>SEE TABLE 3 FOR DENSITY TEST REQUIREMENTS</td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 1**

**REQUIRED NON-STRUCTURAL SPECIAL INSPECTION**
**REFER TO SPECIFICATION SECTION 01 45 33**

**SYSTEM OR MATERIAL**

**2015 IBC CODE REFERENCE**

**REFERENCED STANDARD**

**PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)**

**CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION**

**COMMENTS**

**TESTING FOR SPECIAL INSPECTION**

**TABLE 1**

**REQUIRED NON-STRUCTURAL SPECIAL INSPECTION**
**REFER TO SPECIFICATION SECTION 01 45 33**

<table>
<thead>
<tr>
<th>SYSTEM OR MATERIAL</th>
<th>2015 IBC CODE REFERENCE</th>
<th>REFERENCED STANDARD</th>
<th>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</th>
<th>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</th>
<th>COMMENTS</th>
<th>TESTING FOR SPECIAL INSPECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SOILS:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. VERIFY MATERIALS BELOW SHALLOW FOUNDATIONS ARE ADEQUATE TO ACHIEVE THE DESIGN BEARING CAPACITY</td>
<td>1705.6, 1803.5.8, 1803.5.9, 1804.6</td>
<td>SECTION 31 23 13, SUBGRADE PREPARATION</td>
<td>X</td>
<td></td>
<td>PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER</td>
<td></td>
</tr>
<tr>
<td>B. VERIFY EXCAVATIONS ARE EXTENDED TO PROPER DEPTH AND HAVE REACHED PROPER MATERIAL</td>
<td>1705.6</td>
<td>SECTION 31 23 16, EXCAVATION</td>
<td>X</td>
<td></td>
<td>PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER</td>
<td></td>
</tr>
<tr>
<td>C. PERFORM CLASSIFICATION AND TESTING OF COMPACTED FILL MATERIALS</td>
<td>1705.6</td>
<td>SECTION 31 23 23, FILL AND BACKFILL</td>
<td>X</td>
<td></td>
<td>SEE TABLE 3 FOR GRADATION TEST REQUIREMENTS</td>
<td></td>
</tr>
<tr>
<td>D. VERIFY USE OF PROPER MATERIALS, DENSITIES, AND LIFT THICKNESSES DURING PLACEMENT AND COMPACTION OF COMPACTED FILL</td>
<td>1705.6, 1803.5.8</td>
<td>SECTION 31 23 23, FILL AND BACKFILL</td>
<td>X</td>
<td></td>
<td>SEE TABLE 3 FOR DENSITY TEST REQUIREMENTS</td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 1**

**REQUIRED NON-STRUCTURAL SPECIAL INSPECTION**
**REFER TO SPECIFICATION SECTION 01 45 33**

<table>
<thead>
<tr>
<th>SYSTEM OR MATERIAL</th>
<th>2015 IBC CODE REFERENCE</th>
<th>REFERENCED STANDARD</th>
<th>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</th>
<th>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</th>
<th>COMMENTS</th>
<th>TESTING FOR SPECIAL INSPECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SOILS:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. VERIFY MATERIALS BELOW SHALLOW FOUNDATIONS ARE ADEQUATE TO ACHIEVE THE DESIGN BEARING CAPACITY</td>
<td>1705.6, 1803.5.8, 1803.5.9, 1804.6</td>
<td>SECTION 31 23 13, SUBGRADE PREPARATION</td>
<td>X</td>
<td></td>
<td>PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER</td>
<td></td>
</tr>
<tr>
<td>B. VERIFY EXCAVATIONS ARE EXTENDED TO PROPER DEPTH AND HAVE REACHED PROPER MATERIAL</td>
<td>1705.6</td>
<td>SECTION 31 23 16, EXCAVATION</td>
<td>X</td>
<td></td>
<td>PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER</td>
<td></td>
</tr>
<tr>
<td>C. PERFORM CLASSIFICATION AND TESTING OF COMPACTED FILL MATERIALS</td>
<td>1705.6</td>
<td>SECTION 31 23 23, FILL AND BACKFILL</td>
<td>X</td>
<td></td>
<td>SEE TABLE 3 FOR GRADATION TEST REQUIREMENTS</td>
<td></td>
</tr>
<tr>
<td>D. VERIFY USE OF PROPER MATERIALS, DENSITIES, AND LIFT THICKNESSES DURING PLACEMENT AND COMPACTION OF COMPACTED FILL</td>
<td>1705.6, 1803.5.8</td>
<td>SECTION 31 23 23, FILL AND BACKFILL</td>
<td>X</td>
<td></td>
<td>SEE TABLE 3 FOR DENSITY TEST REQUIREMENTS</td>
<td></td>
</tr>
<tr>
<td>SYSTEM OR MATERIAL</td>
<td>2015 IBC CODE REFERENCE</td>
<td>REFERENCED STANDARD</td>
<td>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</td>
<td>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</td>
<td>COMMENTS</td>
<td>TESTING FOR SPECIAL INSPECTION</td>
</tr>
<tr>
<td>--------------------</td>
<td>--------------------------</td>
<td>---------------------</td>
<td>----------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>----------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>E. PRIOR TO PLACEMENT OF COMPACTED FILL, INSPECT SUBGRADE AND VERIFY THAT SITE HAS BEEN PREPARED PROPERLY</td>
<td>1705.6</td>
<td>SECTION 31 23 13, SUBGRADE PREPARATION</td>
<td>X</td>
<td></td>
<td>PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER</td>
<td>SEE TABLE 3 FOR DENSITY TEST REQUIREMENTS</td>
</tr>
<tr>
<td>3. CAST-IN-PLACE DEEP FOUNDATION ELEMENTS:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. INSPECT DRILLING OPERATIONS AND MAINTAIN COMPLETE AND ACCURATE RECORDS FOR EACH ELEMENT</td>
<td>1705.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. VERIFY PLACEMENT LOCATIONS AND PLUMBNESS, CONFIRM ELEMENT DIAMETERS, BELL DIAMETERS (IF APPLICABLE), LENGTHS, EMBEDMENT INTO BEDROCK (IF APPLICABLE), AND ADEQUATE END BEARING STRATA CAPACITY. RECORD CONCRETE OR GROUT VOLUMES.</td>
<td>1705.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SEE TABLE 3 FOR PILE INTEGRITY TESTING</td>
</tr>
<tr>
<td>SYSTEM OR MATERIAL</td>
<td>2015 IBC CODE REFERENCE</td>
<td>REFERENCED STANDARD</td>
<td>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</td>
<td>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</td>
<td>COMMENTS</td>
<td>TESTING FOR SPECIAL INSPECTION</td>
</tr>
<tr>
<td>--------------------</td>
<td>--------------------------</td>
<td>---------------------</td>
<td>------------------------------------------------------</td>
<td>--------------------------------</td>
<td>---------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>C. FOR CONCRETE ELEMENTS, PERFORM ADDITIONAL INSPECTIONS IN ACCORDANCE WITH SECTION 1705.3</td>
<td>1705.8</td>
<td></td>
<td></td>
<td>SEE TABLE 2 FOR REQUIRED INSPECTIONS FOR CONCRETE CONSTRUCTION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. MECHANICALLY STABILIZED EARTH RETAINING WALLS:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. VERIFY MODULAR UNIT AND GEOSYNTHETIC REINFORCEMENT PRODUCT NAMES, TYPES, AND DIMENSIONS</td>
<td>1703.4.2, 1705.1.1 ITEM 3</td>
<td>GEOTECHNICAL AND ICC-ES EVALUATION REPORTS</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. VERIFY MODULAR UNIT PLACEMENT INCLUDING ALIGNMENT AND INCLINATION</td>
<td>1703.4.2, 1705.1.1 ITEM 3</td>
<td>GEOTECHNICAL AND ICC-ES EVALUATION REPORTS</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. VERIFY PLACEMENT OF REINFORCEMENT, BACKFILL PLACEMENT AND COMPACTION, AND DRAINAGE PROVISIONS</td>
<td>1703.4.2, 1705.1.1 ITEM 3</td>
<td>GEOTECHNICAL AND ICC-ES EVALUATION REPORTS</td>
<td></td>
<td>X</td>
<td>SEE TABLE 3 FOR DENSITY TEST REQUIREMENTS</td>
<td></td>
</tr>
<tr>
<td>7. ROCK ANCHORS:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. VERIFY ANCHOR MATERIALS, SIZES, LENGTHS AND CORROSION PROTECTION COMPLY WITH THE REQUIREMENTS</td>
<td>1705.1.1 ITEM 2</td>
<td>GEOTECHNICAL REPORT</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SYSTEM OR MATERIAL</td>
<td>2015 IBC CODE REFERENCE</td>
<td>REFERENCED STANDARD</td>
<td>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</td>
<td>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</td>
<td>COMMENTS</td>
<td>TESTING FOR SPECIAL INSPECTION</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------------</td>
<td>-------------------------</td>
<td>---------------------</td>
<td>----------------------------------------------------------</td>
<td>----------------------------------------------</td>
<td>-----------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>B. VERIFY PLACEMENT LOCATIONS, LENGTHS, EMBEDMENT INTO ROCK</td>
<td>1705.1.1 ITEM 2</td>
<td>GEOTECHNICAL REPORT</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. DETERMINE CAPACITIES OF ANCHORS AND CONDUCT ADDITIONAL LOAD TESTS, AS REQUIRED</td>
<td>1705.1.1 ITEM 2</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>SEE TABLE 3 FOR PULLOUT TEST REQUIREMENTS</td>
</tr>
<tr>
<td>D. APPLICATION OF PRESTRESSING FORCES AND GROUTING OF BONDED TENDONS</td>
<td>1705.1.1 ITEM 2</td>
<td></td>
<td>SEE TABLE 2 FOR REQUIRED INSPECTIONS FOR CONCRETE CONSTRUCTION</td>
<td></td>
<td></td>
<td>SEE TABLE 3 FOR GROUT TEST AND TENDON PERFORMANCE AND PROOF TEST REQUIREMENTS</td>
</tr>
<tr>
<td>E. PERFORM ADDITIONAL INSPECTIONS IN ACCORDANCE WITH SECTION 1705.3</td>
<td>1705.1.1 ITEM 2</td>
<td></td>
<td>SEE TABLE 2 FOR REQUIRED INSPECTIONS FOR CONCRETE CONSTRUCTION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SYSTEM OR MATERIAL</td>
<td>2015 IBC CODE REFERENCE</td>
<td>REFERENCED STANDARD</td>
<td>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</td>
<td>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</td>
<td>COMMENTS</td>
<td>TESTING FOR SPECIAL INSPECTION</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------------</td>
<td>-------------------------</td>
<td>---------------------</td>
<td>----------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>----------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td><strong>ARCHITECTURAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. SPRAYED FIRE-RESISTANT MATERIALS FOR FLOOR, ROOF, AND WALL ASSEMBLIES AND STRUCTURAL MEMBERS: CONDITION OF SUBSTRATES, THICKNESS OF APPLICATION, DENSITY, BOND STRENGTH ADHESION/COHESION, AND CONDITION OF FINISHED APPLICATION.</td>
<td>1705.14</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>SEE TABLE 3 FOR THICKNESS, DENSITY, AND BOND STRENGTH TEST REQUIREMENTS</td>
</tr>
<tr>
<td>3. EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS) : VERIFY MATERIALS, DETAILS AND INSTALLATION</td>
<td>1703.4.2, 1705.16</td>
<td>ICC-ES EVALUATION REPORTS</td>
<td>X</td>
<td></td>
<td></td>
<td>NOT REQUIRED IF EIFS OVER CONCRETE MASONRY OR OVER A DRAINED WATER-RESISTIVE BARRIER</td>
</tr>
<tr>
<td>4. WATER-RESISTIVE BARRIER COATING WHEN APPLIED OVER SHEATHING SUBSTRATE</td>
<td>1705.16.1</td>
<td>ASTM E2570</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. FIRE-RESISTANT PENETRATIONS AND JOINTS IN BUILDING ASSIGNED TO RISK CATEGORY III OR IV:</td>
<td>1705.17.1</td>
<td>ASTM E2174</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
1. SEE NOTE 1 for additional requirements.
<table>
<thead>
<tr>
<th>SYSTEM OR MATERIAL</th>
<th>2015 IBC CODE REFERENCE</th>
<th>REFERENCED STANDARD</th>
<th>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</th>
<th>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</th>
<th>COMMENTS</th>
<th>TESTING FOR SPECIAL INSPECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. FIRE-RESISTANT JOINT SYSTEMS</td>
<td>1705.17.2</td>
<td>ASTM E2393</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### BUILDING MECHANICAL

1. INSTALLATION OF SMOKE CONTROL SYSTEMS:

   A. LEAKAGE TESTING AND RECORDING OF DEVICE LOCATIONS PRIOR TO CONCEALMENT

   | 1705.18 | X | |

   B. PRIOR TO OCCUPANCY AND AFTER SUFFICIENT COMPLETION, PRESSURE DIFFERENCE TESTING, FLOW MEASUREMENTS, AND DETECTION AND CONTROL VERIFICATION

<p>| 1705.18 | X | | | | |</p>
<table>
<thead>
<tr>
<th>SYSTEM OR MATERIAL</th>
<th>2015 IBC CODE REFERENCE</th>
<th>REFERENCED STANDARD</th>
<th>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</th>
<th>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</th>
<th>COMMENTS</th>
<th>TESTING FOR SPECIAL INSPECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CONSTRUCTION MATERIALS AND SYSTEMS THAT ARE ALTERNATIVES TO MATERIALS AND SYSTEMS PRESCRIBED BY CODE</td>
<td>1705.1.1 ITEM 1</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. UNUSUAL DESIGN APPLICATION OF CODE MATERIALS</td>
<td>1705.1.1 ITEM 2</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. INSTALLATION OF MATERIALS THAT REQUIRE ADDITIONAL MANUFACTURER'S INSTRUCTIONS BEYOND CODE REQUIREMENTS</td>
<td>1703.4.2, 1705.1.1 ITEM 3</td>
<td>ICC-ES EVALUATION REPORTS</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GENERAL

<table>
<thead>
<tr>
<th>SYSTEM OR MATERIAL</th>
<th>2015 IBC CODE REFERENCE</th>
<th>REFERENCED STANDARD</th>
<th>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</th>
<th>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</th>
<th>COMMENTS</th>
<th>TESTING FOR SPECIAL INSPECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CONSTRUCTION MATERIALS AND SYSTEMS THAT ARE ALTERNATIVES TO MATERIALS AND SYSTEMS PRESCRIBED BY CODE</td>
<td>1705.1.1 ITEM 1</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. UNUSUAL DESIGN APPLICATION OF CODE MATERIALS</td>
<td>1705.1.1 ITEM 2</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. INSTALLATION OF MATERIALS THAT REQUIRE ADDITIONAL MANUFACTURER'S INSTRUCTIONS BEYOND CODE REQUIREMENTS</td>
<td>1703.4.2, 1705.1.1 ITEM 3</td>
<td>ICC-ES EVALUATION REPORTS</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

STRUCTURAL

<table>
<thead>
<tr>
<th>SYSTEM OR MATERIAL</th>
<th>2015 IBC CODE REFERENCE</th>
<th>REFERENCED STANDARD</th>
<th>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</th>
<th>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</th>
<th>COMMENTS</th>
<th>TESTING FOR SPECIAL INSPECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CONSTRUCTION MATERIALS AND SYSTEMS THAT ARE ALTERNATIVES TO MATERIALS AND SYSTEMS PRESCRIBED BY CODE</td>
<td>1705.1.1 ITEM 1</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. UNUSUAL DESIGN APPLICATION OF CODE MATERIALS</td>
<td>1705.1.1 ITEM 2</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. INSTALLATION OF MATERIALS THAT REQUIRE ADDITIONAL MANUFACTURER'S INSTRUCTIONS BEYOND CODE REQUIREMENTS</td>
<td>1703.4.2, 1705.1.1 ITEM 3</td>
<td>ICC-ES EVALUATION REPORTS</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
1. PERIODIC INSPECTION IS DEFINED AS INSPECTION BY THE SPECIAL INSPECTOR OF ALL MATERIALS AND SYSTEMS, IN SOME CASES PERFORMED DURING THEIR PLACEMENT AND IN ALL CASES PERFORMED UPON COMPLETION OF THEIR PLACEMENT. THE COMPLETION INSPECTION SHALL BE PERFORMED SO THAT WORK CAN BE CORRECTED PRIOR TO OTHER RELATED WORK PROCEEDING AND COVERING INSPECTED WORK.
<table>
<thead>
<tr>
<th>System</th>
<th>2015 IBC Code Reference</th>
<th>Referenced Standard</th>
<th>Periodic Owner Furnished Special Inspection (See Note 1)</th>
<th>Continuous Owner Furnished Special Inspection</th>
<th>Comments</th>
<th>Testing for Special Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Inspect Reinforcing Steel, Including Prestressing Tendons, and Verify Placement</td>
<td>1705.3, 1908.4</td>
<td>ACI 318: Ch. 20, 25.2, 25.3, 26.6.1-26.6.3</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Inspection of Reinforcing Steel Welding</td>
<td>1705.3</td>
<td>AWS D1.4</td>
<td>ACI 318: 26.6.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Inspection of Anchors Cast in Concrete</td>
<td>1705.3</td>
<td>ACI 318: 17.8.2</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SYSTEM</td>
<td>2015 IBC CODE REFERENCE</td>
<td>REFERENCED STANDARD</td>
<td>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</td>
<td>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</td>
<td>COMMENTS</td>
<td>TESTING FOR SPECIAL INSPECTION</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------</td>
<td>---------------------</td>
<td>----------------------------------------------------------</td>
<td>---------------------------------------------</td>
<td>-----------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>4. INSPECT ANCHORS POST-INSTALLED IN HARDENED CONCRETE MEMBERS</td>
<td></td>
<td>ACI 318: 26.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. ADHESIVE ANCHORS INSTALLED IN HORIZONTALLY OR UPWARDLY INCLINED ORIENATIONS TO RESIST SUSTAINED TENSION LOADS</td>
<td>1705.3</td>
<td>ACI 318: 17.8.2.4, ICC-ES EVALUATION REPORTS</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. MECHANICAL ANCHORS AND ADHESIVE ANCHORS NOT DEFINED IN 4A.</td>
<td>1705.3</td>
<td>ACI 318: 17.8.2, ICC-ES EVALUATION REPORTS</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. VERIFY USE OF REQUIRED DESIGN MIX</td>
<td>1705.3, 1904.1, 1904.2, 1908.2, 1908.3</td>
<td>ACI 318: Ch. 19, 26.4.3, 26.4.4</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SYSTEM</td>
<td>2015 IBC CODE REFERENCE</td>
<td>REFERENCED STANDARD</td>
<td>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</td>
<td>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</td>
<td>COMMENTS</td>
<td>TESTING FOR SPECIAL INSPECTION</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------</td>
<td>---------------------</td>
<td>--------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>-----------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>7. INSPECT CONCRETE AND SHOTCRETE PLACEMENT FOR PROPER APPLICATION TECHNIQUES</td>
<td>1705.3, 1908.6, 1908.7, 1908.8</td>
<td>ACI 318: 26.5.1.1, 26.5.2.1</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. VERIFY MAINTENANCE OF SPECIFIED CURING TEMPERATURE AND TECHNIQUES</td>
<td>1705.3, 1908.9</td>
<td>ACI 318: 26.5.3.2, 26.5.4.2, 26.5.5.2</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. INSPECT FORMWORK FOR SHAPE, LOCATION AND DIMENSIONS OF THE CONCRETE MEMBER BEING FORMED</td>
<td>1705.3</td>
<td>ACI 318: 26.11.1.2</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. INSPECTION OF WATERSTOPS FOR PROPER SHAPE, LOCATION, JOINT QUALITY, AND SURROUNDING CONCRETE PLACEMENT</td>
<td></td>
<td>ACI: 26.5.6.2</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. VERIFY PROPER INSTALLATION OF MECHANICAL REINFORCING SPLICES AND CONNECTIONS</td>
<td>1705.1.1 ITEM 3, 1705.3</td>
<td>ICC-ES EVALUATION REPORTS</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SYSTEM</td>
<td>2015 IBC CODE REFERENCE</td>
<td>REFERENCED STANDARD</td>
<td>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</td>
<td>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</td>
<td>COMMENTS</td>
<td>TESTING FOR SPECIAL INSPECTION</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------</td>
<td>---------------------</td>
<td>-------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>-----------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>MASONRY LEVEL C</td>
<td>1705.4</td>
<td>ACI 530: Sec. 3.1.3 ACI 530.1: Art. 1.4B</td>
<td>X</td>
<td></td>
<td></td>
<td>SEE TABLE 3 FOR MASONRY TEST REQUIREMENTS</td>
</tr>
<tr>
<td>1. VERIFICATION OF $f_m'$ AND $f_{\text{AAC}}'$ PRIOR TO CONSTRUCTION AND FOR EVERY 5,000 SQUARE FEET DURING CONSTRUCTION</td>
<td>1705.4</td>
<td>ACI 530: Sec. 3.1.3 ACI 530.1: Art. 1.4B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. VERIFICATION OF PROPORTIONS OF MATERIALS IN PREMIXED OR PREBLENDED MORTAR, PRESTRESSING GROUT, AND GROUT OTHER THAN SELF-CONSOLIDATING GROUT, AS DELIVERED TO THE PROJECT SITE</td>
<td>1705.4</td>
<td>ACI 530: Sec. 3.1.3 ACI 530.1: Art. 1.5B</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. FOR SELF-CONSOLIDATING GROUT: VERIFICATION OF SLUMP FLOW AND VSI AS DELIVERED TO THE PROJECT SITE,</td>
<td>1705.4</td>
<td>ACI 530: Sec. 3.1.3 ACI 530.1: Art. 1.5B.1.b.3</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. VERIFY COMPLIANCE WITH THE APPROVED SUBMITTALS</td>
<td>1705.4</td>
<td>ACI 530: Sec. 3.1.3 ACI 530.1: Art. 1.5</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SYSTEM</td>
<td>2015 IBC CODE REFERENCE</td>
<td>REFERENCED STANDARD</td>
<td>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</td>
<td>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</td>
<td>COMMENTS</td>
<td>TESTING FOR SPECIAL INSPECTION</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------</td>
<td>--------------------</td>
<td>--------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>-----------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>A. PROPORTIONS OF SITE-MIXED MORTAR, GROUT, AND PRESTRESSING GROUT FOR BONDED TENDONS</td>
<td>1705.4</td>
<td>ACI 530: Sec. 3.1.3, 3.1.6, ACI 530.1: Art. 2.1, 2.4G.1.b, 2.6A, 2.6B, 2.6C</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. GRADE, TYPE, AND SIZE OF REINFORCEMENT AND ANCHOR BOLTS, AND PRESTRESSING TENDONS AND ANCHORAGE</td>
<td>1705.4</td>
<td>ACI 530: Sec. 3.1.3, 3.1.6, ACI 530.1: Art. 2.4, 3.4</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. PLACEMENT OF MASONRY UNITS AND CONSTRUCTION OF MORTAR JOINTS</td>
<td>1705.4</td>
<td>ACI 530: Sec. 3.1.3, ACI 530.1: Art. 3.3B</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. PLACEMENT OF REINFORCEMENT, CONNECTORS, AND PRESTRESSING TENDONS AND ANCHORAGE</td>
<td>1705.4</td>
<td>ACI 530: Sec. 3.1.3, 3.1.6, 6.2.1, 6.2.6, 6.2.7, ACI 530.1: Art. 3.2E, 3.4, 3.6A</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. GROUT SPACE PRIOR TO GROUTING</td>
<td>1705.4</td>
<td>ACI 530: Sec. 3.1.3, ACI 530.1: Art. 3.2D, 3.2F</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SYSTEM</td>
<td>2015 IBC CODE REFERENCE</td>
<td>REFERENCED STANDARD</td>
<td>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</td>
<td>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</td>
<td>COMMENTS</td>
<td>TESTING FOR SPECIAL INSPECTION</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------</td>
<td>--------------------------</td>
<td>---------------------</td>
<td>----------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>-----------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>F. PLACEMENT OF GROUT AND PRESTRESSING GROUT FOR BONDED TENDONS</td>
<td>1705.4</td>
<td>ACI 530: Sec. 3.1.3</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ACI 530.1: Art. 3.5, 3.6C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G. SIZE AND LOCATION OF STRUCTURAL ELEMENTS</td>
<td>1705.4</td>
<td>ACI 530: Sec. 3.1.3</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ACI 530.1: Art. 3.3F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H. TYPE, SIZE, AND LOCATION OF ANCHORS, INCLUDING OTHER DETAILS OF ANCHORAGE OF MASONRY TO STRUCTURAL MEMBERS, FRAMES OR OTHER CONSTRUCTION</td>
<td>1705.4</td>
<td>ACI 530: Sec. 1.2.1(e), 3.1.3, 6.1.4.3, 6.2.1</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. WELDING OF REINFORCEMENT</td>
<td>1705.4</td>
<td>ACI 530: Sec. 3.1.3, 8.1.6.7.2, 9.3.3.4(c), 11.3.3.4(b)</td>
<td>X</td>
<td>SEE STRUCTURAL STEEL (IN THIS TABLE) FOR WELDING INSPECTION REQUIREMENTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SYSTEM</td>
<td>2015 IBC CODE REFERENCE</td>
<td>REFERENCED STANDARD</td>
<td>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</td>
<td>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</td>
<td>COMMENTS</td>
<td>TESTING FOR SPECIAL INSPECTION</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------</td>
<td>---------------------</td>
<td>-------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>-----------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>J. PREPARATION, CONSTRUCTION, AND PROTECTION OF MASONRY DURING COLD WEATHER (TEMP. BELOW 40 DEGREES F) OR HOT WEATHER (TEMP. ABOVE 90 DEGREES F)</td>
<td>1705.4</td>
<td>ACI 530: Sec. 3.1.3 ACI 530.1: Art. 1.8C, 1.8D</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. PLACEMENT OF AAC MASONRY UNITS AND CONSTRUCTION OF THIN-BED MORTAR JOINTS</td>
<td>1705.4</td>
<td>ACI 530: Sec. 3.1.3 ACI 530.1: Art. 3.3B.9, 3.3F.1.b</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M. PROPERTIES OF THIN-BED MORTAR FOR AAC MASONRY</td>
<td>1705.4</td>
<td>ACI 530: Sec. 3.1.3 ACI 530.1: Art. 2.1C.1</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. OBSERVE PREPARATION OF GROUT SPECIMENS, MORTAR SPECIMENS, AND/OR PRISMS</td>
<td>1705.4</td>
<td>ACI 530: Sec. 3.1.3 ACI 530.1: Art. 1.4B.2.a.3, 1.4B.2.b.3, 1.4B.2.c.3, 1.4B.3, 1.4B.4</td>
<td>X</td>
<td></td>
<td>SEE TABLE 3 FOR UNIT STRENGTH TESTS AND PRISM TESTS FOR MASONRY</td>
<td></td>
</tr>
</tbody>
</table>
### Structural Steel

<table>
<thead>
<tr>
<th>1. Material Verification of Structural Steel:</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Identification Markings to Conform to AISC 360</td>
<td>1705.2.1, 2203.1</td>
<td>Applicable ASTM Material Standards</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>B. Manufacturer's Certified Test Reports</td>
<td>1705.2.1</td>
<td>AISC 360: Sec. N3.2, N5.2</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Prior to Bolting, Verify that the Following are in Compliance:</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Manufacturer's Certifications Available for Fastener Materials</td>
<td>1705.2.1</td>
<td>AISC 360: Sec. N3.2, N5.2, N5.6 RCSC: Sec. 2.1, 9.1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>B. Fasteners Marked in Accordance with ASTM Requirements</td>
<td>1705.2.1</td>
<td>AISC 360: Sec. N3.2, N5.2, N5.6 Applicable ASTM Material Standards</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>C. Proper Bolting Procedure Selected for Joint Detail</td>
<td>1705.2.1</td>
<td>AISC 360: Sec. N5.6 RCSC: Sec. 4</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>SYSTEM</td>
<td>2015 IBC CODE REFERENCE</td>
<td>REFERENCED STANDARD</td>
<td>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</td>
<td>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------</td>
<td>-------------------------</td>
<td>---------------------</td>
<td>----------------------------------------------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>D. CONNECTING ELEMENTS, INCLUDING THE APPROPRIATE FAYING SURFACE CONDITION AND HOLE PREPARATION, IF SPECIFIED, MEET APPLICABLE REQUIREMENTS</td>
<td>1705.2.1</td>
<td>AISC 360: Sec. N5.6</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>E. PRE-INSTALLATION VERIFICATION TESTING BY INSTALLATION PERSONNEL OBSERVED AND DOCUMENTED FOR FASTENER ASSEMBLIES AND METHODS USED</td>
<td>1705.2.1</td>
<td>AISC 360: Sec. N5.6</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>F. PROPER STORAGE PROVIDED FOR BOLTS, NUTS, WASHERS AND OTHER FASTENER COMPONENTS</td>
<td>1705.2.1</td>
<td>AISC 360: Sec. N5.6</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>SYSTEM</td>
<td>2015 IBC CODE REFERENCE</td>
<td>REFERENCED STANDARD</td>
<td>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</td>
<td>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------</td>
<td>--------------------</td>
<td>-------------------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>3. VERIFY DURING BOLTING:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. FASTENER ASSEMBLIES, OF SUITABLE CONDITION, PLACED IN ALL HOLES AND WASHERS (IF REQUIRED) ARE POSITIONED AS REQUIRED</td>
<td>1705.2.1</td>
<td>AISC 360: Sec. N5.6</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>B. JOINT BROUGHT TO SNUG-TIGHT CONDITION PRIOR TO THE PRETENSIONING OPERATION</td>
<td>1705.2.1</td>
<td>AISC 360: Sec. N5.6</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>C. FASTENER COMPONENT NOT TURNED BY THE WRENCH PREVENTED FROM ROTATING</td>
<td>1705.2.1</td>
<td>AISC 360: Sec. N5.6</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>D. FASTENERS ARE PRETENSIONED IN ACCORDANCE WITH THE RCSC SPECIFICATION, PROGRESSING SYSTEMATICALLY FROM THE MOST RIGID POINT TOWARD THE FREE EDGES</td>
<td>1705.2.1</td>
<td>AISC 360: Sec. N5.6</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>SYSTEM</td>
<td>2015 IBC CODE REFERENCE</td>
<td>REFERENCED STANDARD</td>
<td>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</td>
<td>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------</td>
<td>---------------------</td>
<td>------------------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>4. PRIOR TO WELDING, VERIFY THAT THE FOLLOWING ARE IN COMPLIANCE:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. APPROVED WELDING PROCEDURE SPECIFICATIONS (WPS) AVAILABLE TO WELDERS AND WELDING INSPECTOR(S)</td>
<td>1705.2.1</td>
<td>AWS D1.1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>B. WELDER QUALIFICATIONS AND JOINT FIT-UP</td>
<td>1705.2</td>
<td>AWS D1.1</td>
<td>X</td>
<td>NOTE 2</td>
</tr>
<tr>
<td>5. VERIFY DURING WELDING:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. CONTROL AND HANDLING OF WELDING CONSUMABLES</td>
<td>1705.2.1</td>
<td>AWS D1.1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>B. ENVIRONMENTAL CONDITIONS</td>
<td>1705.2.1</td>
<td>AWS D1.1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>C. COMPLIANCE WITH WPS REQUIREMENTS</td>
<td>1705.2.1</td>
<td>AWS D1.1</td>
<td>X</td>
<td>NOTE 2</td>
</tr>
</tbody>
</table>

PW\DEN003\696780

9/23/2019©COPYRIGHT 2019 CH2M HILL

SPECIAL INSPECTION, OBSERVATION, AND TESTING
01 45 33 SUPPLEMENT - 21
6. AFTER WELDING, VERIFY THE FOLLOWING:

<table>
<thead>
<tr>
<th></th>
<th>SYSTEM</th>
<th>2015 IBC REFERENCE</th>
<th>REFERENCED STANDARD</th>
<th>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</th>
<th>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</th>
<th>COMMENTS</th>
<th>TESTING FOR SPECIAL INSPECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A. SIZE, LENGTH AND LOCATION OF WELDS</td>
<td>1705.2.1</td>
<td>AWS D1.1</td>
<td>X</td>
<td>NOTE 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>B. WELDS MEET VISUAL ACCEPTANCE CRITERIA</td>
<td>1705.2.1</td>
<td>AWS D1.1</td>
<td>X</td>
<td>NOTE 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. BACKING REMOVED AND WELD TABS REMOVED (IF REQUIRED)</td>
<td>1705.2.1</td>
<td>AWS D1.1</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D. NONDESTRUCTIVE WELDING INSPECTION</td>
<td>1705.2</td>
<td>AWS D1.1</td>
<td>X</td>
<td>NOTE 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. INSPECTION OF STEEL FRAME JOINT DETAILS FOR COMPLIANCE:

<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A. DETAILS SUCH AS BRACING AND STIFFENING</td>
<td>1705.2.1</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>B. MEMBER LOCATIONS</td>
<td>1705.2.1</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. APPLICATION OF JOINT DETAILS AT EACH CONNECTION</td>
<td>1705.2.1</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SYSTEM</td>
<td>2015 IBC CODE REFERENCE</td>
<td>REFERENCED STANDARD</td>
<td>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</td>
<td>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</td>
<td>COMMENTS</td>
<td>TESTING FOR SPECIAL INSPECTION</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------</td>
<td>---------------------</td>
<td>------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>----------</td>
<td>-----------------------------</td>
<td></td>
</tr>
<tr>
<td>8. INSPECTION OF STEEL ELEMENTS OF COMPOSITE CONSTRUCTION PRIOR TO CONCRETE PLACEMENT:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. PLACEMENT AND INSTALLATION OF STEEL DECK</td>
<td>1705.2.1</td>
<td>AISC 360: Table N6.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. PLACEMENT AND INSTALLATION OF STEEL HEADED STUD ANCHORS</td>
<td>1705.2.1</td>
<td>AWS D1.1</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**STEEL CONSTRUCTION OTHER THAN STRUCTURAL STEEL**

<p>| 1. CONNECTION OF COLD-FORMED STEEL DECK TO SUPPORTING STRUCTURE: | | | | | | |
| A. FLOOR AND ROOF DECK WELDS | 1705.2.2 | AWS D1.3 SDI: QA/QC | X | | | |
| B. OTHER FASTENERS: VERIFY FASTENERS ARE IN CONFORMANCE WITH APPROVED SUBMITTAL | 1705.2.2 | AISC 360: SEC N6 | X | | | |</p>
<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>2015 IBC CODE REFERENCE</th>
<th>REFERENCED STANDARD</th>
<th>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</th>
<th>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</th>
<th>COMMENTS</th>
<th>TESTING FOR SPECIAL INSPECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. OTHER FASTENERS: VERIFY FASTENERS INSTALLATION IS IN ACCORDANCE WITH APPROVED SUBMITTAL</td>
<td>1705.2.2</td>
<td>AISC 360: SEC N6</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. INSPECTION OF WELDING, REINFORCING STEEL:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. VERIFICATION OF WELDABILITY OF REINFORCING STEEL OTHER THAN ASTM A706</td>
<td>1705.3</td>
<td>AWS D1.4 ACI 318: 26.5.4</td>
<td>X</td>
<td></td>
<td>NOTE 2</td>
<td>CONTRACTOR TO DETERMINE THE CARBON EQUIVALENT TO DEVELOP WPS REQUIREMENTS</td>
</tr>
<tr>
<td>B. INSPECT SINGLE-PASS FILLET WELDS, MAX 5/16&quot;</td>
<td>1705.3</td>
<td>AWS D1.4 ACI 318: 26.5.4</td>
<td>X</td>
<td></td>
<td></td>
<td>SEE TABLE 3 FOR TESTING OF WELDING REINFORCING STEEL</td>
</tr>
<tr>
<td>C. INSPECT ALL OTHER WELDS</td>
<td>1705.3</td>
<td>AWS D1.4 ACI 318: 26.5.4</td>
<td>X</td>
<td></td>
<td></td>
<td>SEE TABLE 3 FOR TESTING OF WELDING REINFORCING STEEL</td>
</tr>
</tbody>
</table>
### 3. INSTALLATION OF OPEN-WEB STEEL JOISTS AND JOIST GIRDERs

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>2015 IBC CODE REFERENCE</th>
<th>REFERENCED STANDARD</th>
<th>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</th>
<th>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</th>
<th>COMMENTS</th>
<th>TESTING FOR SPECIAL INSPECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. END CONNECTIONS—WELDED OR BOLTED</td>
<td>1705.2.3, 2207.1</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. BRIDGING—HORIZONTAL OR DIAGONAL</td>
<td>1705.2.3, 2207.1</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. STANDARD BRIDGING</td>
<td>1705.2.3, 2207.1</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. BRIDGING THAT DIFFERS FROM SECTION 2207.1</td>
<td>1705.2.3</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**

1. PERIODIC INSPECTION IS DEFINED AS INSPECTION BY THE SPECIAL INSPECTOR OF ALL MATERIALS AND SYSTEMS, IN SOME CASES PERFORMED DURING THEIR PLACEMENT AND IN ALL CASES PERFORMED UPON COMPLETION OF THEIR PLACEMENT. THE COMPLETION INSPECTION SHALL BE PERFORMED SO THAT WORK CAN BE CORRECTED PRIOR TO OTHER RELATED WORK PROCEEDING AND COVERING INSPECTED WORK.

2. VISUAL INSPECTION IS THE RESPONSIBILITY OF THE CONTRACTOR'S WELDING INSPECTOR(S) AND IS NOT CONSIDERED SPECIAL INSPECTION. CONTRACTOR MUST PROVIDE A QUALIFIED WELDING INSPECTOR TO OVERSEE CONTRACTOR'S WELDING OPERATIONS, AS REQUIRED BY AWS D1.1, SECTIONS 6.1.2 & 6.6, SPEC. SECTION 05 05 23 AND REFERENCED WELDING CODES.

**Notes to User:**

INFO 1. (LIMIT USE TO HIGH CHALLENGE ENVIRONMENTS PER ICC REVIEW OF S72-04/05) —not code adopted but proposed). A high challenge environment is a high importance diaphragm, shear wall, connections, joints, etc that effect the lateral load resisting system.
<table>
<thead>
<tr>
<th>MATERIAL TYPE OR SCOPE</th>
<th>TYPE OR SCOPE</th>
<th>STANDARD</th>
<th>REFERENCE</th>
<th>FREQUENCY</th>
<th>BY WHOM</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPACTED FILL GRADATION</td>
<td>COMPACTED FILL</td>
<td>ASTM C117, C136</td>
<td>SECTION 31.23, FILL AND BACKFILL</td>
<td>OWNER'S TESTING AGENCY</td>
<td>1705.6</td>
<td></td>
</tr>
<tr>
<td>COMPACTED FILL COMPACTION</td>
<td>COMPACTED FILL</td>
<td>ASTM D5967</td>
<td>SECTION 31.23, FILL AND BACKFILL</td>
<td>OWNER'S TESTING AGENCY</td>
<td>1705.6</td>
<td></td>
</tr>
<tr>
<td>COMPACTED FILL DENSITY</td>
<td>COMPACTED FILL</td>
<td>ASTM D698</td>
<td>SECTION 31.23, SUBGRADE PREPARATION</td>
<td>OWNER'S TESTING AGENCY</td>
<td>1705.6</td>
<td></td>
</tr>
<tr>
<td>PREPARED SUBGRADE DENSITY</td>
<td>PREPARED SUBGRADE</td>
<td>ASTM D698</td>
<td>SECTION 31.23, SUBGRADE PREPARATION</td>
<td>OWNER'S TESTING AGENCY</td>
<td>1705.6</td>
<td></td>
</tr>
<tr>
<td>CAST-IN-PLACE DEEP FOUNDATIONS</td>
<td>CAST-IN-PLACE DEEP FOUNDATIONS</td>
<td>ASTM D9882</td>
<td>SECTION 31.09, DYNAMIC PILE TESTING</td>
<td>CONTRACTOR'S APPROVED TESTING AGENCY</td>
<td>1705.8</td>
<td></td>
</tr>
<tr>
<td>PULLOUT TEST</td>
<td>NONPRESTRESSED ROCK ANCHORS</td>
<td>ASTM D4435</td>
<td>SECTION 31.68, NONPRESTRESSED ROCK ANCHORS</td>
<td>CONTRACTOR'S APPROVED TESTING AGENCY</td>
<td>1705.1.1-ITEM 2</td>
<td></td>
</tr>
<tr>
<td>TENDON PERFORMANCE TEST</td>
<td>PRESTRESSED ROCK ANCHORS</td>
<td>ASTM C942</td>
<td>SECTION 31.68, PRESTRESSED ROCK ANCHORS</td>
<td>CONTRACTOR'S APPROVED TESTING AGENCY</td>
<td>1705.1.1-ITEM 2</td>
<td></td>
</tr>
<tr>
<td>GROUT TEST</td>
<td>PRESTRESSED ROCK ANCHORS</td>
<td>ASTM C942</td>
<td>SECTION 31.68, PRESTRESSED ROCK ANCHORS</td>
<td>CONTRACTOR'S APPROVED TESTING AGENCY</td>
<td>1705.1.1-ITEM 2</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 3

TESTING FOR REQUIRED SPECIAL INSPECTION REFER TO SPECIFICATION SECTION 01 45 33

<table>
<thead>
<tr>
<th>2015 IBC CODE</th>
<th>REFERENCE GEO-TECHNICAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 IBC CODE</td>
<td>1705.6</td>
</tr>
</tbody>
</table>

SPECIAL INSPECTION, OBSERVATION, AND TESTING 01 45 33 SUPPLEMENT - 26
<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>TYPE OR SCOPE</th>
<th>STANDARD</th>
<th>2015 IBC CODE REFERENCE</th>
<th>FREQUENCY</th>
<th>BY WHOM</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRESTRESSED ROCK ANCHORS</td>
<td>TENDON PROOF</td>
<td>1705.1.1- ITEM 2</td>
<td>SECTION 31 68 13, PRESTRESSED ROCK ANCHORS</td>
<td>CONTRACTOR'S APPROVED TESTING AGENCY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONCRETE</td>
<td>STRENGTH</td>
<td>ASTM C39</td>
<td>1705.3</td>
<td>ONCE EACH DAY, BUT NOT LESS THAN ONE SAMPLE FOR EACH 150 CUBIC YARDS OR 5,000 SFT OF WALLS OR SLABS PLACED</td>
<td>OWNER'S TESTING AGENCY</td>
<td></td>
</tr>
<tr>
<td>SHOTCRETE</td>
<td>STRENGTH</td>
<td>ASTM C42</td>
<td>1705.3, 1908.10</td>
<td>ONCE EACH SHIFT, BUT NOT LESS THAN ONE SAMPLE FOR EACH 50 CUBIC YARDS PLACED</td>
<td>OWNER'S TESTING AGENCY</td>
<td></td>
</tr>
<tr>
<td>CONCRETE</td>
<td>SLUMP</td>
<td>ASTM C143, C94</td>
<td>1705.3</td>
<td>ONE SAMPLE PER STRENGTH TEST</td>
<td>OWNER'S TESTING AGENCY</td>
<td></td>
</tr>
<tr>
<td>CONCRETE</td>
<td>AIR CONTENT</td>
<td>ASTM C231, C94</td>
<td>1705.3</td>
<td>ONE SAMPLE PER STRENGTH TEST</td>
<td>OWNER'S TESTING AGENCY</td>
<td></td>
</tr>
<tr>
<td>CONCRETE</td>
<td>TEMPERATURE</td>
<td>ASTM C1064</td>
<td>1705.3</td>
<td>ONE SAMPLE PER STRENGTH TEST</td>
<td>OWNER'S TESTING AGENCY</td>
<td></td>
</tr>
<tr>
<td>MATERIAL</td>
<td>TYPE OR SCOPE</td>
<td>STANDARD</td>
<td>2015 IBC CODE</td>
<td>FREQUENCY</td>
<td>BY WHOM</td>
<td>COMMENTS</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-----------------------------</td>
<td>------------------</td>
<td>----------------</td>
<td>--------------------</td>
<td>---------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>MASONRY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONCRETE MASONRY</td>
<td>UNIT STRENGTH</td>
<td>ASTM C140</td>
<td>2105.1</td>
<td>ONE SAMPLE SET</td>
<td>OWNER'S TESTING AGENCY</td>
<td>(6 FULL SIZE UNITS) PER 5,000 SQ. FT. DURING CONSTRUCTION</td>
</tr>
<tr>
<td>MASONRY</td>
<td>COMRESSIVE STRENGTH OF GROUT</td>
<td>ASTM C1019</td>
<td>2105.1</td>
<td>THREE SAMPLES PRIOR TO CONSTRUCTION</td>
<td>OWNER'S TESTING AGENCY</td>
<td></td>
</tr>
<tr>
<td>MASONRY</td>
<td>PRISM</td>
<td>ASTM C1314</td>
<td>2105.1</td>
<td>TEST THREE PRISMS PRIOR TO CONSTRUCTION</td>
<td>OWNER'S TESTING AGENCY</td>
<td></td>
</tr>
<tr>
<td>STEEL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STEEL STUD WELDING</td>
<td>PRE-PRODUCTION TESTING</td>
<td>AWS D1.1 Sec. 7.7.1</td>
<td>1705.2</td>
<td>PRIOR TO CONSTRUCTION FOR EACH SIZE AND TYPE AND FIRST 2 STUDS EACH SHIFT</td>
<td>CONTRACTOR'S WELDING INSPECTOR</td>
<td></td>
</tr>
<tr>
<td>HIGH-STRENGTH BOLTING</td>
<td>PRE-INSTALLATION VERIFICATION TESTING OF PRETENSIONED BOLTS</td>
<td>RCSC SPECIFICATION FOR STRUCTURAL JOINTS USING ASTM A325 OR A490 BOLTS, Sec. 7</td>
<td>1705.2</td>
<td>3 FASTENER ASSEMBLIES OF EACH COMBINATION OF DIAMETER, LENGTH, GRADE AND LOT</td>
<td>OWNER'S TESTING AGENCY</td>
<td></td>
</tr>
<tr>
<td>MATERIAL</td>
<td>TYPE OR SCOPE</td>
<td>STANDARD</td>
<td>2015 IBC CODE REFERENCE</td>
<td>FREQUENCY</td>
<td>BY WHOM</td>
<td>COMMENTS</td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------------------------------------</td>
<td>----------------</td>
<td>--------------------------</td>
<td>----------------------------</td>
<td>------------------------------</td>
<td>-------------------------------------------------------</td>
</tr>
<tr>
<td>STRUCTURAL STEEL</td>
<td>ULTRASONIC OR RADIOPHASIC NONDESTRUCTIVE TESTING</td>
<td>AWS D1.1</td>
<td>1705.2</td>
<td>SECTION 05 05 23, WELDING</td>
<td>OWNER’S TESTING AGENCY</td>
<td>PERFORM RT OR UT ON GROOVE WELDS</td>
</tr>
<tr>
<td>REINFORCING STEEL</td>
<td>MAGNETIC PARTICLE NONDESTRUCTIVE TESTING</td>
<td>AWS D1.4</td>
<td>1705.3</td>
<td>SECTION 05 05 23, WELDING</td>
<td>OWNER’S TESTING AGENCY</td>
<td>PERFORM ON FILLET WELDS AND PARTIAL JOINT PENETRATION WELDS</td>
</tr>
</tbody>
</table>

**ARCHITECTURAL COMPONENTS**

<p>| SPRAYED FIRE-RESISTANT MATERIALS | THICKNESS TESTING | ASTM E605 | 1705.14.4 | 4 TESTS PER 1,000 SF OF SPRAYED AREA ON EACH FLOOR, ROOF AND WALL AND 25 PERCENT OF STRUCTURAL MEMBERS ON EACH FLOOR | OWNER’S TESTING AGENCY |
| SPRAYED FIRE-RESISTANT MATERIALS | DENSITY           | ASTM E605 | 1705.14.5 | ONE SAMPLE FOR EVERY 2,500 SF OF SPRAYED AREA ON EACH FLOOR, ROOF AND WALL ASSEMBLIES IN EACH STORY. ONE SAMPLE FOR EACH TYPE OF STRUCTURAL MEMBER IN THE TESTED AREA. | OWNER’S TESTING AGENCY |</p>
<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>TYPE OR SCOPE</th>
<th>STANDARD</th>
<th>2015 IBC CODE REFERENCE</th>
<th>FREQUENCY</th>
<th>BY WHOM</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPRAYED FIRE-RESISTANT MATERIALS</td>
<td>BOND STRENGTH</td>
<td>ASTM E736</td>
<td>1705.14.6</td>
<td>ONE TEST PER 2,500 SF OF SPRAYED AREA ON FLOOR, ROOF AND WALL ASSEMBLIES IN EACH STORY. ONE TEST FOR EACH TYPE OF STRUCTURAL MEMBER IN THE TESTED AREA.</td>
<td>OWNER'S TESTING AGENCY</td>
<td></td>
</tr>
</tbody>
</table>
The Seismic Design Category (SDC) for this Project is C.

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>INSPECTION REQUIRED FOR FOLLOWING SEISMIC DESIGN CATEGORIES</th>
<th>2015 IBC CODE REFERENCE</th>
<th>PERIODIC OWNER FURNISHED SPECIAL INSPECTION</th>
<th>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</th>
<th>COMMENTS</th>
<th>TESTING FOR SPECIAL INSPECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSTALLATION OF ANCHORAGE OF ELECTRICAL EQUIPMENT FOR EMERGENCY OR STANDBY POWER SYSTEMS</td>
<td>&quot;C&quot; AND ABOVE</td>
<td>1705.12.6 ITEM 1</td>
<td>X</td>
<td></td>
<td>NOTES 2 &amp; 3</td>
<td></td>
</tr>
<tr>
<td>INSTALLATION OF PIPING INTENDED TO EQUIPMENT USING COMBUSTIBLE ENERGY SOURCES</td>
<td>&quot;C&quot; AND ABOVE</td>
<td>1705.12.6 ITEM 3</td>
<td>X</td>
<td></td>
<td>NOTES 2 &amp; 3</td>
<td></td>
</tr>
<tr>
<td>INSTALLATION OF OTHER SEISMIC SUPPORTS FOR DESIGNATED ELECTRICAL SYSTEMS AND THEIR COMPONENTS</td>
<td>&quot;B&quot; AND ABOVE</td>
<td>1705.13.2</td>
<td>X</td>
<td></td>
<td>NOTES 2 &amp; 3</td>
<td>SEE TABLE 6</td>
</tr>
<tr>
<td>SYSTEM</td>
<td>INSPECTION REQUIRED FOR FOLLOWING SEISMIC DESIGN CATEGORIES</td>
<td>2015 IBC CODE REFERENCE</td>
<td>PERIODIC OWNER Furnished SPECIAL INSPECTION (SEE NOTE 1)</td>
<td>CONTINUOUS OWNER Furnished SPECIAL INSPECTION</td>
<td>COMMENTS</td>
<td>TESTING FOR SPECIAL INSPECTION</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------------------------------------------</td>
<td>--------------------------</td>
<td>--------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>----------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>PROCESS MECHANICAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>INSTALLATION OF PIPING SYSTEMS MEANT TO CARRY HAZARDOUS MATERIALS AND ITS ASSOCIATED MECHANICAL UNITS</td>
<td>&quot;C&quot; AND ABOVE</td>
<td>1705.12.6 ITEM 3</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>INSTALLATION OF OTHER SEISMIC SUPPORTS FOR DESIGNATED MECHANICAL SYSTEMS AND THEIR COMPONENTS</td>
<td>&quot;B&quot; AND ABOVE</td>
<td>1705.13.2</td>
<td>X</td>
<td>NOTES 2 &amp; 3</td>
<td>SEE TABLE 6</td>
</tr>
<tr>
<td></td>
<td><strong>BUILDING MECHANICAL AND PLUMBING</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>INSTALLATION AND ANCHORAGE OF HVAC DUCTWORK THAT WILL CONTAIN HAZARDOUS MATERIALS</td>
<td>&quot;C&quot; AND ABOVE</td>
<td>1705.12.6 ITEM 4</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>INSTALLATION OF VIBRATION ISOLATION SYSTEMS WHERE THE CONSTRUCTION DOCUMENTS REQUIRE A NOMINAL CLEARANCE OF 0.25 INCHES OR LESS BETWEEN THE EQUIPMENT SUPPORT FRAME AND RESTRAINT</td>
<td>&quot;C&quot; AND ABOVE</td>
<td>1705.12.6 ITEM 5</td>
<td>X</td>
<td>NOTES 2 &amp; 3</td>
<td></td>
</tr>
<tr>
<td>SYSTEM</td>
<td>INSPECTION REQUIRED FOR FOLLOWING SEISMIC DESIGN CATEGORIES</td>
<td>2015 IBC CODE REFERENCE</td>
<td>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</td>
<td>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</td>
<td>COMMENTS</td>
<td>TESTING FOR SPECIAL INSPECTION</td>
</tr>
<tr>
<td>---------</td>
<td>------------------------------------------------------------</td>
<td>--------------------------</td>
<td>---------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>----------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>INSTALLATION OF OTHER SEISMIC SUPPORTS FOR DESIGNATED MECHANICAL SYSTEMS AND THEIR COMPONENTS</td>
<td>&quot;B&quot; AND ABOVE</td>
<td>1705.13.2</td>
<td>X</td>
<td></td>
<td>NOTES 2 &amp; 3</td>
<td>SEE TABLE 6</td>
</tr>
<tr>
<td>STRUCTURAL STEEL INSPECTION OF SEISMIC-FORCE-RESISTING SYSTEMS</td>
<td>&quot;B&quot; AND ABOVE</td>
<td>1705.12.1.1, AISC 341</td>
<td>X</td>
<td></td>
<td></td>
<td>SEE TABLE 6 FOR STRUCTURAL STEEL TESTING</td>
</tr>
<tr>
<td>INSPECTION OF STRUCTURAL STEEL ELEMENTS INCLUDING STRUTS, COLLECTORS, CHORDS AND FOUNDATION ELEMENTS</td>
<td>&quot;B&quot; AND ABOVE</td>
<td>1705.12.1.2, AISC 341</td>
<td>X</td>
<td></td>
<td></td>
<td>SEE TABLE 6 FOR STRUCTURAL STEEL TESTING</td>
</tr>
<tr>
<td>COLD FORMED STEEL LIGHT-FRAMED CONSTRUCTION: WELDING, SCREW ATTACHMENT, BOLTING, ANCHORING AND OTHER FASTENINGS WITHIN THE SEISMIC FORCE-RESISTING SYSTEM INCLUDING SHEAR WALLS, BRACES, DIAPHRAGMS, COLLECTORS (DRAG STRUTS), AND HOLD-DOWNS</td>
<td>&quot;C&quot; AND ABOVE</td>
<td>1705.12.3</td>
<td>X</td>
<td></td>
<td>NOTE 4</td>
<td></td>
</tr>
<tr>
<td>SYSTEM</td>
<td>INSPECTION REQUIRED FOR FOLLOWING SEISMIC DESIGN CATEGORIES</td>
<td>2015 IBC CODE REFERENCE</td>
<td>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</td>
<td>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</td>
<td>COMMENTS</td>
<td>TESTING FOR SPECIAL INSPECTION</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>INSPECT AND VERIFY THAT THE DESIGNATED SEISMIC SYSTEM COMPONENTS ARE LABELED AND ANCHORAGE OR MOUNTING CONFORMS TO THE CERTIFICATE OF COMPLIANCE</td>
<td>&quot;C&quot; AND ABOVE</td>
<td>1705.12.4</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
1. PERIODIC INSPECTION IS DEFINED AS INSPECTION BY THE SPECIAL INSPECTOR OF ALL MATERIALS AND SYSTEMS. IN SOME CASES PERFORMED DURING THEIR PLACEMENT AND IN ALL CASES PERFORMED UPON COMPLETION OF THEIR PLACEMENT. THE COMPLETION INSPECTION SHALL BE PERFORMED SO THAT WORK CAN BE CORRECTED PRIOR TO OTHER RELATED WORK PROCEEDING AND COVERING THE INSPECTED WORK.
2. TESTING OF SYSTEMS AND THEIR ANCHORAGE SHALL BE IN CONFORMANCE WITH 2015 IBC SECTION 1705.13.2.
3. CERTIFICATION OF SYSTEMS AND THEIR ANCHORAGE SHALL BE IN CONFORMANCE WITH 2015 IBC SECTION 1705.13.3.
4. NOT REQUIRED IF SHEATHING IS GYPSUM BOARD OR FIBERBOARD OR IF SHEATHING IS WOOD STRUCTURAL PANEL OR STEEL SHEETS ON ONE SIDE OF PANEL OR DIAPHRAGM ONLY AND THE FASTENER SPACING IS MORE THAN 4 INCHES.
## TABLE 5
REQUIRED SPECIAL INSPECTION FOR WIND RESISTANCE FOR STRUCTURAL SYSTEMS
REFER TO SPECIFICATION SECTION 01 45 33

The Nominal Design Wind Speed (3-second-gust) for this Project is 120 mph.
The Wind Exposure is Category C.

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>2015 IBC CODE REFERENCE</th>
<th>STANDARD OR CODE</th>
<th>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</th>
<th>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>COLD FORMED STEEL LIGHT-FRAMED CONSTRUCTION: WELDING, SCREW ATTACHMENT, BOLTING, ANCHORING AND OTHER FASTENINGS WITHIN THE MAIN WIND FORCE-RESISTING SYSTEM INCLUDING SHEAR WALLS, BRACES, DIAPHRAGMS, COLLECTORS (DRAG STRUTS), AND HOLD-DOWNS</td>
<td>1705.11.2</td>
<td></td>
<td>X</td>
<td></td>
<td>NOTES 2 AND 3</td>
</tr>
<tr>
<td>FASTENING OF ROOF COVERING, ROOF DECK AND ROOF FRAMING CONNECTIONS</td>
<td>1705.11.3</td>
<td></td>
<td>X</td>
<td></td>
<td>NOTE 2</td>
</tr>
<tr>
<td>SYSTEM</td>
<td>2015 IBC CODE REFERENCE</td>
<td>STANDARD OR CODE</td>
<td>PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)</td>
<td>CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION</td>
<td>COMMENTS</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------</td>
<td>------------------</td>
<td>--------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>FASTENING OF EXTERIOR WALL CLADDING AND WALL CONNECTIONS TO ROOF AND FLOOR DIAPHRAGMS AND FRAMING</td>
<td>1705.11.3</td>
<td></td>
<td>X</td>
<td></td>
<td>NOTE 2</td>
</tr>
</tbody>
</table>

NOTES:

1. PERIODIC INSPECTION IS DEFINED AS INSPECTION BY THE SPECIAL INSPECTOR OF ALL MATERIALS AND SYSTEMS, IN SOME CASES PERFORMED DURING THEIR PLACEMENT AND IN ALL CASES PERFORMED UPON COMPLETION OF THEIR PLACEMENT. THE COMPLETION INSPECTION SHALL BE PERFORMED SO THAT WORK CAN BE CORRECTED PRIOR TO OTHER RELATED WORK PROCEEDING AND COVERING THE INSPECTED WORK.

2. SPECIAL INSPECTIONS FOR WIND RESISTANCE ARE REQUIRED FOR BUILDINGS AND STRUCTURES CONSTRUCTED IN WIND EXPOSURE CATEGORY B, WHERE THE 3-SECOND-GUST NOMINAL DESIGN WIND SPEED IS 120 MPH OR GREATER, OR IN WIND EXPOSURE CATEGORIES C OR D, WHERE THE 3-SECOND-GUST NOMINAL DESIGN WIND SPEED IS 110 MPH OR GREATER.

3. NOT REQUIRED IF SHEATHING IS GYPSUM BOARD OR FIBERBOARD, OR IF SHEATHING IS WOOD STRUCTURAL PANEL OR STEEL SHEETS ON ONE SIDE OF PANEL OR DIAPHRAGM ONLY AND THE FASTENER SPACING IS MORE THAN 4 INCHES.
<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>TYPE OR SCOPE</th>
<th>STANDARD</th>
<th>2015 IBC CODE REFERENCE</th>
<th>FREQUENCY</th>
<th>BY WHOM</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEEL</td>
<td>TEST IN ACCORDANCE WITH THE QUALITY ASSURANCE REQUIREMENTS OF AISC 341</td>
<td>NONDESTRUCTIVE TESTING</td>
<td>AISC 341 AWS D1.8</td>
<td>1705.13.1.1, 1705.13.1.2</td>
<td>CONTINUOUS</td>
<td>OWNER’S SPECIAL INSPECTOR</td>
</tr>
<tr>
<td></td>
<td>RADIOSCOPI thousands (RT) OR ULTRASONIC (UT) NONDESTRUCTIVE TESTING OF GROOVE WELDS</td>
<td>NONDESTRUCTIVE TESTING</td>
<td>AISC 341 AWS D1.8</td>
<td>1705.13.1.1, 1705.13.1.2</td>
<td>CONTINUOUS</td>
<td>OWNER’S SPECIAL INSPECTOR</td>
</tr>
<tr>
<td></td>
<td>MAGNETIC PARTICLE (MT) OR LIQUID PENETRANT (PT) NONDESTRUCTIVE TESTING</td>
<td>NONDESTRUCTIVE TESTING</td>
<td>AISC 341 AWS D1.8</td>
<td>1705.13.1.1, 1705.13.1.2</td>
<td>CONTINUOUS</td>
<td>OWNER’S SPECIAL INSPECTOR</td>
</tr>
<tr>
<td></td>
<td>DESIGNATED SEISMIC SYSTEM COMPONENTS (AND ASSOCIATED ANCHORAGES) SUBJECT TO PROVISIONS OF ASCE 7 SECTION 13.2.2</td>
<td>CERTIFICATE OF COMPLIANCE</td>
<td>ASCE 7 SECTION 13.2.2</td>
<td>1705.13.3</td>
<td>EACH SYSTEM OR COMPONENT</td>
<td>MANUFACTURER</td>
</tr>
</tbody>
</table>

TABLE 6
TESTING FOR SEISMIC RESISTANCE
REFER TO SPECIFICATION SECTION 01 45 33
### NOTES:
1. TESTING AND QUALIFICATION FOR SEISMIC RESISTANCE ARE REQUIRED FOR SEISMIC-FORCE-RESISTING SYSTEMS IN STRUCTURES ASSIGNED TO SEISMIC DESIGN CATEGORY B, C, D, E, OR F, UNLESS OTHERWISE NOTED.
2. BASED ON ACTUAL TEST ON SHAKE TABLE, BY THREE-DIMENSIONAL SHOCK TESTS, BY AN ANALYTICAL METHOD USING DYNAMIC CHARACTERISTICS AND FORCES, BY THE USE OF EXPERIENCE DATA, OR BY MORE RIGOROUS ANALYSIS PROVIDING FOR EQUIVALENT SAFETY.
SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1   GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

4. Telecommunications Industry Association (TIA); Electronic Industries Alliance (EIA): 568B, Commercial Building Telecommunications Cabling Standard.

1.02 SUBMITTALS

A. Informational Submittals:

1. Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.
2. Temporary Utility Submittals:
   a. Electric power supply and distribution plans.
   b. Water supply and distribution plans.
   c. Dewatering well locations.
   d. Sanitary.
3. Temporary Construction Submittals:
   a. Access Roads: Routes, cross-sections, and drainage facilities.
   b. Diversion and Care of Water plan.
   c. Parking area plans.
   d. Contractor’s field office, storage yard, and storage building plans, including gravel surfaced area.
   e. Fencing and protective barrier locations and details.
   f. Staging area location plan.
   g. Traffic and Pedestrian Control and Routing Plans: As specified herein, and proposed revisions thereto.
4. Temporary Control Submittals:
   a. Noise control plan.
   b. Dust control plan.
   c. Plan for disposal of waste materials and intended haul routes.

1.03 MOBILIZATION

A. Mobilization includes, but is not limited to, these principal items:
   1. Obtaining required permits.
   2. Moving Contractor’s field office and equipment required for first month operations onto Site.
   3. Installing temporary construction power, wiring, and lighting facilities.
   4. Providing onsite Internet service and telephones.
   5. Providing onsite sanitary facilities and potable water facilities as specified and as required by Laws and Regulations, and governing agencies.
   6. Arranging for and erection of Contractor’s work and storage yard.
   7. Posting OSHA required notices and establishing safety programs and procedures.
   8. Having Contractor’s superintendent at Site full time.

B. Use area designated for Contractor’s temporary facilities as shown on Drawings.

1.04 PROTECTION OF WORK AND PROPERTY

A. Comply with Owner’s safety rules while on Owner’s property.

B. Keep Owner informed of serious onsite accidents and related claims.

C. Use of Explosives: No blasting or use of explosives will be allowed onsite.

1.05 VEHICULAR TRAFFIC

A. Traffic Control Plan: Adhere to traffic control plan reviewed and accepted by Engineer. Changes to this plan shall be made only by written approval of appropriate public authority. Secure approvals for necessary changes so as not to delay progress of the Work.

B. Traffic Routing Plan: Show sequences of construction affecting use of roadways, time required for each phase of the Work, provisions for decking over excavations and phasing of operations to provide necessary access, and plans for signing, barricading, and striping to provide passages for pedestrians and vehicles.
PART 2 PRODUCTS

2.01 PROJECT SIGN

A. Provide and maintain one, 8-foot-wide by 4-foot-high sign constructed of 3/4-inch exterior high density overlaid plywood. Sign shall bear name of Project, Owner, Contractor, Engineer, and other participating agencies. Lettering shall be blue applied on white background by an experienced sign painter. Information to be included and logo graphic will be provided by Owner.

PART 3 EXECUTION

3.01 TEMPORARY UTILITIES

A. Power:

1. No electric power is available at Site. Make arrangements to obtain and pay for electrical power used until final payment and acceptance by Owner, unless otherwise recommended by Engineer at Substantial Completion.
2. Cost of electric power will be borne by Contractor.

B. Lighting: Provide temporary lighting to meet applicable safety requirements to allow erection, application, or installation of materials and equipment, and observation or inspection of the Work.

C. Heating, Cooling, and Ventilating:

1. Provide as required to maintain adequate environmental conditions to facilitate progress of the Work, to meet specified minimum conditions for installation of materials, and to protect materials, equipment, and finishes from damage because of temperature or humidity. Costs for temporary heat shall be borne by Contractor responsible for constructing structure.
2. Provide adequate forced air ventilation of enclosed areas to cure installed materials, to dispense humidity, and to prevent hazardous accumulations of dust, fumes, vapors, or gases.
3. Pay costs of installation, maintenance, operation, removal, and fuel consumed.
4. Provide portable unit heaters, complete with controls, oil- or gas-fired, and suitably vented to outside as required for protection of health and property.
5. If permanent natural gas piping is used for temporary heating units, do not modify or reroute gas piping without approval of utility company. Provide separate gas metering as required by utility.
D. Water:

1. [A: No construction or potable water is available at Site. Make arrangements for and bear costs of providing water required for construction purposes and for drinking by construction personnel during construction.]

2. [B: Hydrant Water:]
   a. [C: Is available from nearby hydrants. Secure written permission for connection and use from water department and meet requirements for use. Notify fire department before obtaining water from fire hydrants.]
   b. [D: Use only special hydrant-operating wrenches to open hydrants. Make certain hydrant valve is open full, since cracking valve causes damage to hydrant. Repair damaged hydrants and notify appropriate agency as quickly as possible. Hydrants shall be completely accessible to fire department at all times.]
   c. [E: Include costs to connect and transport water to construction areas in Contract Price.]

3. [F: Owner will provide a place of temporary connection for [G: construction] [H: and] [I: drinking] water at Site. Provide temporary facilities and piping required to bring water to point of use and remove when no longer needed. Install an acceptable metering device and pay for water used at Owner’s current rate.]

4. [J: Owner will furnish [K: construction] [L: and] [M: drinking] water required [N: at no cost to Contractor] [O: on Site] [P: at location shown.] [Q: Furnish and install temporary piping and facilities to transport water to the Work.]

5. [R: Provide] [S: and] [T: bear costs of] [U: necessary water] [V: in excess of ________ gpm] [W: required for testing equipment, tanks or basins, and piping prior to Substantial Completion, unless otherwise specifically stated in Specifications for equipment, systems, or facilities to be tested.]

6. [X: Provide means to prevent water used for testing from flowing back into source pipeline.]

7. [Y: ]

E. Sanitary and Personnel Facilities: Provide and maintain facilities for Contractor’s employees, Subcontractors, and other onsite employers’ employees. Service, clean, and maintain facilities and enclosures.

F. Telephone Service:

1. Contractor: Arrange and provide onsite telephone service for use during construction. Pay costs of installation and monthly bills.
G. Fire Protection: Furnish and maintain on Site adequate firefighting equipment capable of extinguishing incipient fires. Comply with applicable parts of NFPA 241.

3.02 PROTECTION OF WORK AND PROPERTY

A. General:

1. Perform Work within right-of-way and easements in a systematic manner that minimizes inconvenience to property owners and the public.

2. Maintain in continuous service existing oil and gas pipelines, underground power, telephone or communication cable, water mains, irrigation lines, sewers, poles and overhead power, and other utilities encountered along line of the Work, unless other arrangements satisfactory to owners of said utilities have been made.

3. Where completion of the Work requires temporary or permanent removal or relocation of existing utility, coordinate activities with owner of said utility and perform work to their satisfaction.

4. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.

5. Keep fire hydrants and water control valves free from obstruction and available for use at all times.

6. In areas where Contractor’s operations are adjacent to or near a utility, such as gas, telephone, television, electric power, water, sewer, or irrigation system, and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection have been made by Contractor.

7. Notify property owners and utility offices that may be affected by construction operation at least 2 days in advance. Before exposing a utility, obtain utility owner’s permission. Should service of utility be interrupted due to Contractor’s operation, notify proper authority immediately. Cooperate with said authority in restoring service as promptly as possible and bear costs incurred.

8. Do not impair operation of existing sewer system. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures.

9. Maintain original Site drainage wherever possible.
B. Site Security:

1. Erect a temporary security fence for protection of existing facilities, as specified in Section 32 31 13, Chain Link Fences and Gates. Maintain fence throughout construction period. Obtain Engineer’s written permission before removal of temporary security fencing.

2. Provide and maintain additional temporary security fences as necessary to protect the Work and Contractor-furnished products not yet installed.

C. Barricades and Lights:

1. Provide as required by Code and in sufficient quantity to safeguard public and the Work.

2. Provide as necessary to prevent unauthorized entry to construction areas and affected roads, streets, and alleyways, inside and outside of fenced area, and as required to ensure public safety and the safety of Contractor’s employees, other employer’s employees, and others who may be affected by the Work.

3. Provide to protect existing facilities and adjacent properties from potential damage.

4. Locate to enable access by facility operators and property owners.

5. Protect streets, roads, highways, and other public thoroughfares that are closed to traffic by effective barricades with acceptable warning signs.

6. Locate barricades at the nearest intersecting public thoroughfare on each side of blocked section.

7. Illuminate barricades and obstructions with warning lights from sunset to sunrise.

D. Signs and Equipment:

1. Conform to requirements of manual published by the State Department of Transportation.

2. Portable TOW-AWAY-NO STOPPING Signs: Place where approved by police department and Owner.

3. Traffic Cones: Provide to delineate traffic lanes to guide and separate traffic movements.

4. High-Level Warning Flag Units: Provide two in advance of traffic approaching the Work, each displaying three flags mounted at a height of 9 feet.

5. Provide at obstructions, such as material piles and equipment.

6. Use to alert general public of construction hazards, which would include surface irregularities, unramped walkways, grade changes, and trenches or excavations in roadways and in other public access areas.
E. Trees and Plantings:

1. Protect from damage and preserve trees, shrubs, and other plants outside limits of the Work and within limits of the Work, which are designated on Drawings to remain undisturbed.
   a. Where practical, tunnel beneath trees when on or near line of trench.
   b. Employ hand excavation as necessary to prevent tree injury.
   c. Do not stockpile materials or permit traffic within drip lines of trees.
   d. Provide and maintain temporary barricades around trees.
   e. Water vegetation as necessary to maintain health.
   f. Cover temporarily exposed roots with wet burlap, and keep burlap moist until soil is replaced around roots.
   g. No trees, except those specifically shown on Drawings to be removed, shall be removed without written approval of Engineer.
   h. Dispose of removed trees in a legal manner off the Site.

2. Balling and burlapping of trees indicated for replacement shall conform to recommended specifications set forth in the American Standards for Nursery Stock, published by American Association of Nurserymen. Balls shall be firm and intact and made-balls will not be accepted. Handle ball and burlap trees by ball and not by top.

3. In event of damage to bark, trunks, limbs, or roots of plants that are not designated for removal, treat damage by corrective pruning, bark tracing, application of a heavy coating of tree paint, and other accepted horticultural and tree surgery practices.

4. Replace each plant that dies as a result of construction activities.

F. Existing Structures:

1. Where Contractor contemplates removal of small structures such as mailboxes, signposts, and culverts that interfere with Contractor’s operations, obtain approval of property owner and Engineer.

2. Replace items removed in their original location and a condition equal to or better than original.

G. Finished Construction: Protect finished floors and concrete floors exposed as well as those covered with composition tile or other applied surfacing.

H. Waterways: Keep ditches, culverts, and natural drainages continuously free of construction materials and debris.

I. Endangered and Threatened Species:

1. Take precautions necessary and prudent to protect native endangered and threatened flora and fauna.
2. Notify Engineer of construction activities that might threaten endangered and threatened species or their habitats.
3. Engineer will mark areas known as habitats of endangered and threatened species prior to commencement of onsite activities.
4. Additional areas will be marked by Engineer as other habitats of endangered and threatened species become known during construction.

3.03 DIVERSION AND CARE OF WATER

A. Utilize a planned, phased approach to isolate work areas for construction within the Arkansas River corridor to allow for conveyance of river and stream flows around the work areas and construction access routes.

B. Contractor is responsible for making his/her own hydraulic calculations and judgements regarding the planning and execution of measures to divert water.

C. Design River Flow: 90,000 cubic feet per second as measured at the USGS Gauge 07164500 Arkansas River at Tulsa, OK. This flow rate has approximately a 10-year recurrence interval.

D. Monitor flows within the Arkansas River and tributaries using publicly available gauge data for the Arkansas River and its tributaries. Coordinate diversion measures and Work with Keystone Dam operations and planned releases.

E. Monitor weather forecasts and climatic conditions which have the potential to influence river flows. Take reasonable and prudent precautions to protect personnel, equipment, materials, temporary structures, and completed work from immanent high flows.

F. Contractor is solely responsible for selection, design, installation, removal, cleanup, maintenance, and repair of cofferdams and diversion measures for all flows up to the design river flow within the construction period.

G. Determination of means and methods for water diversion, cofferdams, and dewatering measures to facilitate completion of the Work is the responsibility of the Contractor.

H. In the event that cofferdams or other diversion measures fail or are overtopped by river flows less than the design river flow, Contractor shall be solely responsible for all delays, cleanup, repairs, materials, and other costs without additional compensation.

I. Contractor may implement cofferdam or diversion measures that are designed for flow less than the Design River Flow; however, the Contractor bears full responsibility for all flows up to and equal to the Design River Flow.
J. Protect natural water resources, wetlands, endangered species, and other natural resources.

K. Comply with all Federal, State, and Local regulations.

L. All equipment working within or adjacent to the Arkansas River shall be clean and free of fluid leaks. Contractor shall have on hand, at all times, necessary items to arrest and contain leaks. Hydraulic equipment shall use vegetable oil or other biodegradable fluid as an alternative to conventional hydraulic fluid.

M. Contractor is responsible for human safety within the work areas, including cofferdam enclosures, at all times.

N. At all times and during all phases of the Work, positively preclude turbidity increases in the Arkansas River downstream of the Project.

O. Protect existing facilities, completed work, adjacent property vulnerable to settlement, scour, or damage from cofferdams, diversions, or dewatering operations as well as construction activities.

P. Dewatering: Construct, maintain, and operate cofferdams, channels, flume drains, sumps, pumps, or other temporary diversion and protection works. Furnish materials required, install, maintain, and operate necessary pumping and other equipment for the environmentally safe removal and disposal of water from the various parts of the Work. Maintain foundations and parts of the Work free from water.

3.04 TEMPORARY CONTROLS

A. Air Pollution Control:

1. Minimize air pollution from construction operations.
2. Burning of waste materials, rubbish, or other debris will not be permitted on or adjacent to Site.
3. Conduct operations of dumping rock and of carrying rock away in trucks to cause a minimum of dust. Give unpaved streets, roads, detours, or haul roads used in construction area a dust-preventive treatment or periodically water to prevent dust. Strictly adhere to applicable environmental regulations for dust prevention.
4. Provide and maintain temporary dust-tight partitions, bulkheads, or other protective devices during construction to permit normal operation of existing facilities. Construct partitions of plywood, insulating board, plastic sheets, or similar material. Construct partitions in such a manner that dust and dirt from demolition and cutting will not enter other parts of existing building or facilities. Remove temporary partitions as soon as need no longer exists.
B. Noise Control:
   1. Provide acoustical barriers so noise emanating from tools or equipment will not exceed legal noise levels.
   2. Noise Control Plan: Propose plan to mitigate construction noise and to comply with noise control ordinances, including method of construction, equipment to be used, and acoustical treatments.

C. Water Pollution Control:
   1. Divert sanitary sewage and nonstorm waste flow interfering with construction and requiring diversion to sanitary sewers. Do not cause or permit action to occur which would cause an overflow to existing waterway.
   2. Prior to commencing excavation and construction, obtain Owner’s agreement with detailed plans showing procedures intended to handle and dispose of sewage, groundwater, and dewatering pump discharges.
   3. Comply with Section 01 57 13, Temporary Erosion and Sediment Control, for stormwater flow and surface runoff.
   4. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.

D. Erosion, Sediment, and Flood Control: Provide, maintain, and operate temporary facilities as specified in Section 01 57 13, Temporary Erosion and Sediment Control, to control erosion and sediment releases, and to protect the Work and existing facilities from flooding during construction period.

3.05 STORAGE YARDS AND BUILDINGS

A. Coordinate requirements with Section 01 61 00, Common Product Requirements.

B. Temporary Storage Yards: Construct temporary storage yards for storage of products that are not subject to damage by weather conditions.

C. Temporary Storage Buildings:
   1. Provide environmental control systems that meet recommendations of manufacturers of equipment and materials stored.
   2. Arrange or partition to provide security of contents and ready access for inspection and inventory.
   3. Store combustible materials (paints, solvents, fuels) in a well-ventilated and remote building meeting safety standards.
3.06 ACCESS ROADS

A. Construct access roads as shown and within easements, rights-of-way, or Project limits.

B. Maintain drainage ways. Install and maintain culverts to allow water to flow beneath access roads. Provide corrosion-resistant culvert pipe of adequate strength to resist construction loads.

C. Provide gravel, crushed rock, or other stabilization material to permit access by all motor vehicles at all times.

D. Maintain road grade and crown to eliminate potholes, rutting, and other irregularities that restrict access.

E. Coordinate with Engineer detours and other operations affecting traffic and access. Provide at least 72 hours’ notice to Engineer of operations that will alter access to Site.

F. Where access road crosses existing fences, install and maintain gates. Gates and gate posts shall conform to those as specified in Section 32 31 13, Chain Link Fences and Gates.

3.07 PARKING AREAS

A. Control vehicular parking to preclude interference with public traffic or parking, access by emergency vehicles, Owner’s operations, or construction operations.

B. Provide parking facilities for personnel working on Project. No employee or equipment parking will be permitted on Owner’s existing paved areas except as specifically designated for Contractor’s use.

3.08 VEHICULAR TRAFFIC

A. Comply with Laws and Regulations regarding closing or restricting use of public streets or highways. No public or private road shall be closed, except by written permission of proper authority. Ensure the least possible obstruction to traffic and normal commercial pursuits.

B. Conduct the Work to interfere as little as possible with public travel, whether vehicular or pedestrian.
C. Whenever it is necessary to cross, close, or obstruct roads, driveways, and walks, whether public or private, provide and maintain suitable and safe bridges, detours, or other temporary expedients for accommodation of public and private travel.

D. Road Closures: Maintain satisfactory means of exit for persons residing or having occasion to transact business along route of the Work. If it is necessary to close off roadway or alley providing sole vehicular access to property for periods greater than 2 hours, provide written notice to each owner so affected 3 days prior to such closure. In such cases, closings of up to 4 hours may be allowed. Closures of up to 10 hours may be allowed if a week’s written notice is given and undue hardship does not result.

E. Maintenance of traffic is not required if Contractor obtains written permission from Owner and tenant of private property, or from authority having jurisdiction over public property involved, to obstruct traffic at designated point.

F. In making street crossings, do not block more than one-half the street at a time. Whenever possible, widen shoulder on opposite side to facilitate traffic flow. Provide temporary surfacing on shoulders as necessary.

G. Maintain top of backfilled trenches before they are paved, to allow normal vehicular traffic to pass over. Provide temporary access driveways where required. Cleanup operations shall follow immediately behind backfilling.

H. When flaggers and guards are required by regulation or when deemed necessary for safety, furnish them with approved orange wearing apparel and other regulation traffic control devices.

I. Notify fire department and police department before closing street or portion thereof. Notify said departments when streets are again passable for emergency vehicles. Do not block off emergency vehicle access to consecutive arterial crossings or dead-end streets, in excess of 300 linear feet, without written permission from fire department. Conduct operations with the least interference to fire equipment access, and at no time prevent such access. Furnish Contractor’s night emergency telephone numbers to police department.

3.09 CLEANING DURING CONSTRUCTION

A. In accordance with General Conditions, as may be specified in other Specification sections, and as required herein.
B. Wet down exterior surfaces prior to sweeping to prevent blowing of dust and debris. At least weekly, sweep floors (basins, tunnels, platforms, walkways, roof surfaces), and pick up and dispose of debris.

C. Provide approved containers for collection and disposal of waste materials, debris, and rubbish. At least weekly, dispose of such waste materials, debris, and rubbish offsite.

D. At least weekly, brush sweep entry drive, roadways, and other streets and walkways affected by the Work and where adjacent to the Work.

END OF SECTION
PART 1 GENERAL

1.01 SUMMARY

A. This section covers Work to implement structural and nonstructural Best Management Practices (BMP) to control soil erosion by wind or water and keep eroded sediments and other construction-generated pollutants from moving off project sites. Requirements described in this specification and shown on Drawings are part of the project Temporary Erosion and Sediment Control Plan (TESC Plan) and are the minimum for all project construction sites and conditions. This specification covers all project activities, including material sources, disposal sites, and offsite mitigation areas unless specific project activities are excluded elsewhere in this specification or in other Contract Documents controlling the Work.

B. National Pollutant Discharge Elimination System: Comply with Federal, state, and local laws, rules and regulations, and the National Pollutant Discharge Elimination System (NPDES) Construction Stormwater Discharge Permit or Permits applicable to the project. A copy of the Project’s General Construction Permit, if applicable to the Project, is available from Owner. NPDES General Construction permits are required on projects that involve disturbance of 1 acre or more with potential to discharge stormwater to surface waters.

C. Other Regulations: A local government erosion and sediment control permit may apply and some local agency requirements may be more stringent than this specification. Adequate erosion and sediment control is essential for complying with the federal Endangered Species Act where construction runoff enters waters inhabited by protected species.

1.02 REFERENCES

A. Activities shall conform to the [A: [jurisdiction] Erosion and Sediment Control Manual] [B: Standard Specifications] [C: special provisions/technical requirements] [D: [jurisdiction] Permit], and Drawings. In the event of a conflict, the more stringent requirement shall apply.
The following is a list of standards that may be referenced in this section:

2. ASTM International (ASTM):
   c. D3776/D3776M, Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.
3. National Weather Service:

6. U.S. Environmental Protection Agency:

7. The sections of the standards referenced above which apply to this Project include, but are not limited to:

<table>
<thead>
<tr>
<th>Standard</th>
<th>Specification or Detail No.</th>
<th>Symbol</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td></td>
<td>[C: Check Dam]</td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Coir Log]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Compost Blanket]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Compost Sock]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Erosion Control Blanket]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Filtration System]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Berm]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: High Visibility Fence]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Inlet Protection]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Mulch]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Natural Buffer or Equivalent]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Outlet Protection]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Plastic Covering]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Sediment Control Barrier]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[Silt (Sediment) Fence]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Stabilized Construction Entrance]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Street Cleaning]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Tackifiers]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Temporary Curb]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Temporary Pipe Slope Drain]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Temporary Sediment Trap]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Tire Wash]</td>
<td></td>
</tr>
<tr>
<td>[A: ]</td>
<td>[B: ]</td>
<td>[C: Wattles]</td>
<td></td>
</tr>
</tbody>
</table>
1.03 SYSTEM DESCRIPTION

A. Erosion and Sediment Control:

1. Provide, maintain, and operate temporary facilities to control erosion and sediment releases during construction period.

B. Erosion and Sediment Control (ESC) Lead:

1. Identify the ESC Lead at the preconstruction discussions and in the TESC Plan. The ESC Lead shall have certification in construction site erosion and sediment control from a course approved by Owner.
2. The ESC Lead shall implement the TESC Plan, including, but not limited to:
   a. Installing and maintaining all temporary erosion and sediment control Best Management Practices (BMPs) included in the TESC Plan to assure continued performance of their intended function. Damaged or inadequate TESC BMPs shall be corrected immediately.
   b. Updating TESC Plan to reflect current field conditions.
   c. Terminating TESC Plan.
3. When a TESC Plan is included in the Contract Plans, ESC Lead shall also inspect all areas disturbed by construction activities, all onsite erosion and sediment control BMPs, all stormwater discharge points, and all temporarily stabilized inactive sites per schedule in the Construction Stormwater Discharge Permit(s) or as directed by Engineer. Complete erosion and sediment control inspection form provided by water resource agency or Owner for each inspection and submit a copy to Engineer no later than end of the next working day following inspection.
C. Personnel Training:

1. Prior to commencement of construction, applicable personnel must have an understanding of the Construction Stormwater Discharge Permit’s requirements and their specific responsibilities under the permit. At a minimum, personnel must be trained to understand the following as it relates to the scope of their job duties:
   a. The location of all stormwater controls and how to maintain them.
   b. Procedures for complying with the pollution prevention requirements.
   c. Procedures for conducting inspections, recording findings, and taking corrective action.

D. Temporary Erosion and Sediment Control Plan (Stormwater Pollution Prevention Plan):

1. A TESC Plan is furnished as part of Drawings, which helps fulfill part of the plan requirement of the NPDES Permit. This initial TESC Plan, when adopted by Contractor, may be used as the basis of the construction TESC Plan. Additional or revised erosion and sediment control features, not shown on the initial TESC Plan, may be required depending on Contractor’s methods of operation and schedule.

2. For each phase of the scheduled work, indicate on the TESC Plan all the BMPs proposed and installed for erosion and sediment control to minimize clearing, stabilize exposed soil, divert or temporarily store flows, limit runoff from exposed areas, and filter transported sediment. Include all temporary slopes, constructed for staging or other reasons, which may not have been identified in the original Contract plans. Refer to the current local jurisdiction’s erosion and sediment control manual.

3. Some TESC Plan required elements typically required by NPDES permits:
   a. Narrative Site Description:
      1) Nature of construction activity planned for the Site.
      2) Estimates of total site area and the areas of the Site expected to be disturbed.
      3) Soil types found onsite and their erosion potential.
      4) The types of fill materials to be used.
      5) Timetable for sequence of major construction events.
   b. Site Map:
      1) All areas of development.
      2) Drainage patterns.
      3) Areas of soil disturbance, including pre-development and post-development elevation contours.
      4) Areas used for storage of soils or wastes.
      5) Areas where vegetative practices are to be implemented.
6) Location of all erosion and sediment control BMP or structures.
7) Location of all impervious structures and surfaces after project is completed.
8) Springs, wetlands, and other surface waters located onsite.
9) Boundaries of the 100-year floodplain, if determined.
10) Ordinary High Water line, if determined.
11) Location of storm drainage outfalls to receiving waters, if applicable.
12) Details of sediment and erosion controls.
13) Details of detention ponds, storm drain piping, inflow and outflow details.

c. Required BMPs and Procedures for Erosion Prevention, Runoff Control, and Sediment Control:
1) Construction entrances and parking areas.
2) Unpaved site roads such as haul roads.
3) Hauling saturated soils from the Site.
4) Water washed from concrete trucks.
5) Correct installation of erosion and sediment control BMPs.
6) Prompt maintenance and repair of BMPs.
7) Clearing and grading practices to minimize area of exposed soil throughout life of the Project.
8) Schedule of phased clearing operations to limit soils to what can be stabilized.
9) Vegetative practices, including preservation of existing vegetation, seeding, mulching, and buffer strips.
10) Preventing erosion of exposed areas.
11) Diverting flows from exposed slopes.
12) Limiting runoff from exposed areas.
13) Limiting sediment transport within work sites and keeping it from moving off of project areas.
14) Perimeter controls for all clearing and grubbing, both planned and installed.
15) Additional controls for wet season work and temporary work suspensions.
16) Sensitive areas such as wetlands.
17) Offsite material source and waste areas.
18) Dust.
19) Emergency materials stockpiled onsite.
20) Storing flows and filtering sediment.
21) Soil stockpiles.

4. Contractor’s construction TESC Plan and implementation schedules must be prepared by a competent individual. Furnish a signed copy of the TESC Plan with individual’s name, title, state certifications, and employing firm if different than Contractor’s firm.
5. Do not begin any Site activities that have potential to cause erosion or sediment movement until the TESC Plan and implementation schedules are approved by Engineer.

6. Keep a copy of the approved TESC Plan with updated changes onsite during all construction activities. During inactive periods longer than 7 calendar days, keep the TESC Plan onsite or provide a copy to Engineer to retain.

7. Continually update the TESC Plan and schedules as needed for unexpected storm or other events to ensure that sediment-laden water does not leave the construction site. Add approved changes to the TESC Plan no later than 24 hours after implementation.

E. Install [A: high visibility fence] [B: clearing limit fence] along the Site [C: preservation lines] [D: no work areas] shown on Drawings or as instructed by Engineer. Space posts and attach fence fabric to posts as shown on Drawings. Do not fasten fence to trees. Throughout the life of the Project, preserve and protect delineated area, acting immediately to repair or restore any fencing damaged or removed.

F. Preventing erosion, and controlling runoff, sedimentation, and non-stormwater pollution, requires Contractor to perform temporary Work items including, but not limited to:

1. Providing ditches, berms, culverts, and other measures to control surface water.
2. Building dams, settling basins, energy dissipaters, and other measures, to control downstream flows.
3. Controlling underground water found during construction.
4. Covering or otherwise protecting slopes until permanent erosion control measures are working.

G. To the degree possible, coordinate this temporary Work with permanent drainage and erosion control work the Contract requires.

H. Engineer may require additional temporary control measures if it appears pollution or erosion may result from weather, nature of materials, or progress on the Work.

I. When natural elements rut or erode the slope, restore and repair damage with eroded material where possible, and remove and dispose of any remaining material found in ditches and culverts. When Engineer orders replacement with additional or other materials, unit Contract prices will cover quantities needed.
J. Install all sediment control devices including, but not limited to, sediment ponds, perimeter silt fencing, or other sediment trapping BMPs prior to any ground disturbing activity. Do not expose more erodible earth than necessary during clearing, grubbing, excavation, borrow, or fill activities without written approval by Engineer. Engineer may increase or decrease the limits based on project conditions. Erodible earth is defined as any surface where soils, grindings, or other materials may be capable of being displaced and transported by rain, wind, or surface water runoff. Cover inactive areas of erodible earth, whether at final grade or not, within specified time period (see [NPDES] Erosion and Sediment Control Permit), using an approved soil covering practice. Phase clearing and grading to maximum extent practical to prevent exposed inactive areas from becoming a source of erosion.

K. Water Management:

1. Manage site water in accordance with the conditions of the waste discharge permit from a local permitting authority. If site water management is not subject to permit, manage as follows:
   a. Groundwater:
      1) When groundwater is encountered in an excavation, treat and discharge as follows:
         a) When groundwater conforms to [A: jurisdiction] Water Quality Standards, it may bypass detention and treatment facilities and be routed directly to its normal discharge point at a rate and method that will not cause erosion.
         b) When turbidity of groundwater is similar to turbidity of site runoff, groundwater may be treated using same detention and treatment facilities being used to treat the site runoff and then discharged at a rate that will not cause erosion.
         c) When groundwater turbidity is greater than turbidity of site runoff, treat ground water separately until turbidity is similar to or better than site runoff, and then it may be combined with site runoff and treated as described above.
   b. Process Water:
      1) Do not discharge high pH process water or wastewater (non-stormwater) that is generated onsite, including water generated during concrete grinding, rubblizing, washout, and hydrodemolition activities, to waters of the [B: jurisdiction], including wetlands. Water may be infiltrated upon approval of Engineer. Offsite disposal of concrete process water is subject to approval of Engineer.
2) Treat all water generated onsite from construction or washing activities that is more turbid than site runoff separately until turbidity is the same or less than site runoff, and then it may be combined with site runoff and treated as described above. Water may be infiltrated upon approval of Engineer.

c. Offsite Water: Prior to disruption of normal watercourse, intercept offsite stormwater and pipe it either through or around the Project Site. This water shall not be combined with onsite stormwater. Discharge offsite water at its preconstruction outfall point preventing an increase in erosion below the site. Submit proposed method for performing this Work for Engineer’s approval.

L. Dispersion/Infiltration: Convey water only to dispersion or infiltration areas designated in the TESC Plan or to sites approved by Engineer. Water shall be conveyed to designated dispersion areas at a rate such that, when runoff leaves the area and enters waters of the [A: jurisdiction], turbidity standards are achieved. Convey water to designated infiltration areas at a rate that does not produce surface runoff.

M. Detention/Retention Pond Construction: Whether permanent or temporary, construct before beginning other grading and excavation Work in the area that drains into that pond. Install temporary conveyances concurrently with grading in accordance with the TESC Plan so that newly graded areas drain to the pond as they are exposed.

N. Pollution Control:

1. Use BMPs to prevent or minimize stormwater exposure to pollutants from spills; vehicle and equipment fueling, maintenance, and storage; other cleaning and maintenance activities; and waste handling activities. These pollutants include fuel, hydraulic fluid, and other oils from vehicles and machinery, as well as debris, leftover paints, solvents, and glues from construction operations. Implement the following BMPs when applicable:
   a. Written spill prevention and response procedures.
   b. Employee training on spill prevention and proper disposal procedures.
   c. Spill kits in all vehicles.
   d. Regular maintenance schedule for vehicles and machinery.
   e. Material delivery and storage controls.
   f. Training and signage.
   g. Covered storage areas for waste and supplies.
O. If Engineer orders the Work suspended, continue to control erosion, pollution, and runoff during the shutdown.

P. Nothing in this section shall relieve Contractor from complying with other Contract requirements.

1.04 SUBMITTALS

A. Informational Submittals:

1. When a TESC Plan is included in Drawings, either adopt or modify the TESC Plan. Provide a schedule for TESC Plan implementation and incorporate it into Contractor’s progress schedule. Obtain Engineer’s approval of the TESC Plan and schedule before any Work begins.

2. Modified TESC Plans shall meet all requirements of the applicable jurisdictions.

3. The TESC Plan shall cover all areas that may be affected inside and outside the limits of the Project (including all Owner-provided sources, disposal sites, and haul roads, and all nearby land, streams, and other bodies of water).

4. Allow at least 5 working days for Engineer to review any original or revised TESC Plan. Failure to approve all or part of any such Plan shall not make Owner liable to Contractor for any Work delays.

PART 2 PRODUCTS

2.01 CHECK DAMS

A. Specified by Contractor with approval of Engineer.

2.02 COIR LOG

A. Logs made of 100 percent durable coconut (coir) fiber uniformly compacted within woven netting.

B. Netting: Made of bristle coir twine with minimum strength of 80 pounds tensile strength. Nominal 2-inch by 2-inch openings.

C. Log Segments: Maximum length of 20 feet, with a minimum diameter as shown on Drawings.


E. Stakes: Untreated softwood species with a notch to secure rope ties.

F. Rope Ties: 1/4-inch diameter commercially available hemp rope.
2.03 COMPOST BLANKET

A. Composed of products resulting from the biological degradation and transformation of plant-derived materials under controlled conditions designed to promote aerobic decomposition and:

1. Stable in oxygen consumption and carbon dioxide generation.
2. Mature and suitable for serving as a soil amendment or an erosion control BMP.
3. Appropriate in Moisture Content: No visible free water or dust produced when handling material.
4. Test compost products in accordance with U.S. Composting Council Testing Methods for the Examination of Compost and Composting (TMECC) 02.02-B, “Sample Sieving for Aggregate Size Classification.”

B. Meet the following criteria for Coarse Compost:

1. Gradation:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>3&quot;</td>
<td>100</td>
</tr>
<tr>
<td>1&quot;</td>
<td>90 100</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>70 100</td>
</tr>
<tr>
<td>1/4&quot;</td>
<td>40 60</td>
</tr>
</tbody>
</table>

Maximum particle length of 6 inches.

2. pH: Between 6.0 and 8.5 when tested in accordance with U.S. Composting Council TMECC 04.11-A, “1:5 Slurry pH.”
3. Manufactured Inert Material (Plastic, Concrete, Ceramics, Metal, etc.): Less than 1.0 percent by weight per U.S. Composting Council TMECC 03.08-A “Classification of Inerts by Sieve Size.”
5. Soluble Salt Content: Less than 4.0 mmhos/cm when tested in accordance with U.S. Composting Council TMECC 04.10 “Electrical Conductivity.”
6. Maturity: Greater than 80 percent in accordance with U.S. Composting Council TMECC 05.05-A, “Germination and Root Elongation.”
7. Stability: 7 mg CO₂–C/g OM/day or below in accordance with U.S. Composting Council TMECC 05.08-B “Carbon Dioxide Evolution Rate.”

8. The compost product must originate a minimum of 65 percent by volume from recycled plant waste. A maximum of 35 percent by volume of feedstocks, source-separated food waste, and/or biosolids may be substituted for recycled plant waste. Provide a list of feedstock sources by percentage in final compost product.

9. Engineer may evaluate compost for maturity using U.S. Composting Council TMECC 05.08-E “Solvita® Maturity Index.” Coarse Compost shall score a 5 or above on the Solvita® Compost Maturity Test.

2.04 COMPOST SOCK

A. Provide socks fabricated from extra heavy weight biodegradable fabric, with a minimum strand thickness of 5 mils.

B. Fill fabric with Coarse Compost.

C. Diameter: 8 inches minimum.

D. Fabric: Clean, evenly woven, and free of encrusted concrete or other contaminating materials. Shall be free from cuts, tears, broken or missing yarns. Shall be free of thin, open, or weak areas. Shall be free of any type of preservative.

E. Wood Stakes: Untreated softwood species, be 2-inch by 2-inch nominal dimension and 36 inches in length.

2.05 EROSION CONTROL BLANKET (MATTING), BIODEGRADABLE

A. Temporary erosion control blanket shall be made of natural plant fibers. Supply independent test results meeting the following:

<table>
<thead>
<tr>
<th>Properties</th>
<th>ASTM Test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protecting Slopes from Rainfall-Induced Erosion</td>
<td>D6459: Test in one soil type. Soil tested shall be sandy loam as defined by the NRCS Soil Texture Triangle.</td>
<td>Maximum C factor of 0.15 using Revised Universal Soil Loss Equation (RUSLE)</td>
</tr>
<tr>
<td>Dry Weight per Unit Area</td>
<td>D6475</td>
<td>0.36 lb/sq. yd. minimum</td>
</tr>
<tr>
<td>Performance in Protecting Earthen Channels from Stormwater-Induced Erosion</td>
<td>D6460: Test in one soil type. Soil tested shall be loam as defined by the NRCS Soil Texture Triangle.</td>
<td>1.0 lb/sq. ft. minimum</td>
</tr>
</tbody>
</table>
Seed Germination Enhancement

<table>
<thead>
<tr>
<th>Properties</th>
<th>ASTM Test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed Germination Enhancement</td>
<td>D7322</td>
<td>200 percent minimum</td>
</tr>
</tbody>
</table>

Nutting, if present, shall be biodegradable with a life span not to exceed 1 year.

B. For permanent erosion control blanket, see Section 31 32 00, Soil Stabilization.

2.06 FILTRATION SYSTEM

A. Sand: The sand filtration system shall be rapid or slow. Rapid sand filters achieve relatively high hydraulic flow rates, on the order of 2 gpm/sf to 20 gpm/sf, because they have automatic backwash systems to remove accumulated solids. Slow sand filters have very low hydraulic rates, on the order of 0.02 gpm/sf, because they do not have backwash systems.

B. Chemical: The chemical treatment system shall consist of a stormwater collection system (either temporary diversion or the permanent site drainage system), a storage pond (or portable trailer-mounted tanks), pumps, a chemical feed system, treatment cells, and interconnecting piping.

2.07 GEOTEXTILE

A. Geotextiles shall consist only of long chain polymeric fibers or yarns formed into a stable network such that the fibers or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the material shall be polyolefins or polyesters. The material shall be free from defects or tears. Geotextile shall also be free of any treatment or coating which might adversely alter its hydraulic or physical properties after installation. Geotextile properties shall be as specified in Section 31 32 19.16, Geotextile, or as described in Table 1 through Table 3.

<table>
<thead>
<tr>
<th>Geotextile Property</th>
<th>ASTM Test Method</th>
<th>Geotextile Property Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Permanent Erosion Control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate Survivability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High Survivability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ditch Lining</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Woven</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nonwoven</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Woven</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nonwoven</td>
</tr>
<tr>
<td>AOS</td>
<td>D4751</td>
<td>See Table 2</td>
</tr>
<tr>
<td>Water Permittivity</td>
<td>D4491</td>
<td>See Table 2</td>
</tr>
</tbody>
</table>

| Water Permittivity | D4491 | See Table 2 | See Table 2 | U.S. No. 30 max. |

0.02 sec\(^{-1}\) min.
### Table 1
Geotextile for Permanent Erosion Control

<table>
<thead>
<tr>
<th>Geotextile Property</th>
<th>ASTM Test Method</th>
<th>Geotextile Property Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Permanent Erosion Control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate Survivability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Woven</td>
</tr>
<tr>
<td>Grab Tensile Strength, in machine and x-machine direction</td>
<td>D4632/ D4632M</td>
<td>250 lb min.</td>
</tr>
<tr>
<td>Grab Failure Strain, in machine and x-machine direction</td>
<td>D4632/ D4632M</td>
<td>15% -50%</td>
</tr>
<tr>
<td>Seam Breaking Strength</td>
<td>D4632/ D4632M</td>
<td>220 lb min.</td>
</tr>
<tr>
<td>Puncture Resistance</td>
<td>D6241</td>
<td>495 lb min.</td>
</tr>
<tr>
<td>Tear Strength, in machine and x-machine direction</td>
<td>D4533</td>
<td>80 lb min.</td>
</tr>
<tr>
<td>Ultraviolet (UV) Radiation Stability</td>
<td>D4355</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2
Filtration Properties for Geotextile for Permanent Erosion Control

<table>
<thead>
<tr>
<th>Geotextile Property</th>
<th>ASTM Test Method</th>
<th>Geotextile Property Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Class A</td>
</tr>
<tr>
<td>AOS</td>
<td>D4751</td>
<td>U.S. No. 40 max.</td>
</tr>
<tr>
<td>Water Permittivity</td>
<td>D4491</td>
<td>0.7 sec⁻¹ min.</td>
</tr>
</tbody>
</table>
### Table 3
Geotextile for Temporary Silt Fence

<table>
<thead>
<tr>
<th>Geotextile Property</th>
<th>ASTM Test Method</th>
<th>Unsupported Between Posts</th>
<th>Supported Between Posts with Wire or Polymeric Mesh</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOS</td>
<td>D4751</td>
<td>U.S. No. 30 max. for silt wovens, U.S. No. 50 for all other geotextile types, U.S. No. 100 min.</td>
<td></td>
</tr>
<tr>
<td>Water Permittivity</td>
<td>D4491</td>
<td>0.2 sec⁻¹ min.</td>
<td></td>
</tr>
<tr>
<td>Grab Tensile Strength, in machine and x-machine direction</td>
<td>D4632/D4632M</td>
<td>180 lb min. in machine direction, 100 lb min. in x-machine direction</td>
<td>100 lb min.</td>
</tr>
<tr>
<td>Grab Failure Strain, in machine and x-machine direction</td>
<td>D4632/D4632M</td>
<td>30% max. at 180 lb or more</td>
<td></td>
</tr>
<tr>
<td>Ultraviolet (UV) Radiation Stability</td>
<td>D4355</td>
<td>70% strength retained min., after 500 hours in xenon arc device</td>
<td></td>
</tr>
</tbody>
</table>

2.08 GRAVEL FILTER, WOOD CHIP OR COMPOST BERM
A. Rock Material Used for Filter Berms: Clean 3/4-inch rock, with no recycled materials.
B. Wood Chips Used for Wood Chip Berm: As specified in Article Wood Chips and Wood Shavings.
C. Compost Used for Compost Berms: Coarse compost as specified in Article Compost Blanket.

2.09 HIGH VISIBILITY FENCING [A: CLEARING LIMIT FENCE] [B: PERIMETER FENCING]
A. High Visibility Fence: UV stabilized, orange, high-density polyethylene or polypropylene mesh.
B. Height: 4 feet minimum.
C. Support Posts: Wood or steel with sufficient strength and durability to support the fence through the life of the Project.

2.10 INLET PROTECTION
A. As specified under Article Geotextile.
2.11 MULCH

A. Short-Term: Provide independent test results documenting that the mulch meets the requirements in Table 4, Short-Term Mulch Test Requirements.

<table>
<thead>
<tr>
<th>Properties</th>
<th>Test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance in Protecting Slopes from Rainfall-Induced Erosion.</td>
<td>ASTM D6459. Test in one soil type. Soil tested shall be sandy loam as defined by the National Resources Conservation Service (NRCS) Soil Texture Triangle.</td>
<td>C Factor = 0.15 maximum using Revised Universal Soil Loss Equation (RUSLE)</td>
</tr>
</tbody>
</table>

B. Moderate-Term: Within 48 hours of application, the Moderate-Term Mulch shall bond with soil surface to create a continuous, absorbent, flexible, erosion-resistant blanket that allows for seed germination and plant growth and conforms to the requirements in Table 5, Moderate-Term Mulch Test Requirements. Provide test results documenting that the mulch meets the requirements in Table 5, Moderate-Term Mulch Test Requirements. Supply independent test results.

<table>
<thead>
<tr>
<th>Properties</th>
<th>Test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance in Protecting Slopes from Rainfall-Induced Erosion.</td>
<td>ASTM D6459. Test in one soil type. Soil tested shall be sandy loam as defined by the NRCS Soil Texture Triangle.</td>
<td>C Factor = 0.05 maximum using Revised Universal Soil Loss Equation (RUSLE)</td>
</tr>
</tbody>
</table>

C. Long-Term:

1. Provide Long-Term Mulch with demonstrated ability:
   a. To adhere to soil and create a blanket-like mass within 2 hours of application.
   b. To bond with the soil surface to create a continuous, porous, absorbent, and flexible erosion-resistant blanket that allows for seed germination and plant growth.
   c. To conform to the requirements in Table 6, Long-Term Mulch Test Requirements.
d. Provide test results documenting that mulch meets requirements in Table 6, Long-Term Mulch Test Requirements. Supply independent test results.

<table>
<thead>
<tr>
<th>Properties</th>
<th>Test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance in Protecting Slopes from Rainfall-Induced Erosion.</td>
<td>ASTM D6459. Test in one soil type. Soil tested shall be sandy loam as defined by the NRCS Soil Texture Triangle.</td>
<td>C Factor = 0.01 maximum using Revised Universal Soil Loss Equation (RUSLE)</td>
</tr>
</tbody>
</table>

2.12 OUTLET PROTECTION

A. Size riprap or quarry spall to resist movement under design flows. Install at least 8 inches deep. Provide riprap or quarry spall material free of extraneous material.

2.13 PLASTIC COVERING

A. Clear plastic meeting requirements of ASTM D4397 for polyethylene sheeting having a minimum thickness of 6 mils.

2.14 POLYACRYLAMIDE (PAM)

A. Meet ANSI/NSF Standard 60 for drinking water treatment with an AMD content not to exceed 0.05 percent.

B. Anionic, linear, and not cross-linked.

C. Minimum average molecular weight greater than 5 mg/mole and minimum 30 percent charge density.

D. 80 percent active ingredients minimum with moisture content not exceeding 10 percent by weight.

E. Delivered in a dry granular or powder form.

2.15 SEDIMENT CONTROL BARRIERS

A. Specified by Contractor with approval of Engineer. May include Compost Filter Sock or Compost Filter Berm.
2.16 SEEDING

A. See Section 3292 00, Turf and Grasses.

2.17 SILT (SEDIMENT) FENCE

A. Geotextile: As specified in Article Geotextile.

B. [A: Reinforcing: [B: Welded wire fabric, 14-gauge minimum with 2-inch by 4-inch mesh.]] [C: Standard chain link fencing.]

C. Support Posts: As recommended by manufacturer of geotextile.

D. Fasteners: Heavy-duty wire staples at least 1-inch long, tie wires, or hog rings, as recommended by manufacturer of geotextile.

2.18 STABILIZED CONSTRUCTION ENTRANCE

A. Construct a pad from stone 3 inches to 6 inches in size, placed at least 8 inches deep and not less than 50 feet long.

B. Provide aggregate free of extraneous materials that may cause or contribute to track out.

C. Place separation geotextile under the rock to prevent fine sediment from pumping up into the rock pad. See Article Geotextile for required geotextile properties.

D. Use of constructed or constructed/manufactured steel plates with ribs (such as, shaker/rumble plates or corrugated steel plates) for entrance/exit access is allowable.

2.19 STRAW [A: BALE BARRIER]

A. Straw:

1. Air dried condition free of noxious weeds, seeds, and other materials detrimental to plant life. Hay is not acceptable. Provide weed-free documentation:
   b. Provide documentation that material is steam or heat treated to kill seeds.
   c. Provide U.S. or state’s Department of Agriculture laboratory test reports, dated within 90 days prior to date of application, showing there are no viable seeds in the straw.
B. Straw Mulch: Suitable for spreading with mulch blower equipment.

C. Posts for Straw Bales: 2-inch by 2-inch untreated wood or commercially manufactured metal posts.

2.20 STREET CLEANING

A. Use self-propelled pickup street sweeper(s). Mechanical broom sweepers are not allowed where environmental concerns exist about storm water pollution or air quality.

2.21 TACKIFIERS

A. Biodegradable Hydraulically Applied Erosion Control Products (HECPs) in a dry condition, free of noxious weeds, seeds, chemical printing ink, germination inhibitors, herbicide residue, chlorine bleach, rock, metal, plastic, and other materials detrimental to plant life. Up to 5 percent by weight may be photodegradable material.

B. Suitable for spreading with a hydroseeder.

C. Furnish HECPs premixed by the manufacturer. Under no circumstances will field mixing of additives or components be acceptable.

D. Provide test results, dated within 3 years prior to the date of application, from an independent, accredited laboratory, as approved by Engineer, showing that the product meets the HECP requirements in Table 7.

<table>
<thead>
<tr>
<th>Properties</th>
<th>Test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Toxicity</td>
<td>EPA-821-R-02-012 Methods for Measuring Acute Toxicity of Effluents. Test leachate from recommended application rate receiving 2 inches of rainfall per hour using static test for No-Observed-Adverse-Effect-Concentration (NOEC).</td>
<td>Four replicates are required with no statistically significant reduction in survival in 100 percent leachate for a Daphnid at 48 hours and Oncorhynchus mykiss (rainbow trout) at 96 hours.</td>
</tr>
<tr>
<td>Properties</td>
<td>Test Method</td>
<td>Requirements</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Solvents</td>
<td>EPA 8260B</td>
<td>Benzene: &lt; 0.03 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Methylene chloride: &lt; 0.02 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Naphthalene: &lt; 5 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tetrachloreoethylene: &lt; 0.05 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Toluene: &lt; 7 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trichloroethylene: &lt; 0.03 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Xylenes: &lt; 9 mg/kg</td>
</tr>
<tr>
<td>Heavy Metals</td>
<td>EPA 6020A Total Metals</td>
<td>Antimony: &lt; 4 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arsenic: &lt; 6 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Barium: &lt; 80 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Boron: &lt; 100 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cadmium: &lt; 2 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chromium: &lt; 2 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Copper: &lt; 5 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lead: &lt; 5 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mercury: &lt; 2 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nickel: &lt; 2 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Selenium: &lt; 10 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Strontium: &lt; 30 mg/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zinc: &lt; 5 mg/kg</td>
</tr>
<tr>
<td>Water Holding</td>
<td>ASTM D7367</td>
<td>900 percent minimum</td>
</tr>
<tr>
<td>Capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organic Matter</td>
<td>ASTM D2974</td>
<td>90 percent minimum</td>
</tr>
<tr>
<td>Content</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moisture Content</td>
<td>ASTM D2974</td>
<td>15 percent</td>
</tr>
<tr>
<td>Seed Germination</td>
<td>ASTM D7322</td>
<td>Long-Term: 420 percent minimum</td>
</tr>
<tr>
<td>Enhancement</td>
<td></td>
<td>Moderate-Term: 400 percent minimum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Short-Term: 200 percent minimum</td>
</tr>
</tbody>
</table>

### 2.22 TEMPORARY CURB

A. Temporary curbs may consist of asphalt, concrete, sand bags, compost socks, wattles, or geotextile/plastic encased berms of sand or gravel, or as approved by Engineer.
2.23 TEMPORARY PIPE SLOPE DRAIN

A. Corrugated polyethylene drain pipe, couplings and fittings (up to 10-inch) meeting the requirements of AASHTO M252 Type C (corrugated both inside and outside) or Type S (corrugated outer wall and smooth inner liner).

1. Maximum Pipe Size: 10 inches in diameter.

2.24 TEMPORARY SEDIMENT TRAP

A. Temporary ponding area with a rock weir or perforated riser pipe at the outlet, formed by excavation or constructing a weir. Specified by Contractor with approval of Engineer.

2.25 TIRE [A: WHEEL] WASH FACILITY

A. Specified by Contractor with approval of Engineer. Wheel wash facilities should have a non-erosive base, and a small grade change, 6 inches to 12 inches for a 10-foot-wide pond, to allow sediment to flow to low side of pond to help prevent re-suspension of sediment. A drainpipe with a 2-foot to 3-foot riser should be installed at low side of pond to allow for cleaning and refilling. Pond should be deep enough to hold 14 inches of water after displacement. Alternatively, pressure washing combined with an adequately-sized and adequately-surfaced pad with direct drainage to a 10-foot by 10-foot sump can be very effective.

2.26 WATTLLES

A. Cylinders of biodegradable plant material such as weed-free straw, coir, compost, wood chips, excelsior, or wood fiber or shavings encased within biodegradable netting.

B. Diameter: 5 inches minimum.

C. Netting Material: Clean, evenly woven, and free of encrusted concrete or other contaminating materials, such as preservatives. Also free from cuts, tears, or weak places with a minimum lifespan of 6 months.

D. Compost Filler: Coarse compost, wood chips, or wood shavings.

E. Wood Stakes: Untreated softwood species, 2-inch by 2-inch nominal dimension and 36 inches in length.
2.27 WOOD CHIPS AND WOOD SHAVINGS

A. Wood Chips:

   1. Derived from softwood species not containing resin, tannin, or other compounds in quantities that would be detrimental to plant life, and meeting the following loose volume gradation:
      a. 2-inch Sieve Size: 95 percent to 100 percent passing.
      b. No. 4 Sieve Size: 0 percent to 30 percent passing.

B. Wood Shavings: Provide shavings with 80 percent of the fibers 6 inches or longer between 0.030 inch wide and 0.50 inch wide, and between 0.017 inch thick and 0.13 inch thick.

PART 3 EXECUTION

3.01 PREPARATION

A. Engineer’s acceptance of the TESC Plan is required prior to starting earth disturbing activities.

B. Include proposed stockpile areas and installation of temporary erosion control devices, ditches, or other facilities in Work phasing plans.

C. Areas designated for Contractor’s use during Project may be temporarily developed as specified to provide working, staging, and administrative areas. Include control of sediment from these areas in the TESC Plan.

D. Check Dams: Install check dams as soon as construction will allow, or when designated by Engineer. Contractor may substitute a different check dam, in lieu of what is specified in the Contract, with approval of Engineer. Check dam is a temporary or permanent structure, built across a minor channel. Water shall not flow through check dam structure. Construct check dams to create a ponding area upstream of dam to allow pollutants to settle, with water from increased flows channeled over a spillway in check dam. Construct check dam to prevent erosion in area below spillway. Place check dams perpendicular to flow of water and install in accordance with Drawings. Extend outer edges up sides of conveyance to prevent water from going around check dam. Provide check dams of sufficient height to maximize detention, without causing water to leave ditch. Place sandbags so that initial row makes tight contact with ditch line for length of dam. Stagger subsequent rows so center of bag is placed over space between bags on previous lift.

E. Coir Log: Install coir logs in accordance with Drawings.
F. Compost Blanket: Place compost blanket to a depth of 3 inches over bare soil prior to seeding or other planting. Place an organic tackifier over entire composted area when dry or windy conditions are present or expected before final application of mulch or erosion control blanket. Apply tackifier immediately after compost application to prevent compost from leaving area.

G. Compost Sock: Exercise care when installing compost socks to ensure method of installation minimizes disturbance of waterways and prevents sediment or pollutant discharge into waterbodies. Lace compost socks together, end-to-end, with coir rope to create a continuous length. Bury loose ends of continuous length 3 feet to 5 feet laterally into the bankslope. Install the upper surface of compost sock parallel to slope. Provide finished grades of a natural appearance with smooth transitions. Secure compost sock with wood stakes or live stakes of species as indicated on Drawings. Drive stakes into place centered on top of compost sock and spaced 3 feet on center throughout length of sock.

H. Erosion Control Blanket (Matting), Biodegradable: Temporary Erosion Control Blankets are used as an erosion prevention device and to enhance establishment of vegetation. Install erosion control blankets according to manufacturer’s recommendations.

1. Erosion control blankets with an open area of 60 percent or greater may be installed prior to seeding and fertilizing. Install blankets with less than 60 percent open space immediately following seeding and fertilizing operation.

2. Select erosion control blanket material for an area based on the intended function; slope or ditch stabilization and Site-specific factors including soil, slope gradient, rainfall, and flow exposure. Do not use erosion Control Blankets on slopes or in ditches that exceed manufacturer’s recommendations.

3. For permanent erosion control blanket, see Section 31 32 00, Soil Stabilization.

I. Filtration System:

1. Sand: Rapid sand filtration systems shall have stormwater pumped from a trap, pond, or tank through filtration system. Slow sand filtration systems shall have flow through using gravity. Sand media filter shall have automatic backwashing features that can filter to 50 μm particle size. Screen or bag filters shall filter down to 5 μm. Fiber wound filters shall remove particles down to 0.5 μm. Sequence filters from the largest to the smallest pore opening. Filtration may be used in conjunction with polymer treatment in a portable system to assure capture of the flocculated solids.
2. Chemical: Prior to discharge, sample each batch of treated and test for compliance with pH and turbidity limits, which may be established by water quality standards or a Site-specific discharge permit. Sampling and testing for other pollutants may be necessary. Obtain regulatory approval and provide a qualified, trained operator, if required by law.

J. Gravel Filter, Wood Chip, or Compost Berm: Construct filter berms to retain sediment and direct flows.

1. Gravel Filter Berm: 1-foot minimum height. Maintain at this height for entire time berm is in use.
2. Wood Chip Berm: 2-foot minimum height. Maintain at this height for entire time berm is in use.
3. Construct compost berm of course compost in accordance with the detail on Drawings.

K. High Visibility Fencing: Install high visibility fencing in accordance with Drawings.

L. Inlet Protection: Install inlet protection below or above, or as a prefabricated cover at each inlet grate, as shown on Drawings. Install inlet protection devices prior to beginning clearing, grubbing or earthwork activities. Geotextile fabric used in prefabricated inlet protection devices must meet or exceed the requirements for Moderate Survivability and minimum filtration properties. When depth of accumulated sediment and debris reaches approximately one-half the height of an internal device or one-third the height of external device (or less when so specified by the manufacturers) or as designated by Engineer, remove deposits and stabilize onsite.

1. Below Inlet Grate:
   a. Prefabricated units specifically designed for inlet protection.
   b. Must remain securely attached to drainage structure when fully loaded with sediment and debris or at the maximum level of sediment and debris specified by manufacturer.

2. Above Inlet Grate:
   a. Devices may be silt fence, sandbags, or prefabricated units specifically designed for inlet protection.
   b. Must remain securely in place around drainage structure under all conditions.

3. Inlet Grate Cover:
   a. Prefabricated units specifically designed for inlet protection and:
      1) Be a sewn geotextile fabric unit fitted to individual grate and completely enclosing grate.
      2) Have built-in lifting devices to allow manual access of stormwater system.
3) Use an orange monofilament geotextile fabric.

b. Check dams or functionally equivalent devices may be used as inlet protection devices with approval of Engineer.

M. Mulch: Furnish, haul, and evenly apply at rates indicated and spread on seeded areas within 48 hours after seeding unless otherwise specified.

1. Distribute straw mulch material with an approved mulch spreader that uses forced air to blow mulch material on seeded areas.
2. Apply wood strand mulch by hand or by straw blower on seeded areas.
3. Hydraulically apply Short-Term Mulch at the rate of 2,500 pounds per acre. May be applied in one lift.
4. Hydraulically apply Moderate-Term Mulch and Long-Term Mulch at the rate of 3,500 pounds per acre with no more than 2,000 pounds applied in any single lift. Mulch may be applied with seed and fertilizer in moist climates. In dry climates, apply seed and fertilizer in a single application followed by mulch application. Provide mulch suitable for application with a hydroteeder.
5. Cover temporary seed applied outside application windows established in Section 32 92 00, Turf and Grasses, with a mulch containing either Moderate-Term Mulch or Long-Term Mulch, as designated by Engineer.
6. Mulch areas not accessible by mulching equipment by approved hand methods.

N. Outlet Protection: Provide outlet protection to prevent scour at outlets of ponds, pipes, ditches, or other conveyances.

O. Plastic Covering: Use clear plastic covering to promote seed germination when seeding is performed outside of specified dates. Use black plastic covering for stockpiles or other areas where vegetative growth is unwanted. Place plastic with at least a 12-inch overlap of all seams. Install and maintain plastic cover to prevent water from cutting under the plastic and to prevent cover from blowing open in the wind.

P. Polyacrylamide (PAM): See Tackifiers.

Q. Sediment Control Barriers: Install sediment control barriers in accordance with TESC Plan or manufacturer’s recommendations in the areas of clearing, grubbing, earthwork, or drainage prior to starting those activities. Maintain sediment control barriers until soils are stabilized.

R. Seeding: See Section 32 92 00, Turf and Grasses.
S. Silt (Sediment) Fence:

1. Silt fence shall be installed in accordance with Drawings. When backup support is used, use steel wire with a maximum mesh spacing of 2 inches by 4 inches, or plastic mesh as resistant to ultraviolet radiation as the geotextile it supports. Provide wire or plastic mesh with strength equivalent to or greater than as required for unsupported geotextile (for example, 180 pounds grab tensile strength in the machine direction).

2. Attach geotextile to posts and support system using staples, wire, or in accordance with manufacturer’s recommendations. Geotextile shall be sewn together at the point of manufacture, or at a location approved by Engineer, to form geotextile lengths as required.

3. Provide wood or steel support posts at sewn seams and overlaps and as shown on Drawings and necessary to support fence.

4. Wood Posts: Minimum dimensions of 1-1/4-inch by 1-1/4-inch by the minimum length shown on Drawings.

5. Steel Posts: Minimum weight of 0.90 lb/ft.

6. When sediment deposits reach approximately one-third the height of the silt fence, remove and stabilize deposits.

T. Stabilized Construction Entrance: Construct temporary stabilized construction entrance in accordance with Drawings, prior to beginning any clearing, grubbing, earthwork, or excavation. When stabilized entrance no longer prevents track out of sediment or debris, either rehabilitate existing entrance to original condition or construct a new entrance.

U. Street Cleaning: Use self-propelled pickup street sweepers whenever required by Engineer to prevent transport of sediment and other debris off Project Site. Provide street sweepers designed and operated to meet air quality standards. Street washing with water will require approval by Engineer. Intentional washing of sediment into storm sewers or drainage ways must not occur. Vacuuming or dry sweeping and material pickup must be used to cleanup released sediments.

V. Tackifiers:

1. Mix and apply tackifier in accordance with manufacturer’s recommendations. If applied with a hydroseeder, add Short-Term Mulch as a tracer at a rate of 125 pounds to 250 pounds per acre to visibly aid uniform application.

2. Soil Binding Using Polyacrylamide (PAM): Apply PAM on bare soil completely dissolved and mixed in water or applied as a dry powder. Apply dissolved PAM at a rate of not more than 2/3 pound per 1,000 gallons of water per acre. Apply a minimum of 200 pounds per acre of Short-Term Mulch with the dissolved PAM. Dry powder
applications may be at a rate of 5 pounds per acre using a hand-held fertilizer spreader or a tractor-mounted spreader.

a. Apply PAM only to areas that drain to completed sedimentation control BMPs in accordance with the TESC Plan. PAM may be reapplied on actively worked areas after a 48-hour period.

b. PAM shall not be applied during rainfall or to saturated soils.

W. Temporary Curb: Provide temporary curbs to divert or redirect water around erodible soils. Temporary curbs shall be installed along pavement edges to prevent runoff from flowing onto erodible slopes. Water shall be directed to areas where erosion can be controlled. Temporary curbs shall be a minimum of 4 inches in height. Ponding shall not be in roadways.

X. Temporary Pipe Slope Drain: Corrugated polyethylene drain pipe constructed in accordance with Drawings. Use water interceptor dikes or temporary curbs to direct water into pipe slope drain. Entrance to drain may consist of a prefabricated funnel device specifically designed for application, rock, sand bags, or as approved by Engineer. Construct pipe with gasketed watertight fittings and secure to slope with metal “T” posts, wood stakes, sand bags, or as approved by Engineer. Discharge water to a stabilized conveyance, sediment trap, stormwater pond, rock splash pad, vegetated strip, or as approved by Engineer. Install pipe so that water does not pond on road surface.

Y. Temporary Sediment Trap: Form trap by constructing a berm or by partial or complete excavation. Direct the discharge flow to a stabilized conveyance outlet or level spreader.

Z. Tire [A: Wheel] Wash Facility: When the Contract requires a tire wash (in conjunction with a stabilized entrance), include details for tire wash and method for containing and treating sediment-laden runoff as part of the TESC Plan. All vehicles leaving the Site shall stop and wash sediment from their tires. Keep the water level 12 inches to 14 inches deep. Change wash water a minimum of once per day. Polymers may be used to promote coagulation and flocculation in a closed-loop system. Polyacrylamide (PAM) added to the wheel wash water at a rate of 0.25 pound to 0.5 pound per 1,000 gallons of water increases effectiveness and reduces cleanup time.

AA. Wattles: Install wattles as soon as construction will allow or when designated by Engineer. Begin trench construction and wattle installation at base of slope and work uphill. Spread excavated material evenly along the uphill slope and compact using hand tamping or other method approved by Engineer. On gradually sloped or clay-type soils, provide trenches 2 inches to 3 inches deep. On loose soils, in high rainfall areas, or on steep slopes, provide trenches 3 inches to 5 inches deep, or half the thickness of the wattle. Exercise care
when installing wattles to minimize disturbance of waterways and prevent sediment or pollutant discharge into waterbodies.

BB. Wood Chips and Wood Shavings: Install in accordance with Drawings.

3.02 ADDITIONAL REQUIREMENTS

A. Natural Buffer or Equivalent:

1. Unless natural buffer between the Project Site and receiving waters has previously been eliminated by pre-existing development disturbances, comply with one of the following alternatives if stormwater from construction will discharge to surface water:
   a. Provide a 50-foot, undisturbed natural buffer between construction disturbances and surface water.
   b. Provide an undisturbed natural buffer that is less than 50 feet supplemented by additional erosion and sediment controls, which in combination, achieve a sediment load reduction that is equivalent to a 50-foot buffer.
   c. If it is infeasible to provide an undisturbed natural buffer of any size, implement erosion and sediment controls that achieve a sediment load reduction that is equivalent to a 50-foot buffer.

3.03 MAINTENANCE

A. The ESCP measures described in this specification are minimum requirements for anticipated Site conditions. During the construction period, upgrade these measures as needed to comply with all applicable local, state, and federal erosion and sediment control regulations.

B. Maintain erosion and sediment control BMPs so they properly perform their function until Engineer determines they are no longer needed.

C. Construction activities must avoid or minimize excavation and creation of bare ground during wet weather.

D. The intentional washing of sediment into storm sewers or drainage ways must not occur. Vacuuming or dry sweeping and material pickup must be used to cleanup released sediments.

E. Inspect BMPs in accordance with the schedule in the Construction Stormwater Discharge Permit(s) or as directed by Engineer.
F. Complete an inspection report within 24 hours of an inspection. Each inspection report shall be signed and identify corrective actions. Document that corrective actions are performed within 7 days of identification. Keep a copy of all inspection reports at the Site or at an easily accessible location.

G. Unless otherwise specified, remove deposits before the depth of accumulated sediment and debris reaches approximately height of BMP. Dispose of debris or contaminated sediment at approved locations. Clean sediments may be stabilized onsite using BMPs as approved by Engineer.

H. Sediment Fence: Remove trapped sediment before it reaches one-third of the above ground fence height and before fence removal.

I. Other Sediment Barriers (such as biobags): Remove sediment before it reaches 2 inches depth above ground height and before BMP removal.

J. Catch Basins: Clean before retention capacity has been reduced by 50 percent.

K. Sediment Basins and Sediment Traps: Remove trapped sediments before design capacity has been reduced by 50 percent and at completion of Project.

L. Initiate repair or replacement of damaged erosion and sediment control BMPs immediately, and work completed by end of next work day. Significant replacement or repair must be completed within 7 days, unless infeasible.

M. Within 24 hours, remediate any significant sediment that has left construction site. Investigate cause of the sediment release and implement steps to prevent a recurrence of discharge within same 24 hours. Perform in-stream cleanup of sediment according to applicable regulations.

N. At end of each work day, stabilize or cover soil stockpiles or implement other BMPs to prevent discharges to surface waters or conveyance systems leading to surface waters.

O. Temporarily stabilize soils at end of shift before holidays and weekends, if needed. Ensure soils are stable during rain events at all times of year.

P. Initiate stabilization by no later than end of next work day after construction work in an area has stopped permanently or temporarily.

Q. Within 14 days of initiating stabilization or as specified in permit, either seed or plant stabilized area (see Section 32 92 00, Turf and Grasses); or apply non-vegetative measures and cover all areas of exposed soil. Seed dry areas as soon as Site conditions allow. Ensure that vegetation covers at least 70 percent of stabilized area. In areas where Contractor’s activities have compromised erosion control functions of existing grasses, overseed existing grass.
Non-vegetative measures may include blown straw and a tackifier, loose straw, or an adequate covering of compost mulch. Complete initial stabilization within 7 days if storm water discharges to surface waters impaired for sediment or nutrients, or high quality waters.

R. Provide permanent erosion control measures on all exposed areas. Do not remove temporary sediment control practices until permanent vegetation or other cover of exposed areas is established. However, do remove all temporary erosion control measures as exposed areas become stabilized, unless doing so conflicts with local requirements. Properly dispose of construction materials and waste, including sediment retained by temporary BMPs.

3.04 EMERGENCY MATERIALS

A. Provide, stockpile, and protect the following emergency erosion and sediment control materials on the Project Site for unknown weather or erosion conditions. Emergency materials are in addition to other erosion control materials required to implement and maintain the TESC Plan. Replenish emergency materials as they are used. Remove all unused emergency materials from the Project Site at completion of the Project.

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silt (sediment) fence</td>
<td>[A: 100 ft] [B: ]</td>
</tr>
<tr>
<td>Plastic sheeting</td>
<td>[A: 260 sq. ft.] [B: ]</td>
</tr>
<tr>
<td>Rope</td>
<td>[A: 1,000 ft] [B: ]</td>
</tr>
<tr>
<td>Sand bags (empty, to be filled as needed)</td>
<td>[A: 50] [B: ]</td>
</tr>
<tr>
<td>Straw bales</td>
<td>[A: 10] [B: ]</td>
</tr>
<tr>
<td>Biofilter bags (with stakes)</td>
<td>[A: 10] [B: ]</td>
</tr>
<tr>
<td>Inflatable pipe plugs</td>
<td>[A: One for each size of pipe]</td>
</tr>
<tr>
<td>Water pump and hose</td>
<td>[A: One] [B: ]</td>
</tr>
<tr>
<td>[A: Other]</td>
<td>[B: ]</td>
</tr>
</tbody>
</table>
3.05 REMOVAL

A. When Engineer determines that an erosion control BMP is no longer required, remove BMP and all associated hardware from the Project limits. When materials are biodegradable, Engineer may approve leaving temporary BMP in place.

B. Permanently stabilize all bare and disturbed soil after removal of erosion and sediment control BMPs. Dress sediment deposits remaining after BMPs have been removed to conform to existing grade. Prepare and seed graded area. If installation and use of erosion control BMPs have compacted or otherwise rendered soil inhospitable to plant growth, such as construction entrances, take measures to rehabilitate soil to facilitate plant growth. This may include, but is not limited to, ripping the soil, incorporating soil amendments, or seeding with specified seed.

END OF SECTION
3.06 MEASUREMENT AND PAYMENT

A. Check Dams will be measured per linear foot one time only along the completed check dam. Unit Contract Price per linear foot for Check Dam shall be full pay for all equipment, labor, and materials to perform the Work as specified, including installation, removal, and disposal at an approved disposal site. No additional measurement will be made for check dams required to be rehabilitated or replaced as a result of wear.

B. Coir Log will be measured by linear foot along ground line of completed installation. Unit Contract Price per linear foot for Coir Log shall be full pay for all equipment, labor, and materials to perform the Work as specified, including installation, removal, and disposal at an approved disposal site.

C. Compost Blanket will be measured by square yard along the ground slope line of surface area covered and accepted.

D. Compost Sock will be measured by linear foot. Unit Contract Price for Compost Sock shall include removal and disposal of compost sock fabric if photodegradable fabric is not used.

E. Emergency Erosion and Sediment Control Materials: No additional payment will be made for stockpiling Emergency Erosion and Sediment Control Materials on Project Site.

F. Erosion Control Blanket (matting) will be measured by square yard along ground slope line of surface area covered and accepted. Unit Contract price per square yard for Erosion Control Blanket shall be full pay for all costs to complete the specified Work.

G. ESC Lead will be measured per day for each day that an inspection is made and a report is filed.

H. Filtration System will be measured per each and shall be full pay for all costs to obtain, install, operate, and remove the system as specified.

I. Gravel Filter, Wood Chip, or Compost Berm will be measured by linear foot along ground line of completed installation. Unit Contract Price per linear foot of berm shall be full pay for all equipment, labor, and materials to perform the Work as specified, including installation, removal, and disposal at an approved disposal site.

J. High Visibility Fence will be measured by linear foot along ground line of completed fence. Unit Contract Price per linear foot for High Visibility Fence shall be full pay for all costs to obtain, install, maintain, and remove fence as specified. Once removed, fencing shall remain property of Contractor.
K. Inlet Protection will be measured per each for each initial installation at a drainage structure. Unit Contract Price per each for Inlet Protection shall be full pay for all equipment, labor, and materials to perform the Work as specified, including installation, removal, and disposal at an approved disposal site.

L. Mulch will be measured by the acre by ground slope measurement or through use of design data.

M. Natural Buffer or Equivalent: No additional payment will be made for providing a Natural Buffer or Equivalent on the Project Site.

N. Outlet Protection will be measured per each initial installation at an outlet location. Unit Contract Price per each for Outlet Protection shall be full payment for all costs incurred to complete the Work.

O. Plastic Covering will be measured by the square yard along ground slope line of surface area covered and accepted. Unit Contract Price per square yard for Plastic Covering shall be full pay for all equipment, labor, and materials to perform the Work as specified, including removal and disposal at an approved disposal site.

P. Polyacrylamide (PAM). See Tackifiers.

Q. Sediment Control Barrier will be measured by linear foot along ground line of completed barrier.

R. Seeding: See Section 32 92 00, Turf and Grasses.

S. Silt (Sediment) Fence will be measured by linear foot along ground line of completed installation.

T. Stabilized Construction Entrance will be measured by square yard for each entrance constructed.

U. Street Cleaning will be measured by the hour for actual time spent cleaning pavement, as authorized by Engineer. Time to move equipment to or from the area on which street cleaning is required, will not be measured.

V. Tackifiers (Polyacrylamide) will be measured by the acre by ground slope measurement or calculated by use of design data. Unit Contract Price per acre for Tackifier shall be full payment for all costs incurred to complete the Work.

W. Temporary Curb will be measured by the linear foot. Unit Contract Price per linear foot for Temporary Curb shall include all costs to install, maintain, remove, and dispose of temporary curb.
X. Temporary Pipe Slope Drain will be measured by the linear foot. Unit Contract Price per linear foot shall be full pay for all Work to complete and remove the installation of pipe slope drain as shown on the Drawings. All materials remain the property of Contractor after removal.

Y. Temporary Sediment Trap will be measured per each for each trap installed.

Z. Tire [A: Wheel] Wash facility will be measured per each for each wash installed. Unit Contract Price per each for tire wash shall include all costs associated with constructing, operating, maintaining, and removing the tire wash.

AA. Wattles will be measured by the linear foot.

BB. Wood Chips and Wood Shavings will be measured by the square yard along the ground slope line of surface area covered and accepted.

CC. [A: Erosion Control will be measured and paid on a lump sum basis. Erosion Control includes:

1. Providing the ESC Lead.
2. Developing, revising, and documenting TESC Plan.
4. Monitoring activities.
5. Furnishing, stockpiling, protecting, restocking, and removing emergency materials.
6. Preparing Project for winter shutdown.
7. Inspecting, maintaining, and removing erosion control devices.
8. Restoring, mulching, tacking, and seeding all disturbed ground, work, and storage areas not otherwise covered.]

DD. No separate or additional payment will be made for:

1. Removing and disposing of sediment build-up behind sediment fences and sediment barriers.
2. Removing and reinstalling required appurtenances to modify temporary slope drains as the embankment slopes are changed.
3. Constructing and removing temporary slope berms.
4. Applying dust control.
5. Erosion control for work outside construction limits including, but not limited to, borrow pits, haul roads, disposal sites, and equipment storage sites.

EE. [A: When only Erosion Control is listed in the Contract Schedule of Items, no separate or additional payment will be made for modifications.
or additions to the BMPs that become necessary for permit compliance during construction.]

FF. [A: Maintenance and removal of erosion and water pollution control devices including removal and disposal of sediment, stabilization, and rehabilitation of soil disturbed by these activities, and any additional Work deemed necessary by Engineer to control erosion and water pollution will be paid by force account in accordance with Section [B: __]. To provide a common Proposal for all Bidders, Owner has entered an amount in the Proposal to become a part of Contractor’s total Bid.]
SECTION 01 61 00
COMMON PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 DEFINITIONS

A. Products:
   1. New items for incorporation in the Work, whether purchased by Contractor or Owner for the Project, or taken from previously purchased stock, and may also include existing materials or components required for reuse.
   2. Includes the terms material, equipment, machinery, components, subsystem, system, hardware, software, and terms of similar intent and is not intended to change meaning of such other terms used in Contract Documents, as those terms are self-explanatory and have well recognized meanings in construction industry.
   3. Items identified by manufacturer’s product name, including make or model designation, indicated in manufacturer’s published product literature, that is current as of the date of the Contract Documents.

1.02 DESIGN REQUIREMENTS

A. Where Contractor design is specified, design of installation, systems, equipment, and components, including supports and anchorage, shall be in accordance with provisions of latest edition of International Building Code (IBC) by International Code Council. See Contract Drawings, Structural Notes.

1.03 ENVIRONMENTAL REQUIREMENTS

A. Altitude: Provide materials and equipment suitable for installation and operation under rated conditions at [A: ] feet above sea level.

B. Provide equipment and devices installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of [A: ] degrees F to [B: ] degrees F.

1.04 PREPARATION FOR SHIPMENT

A. When practical, factory assemble products. Mark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with strippable protective coating.
B. Package products to facilitate handling and protect from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, name of Project and Contractor, equipment number, and approximate weight. Include complete packing list and bill of materials with each shipment.

C. Extra Materials, Special Tools, Test Equipment, and Expendables:

1. Furnish as required by individual specifications.
2. Schedule:
   a. Ensure that shipment and delivery occurs concurrent with shipment of associated equipment.
   b. Transfer to Owner shall occur immediately subsequent to Contractor’s acceptance of equipment from Supplier.
3. Packaging and Shipment:
   a. Package and ship extra materials and special tools to avoid damage during long term storage in original cartons insofar as possible, or in appropriately sized, hinged-cover, wood, plastic, or metal box.
   b. Prominently displayed on each package, the following:
      1) Manufacturer’s part nomenclature and number, consistent with Operation and Maintenance Manual identification system.
      2) Applicable equipment description.
      3) Quantity of parts in package.
      4) Equipment manufacturer.
4. Deliver materials [A: to Site.] [B: to the following address:]

   [C: _______________________________]
   Name

   [D: _______________________________, ______________, __________, ______]
   Street    City    State    Zip

5. [E: Notify [F: Engineer] [G: Owner] [H: Construction Manager] upon arrival for transfer of materials.]
6. Replace extra materials and special tools found to be damaged or otherwise inoperable at time of transfer to Owner.

D. Request a minimum 7-day advance notice of shipment from manufacturer. [A: Upon receipt of manufacturer’s advance notice of shipment, promptly notify Engineer of anticipated date and place of [B: ___ equipment] arrival.]
E. Factory Test Results: Reviewed and accepted by Engineer before product shipment as required in individual specification sections.

1.05 DELIVERY AND INSPECTION

A. Deliver products in accordance with accepted current Progress Schedule and coordinate to avoid conflict with the Work and conditions at Site. Deliver anchor bolts and templates sufficiently early to permit setting prior to placement of structural concrete.

B. Deliver products in undamaged condition, in manufacturer’s original container or packaging, with identifying labels intact and legible. Include on label, date of manufacture and shelf life, where applicable.

C. Unload products in accordance with manufacturer’s instructions for unloading or as specified. Record receipt of products at Site. Promptly inspect for completeness and evidence of damage during shipment.

D. Remove damaged products from Site and expedite delivery of identical new undamaged products, and remedy incomplete or lost products to provide that specified, so as not to delay progress of the Work.

1.06 HANDLING, STORAGE, AND PROTECTION

A. Handle and store products in accordance with manufacturer’s written instructions and in a manner to prevent damage. Store in approved storage yards or sheds provided in accordance with Section 01 50 00, Temporary Facilities and Controls. Provide manufacturer’s recommended maintenance during storage, installation, and until products are accepted for use by Owner.

B. Manufacturer’s instructions for material requiring special handling, storage, or protection shall be provided prior to delivery of material.

C. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to ensure that products are maintained under specified conditions, and free from damage or deterioration. Keep running account of products in storage to facilitate inspection and to estimate progress payments for products delivered, but not installed in the Work.

D. Store electrical, instrumentation, and control products, and equipment with bearings in weather-tight structures maintained above 60 degrees F. Protect electrical, instrumentation, and control products, and insulate against moisture, water, and dust damage. Connect and operate continuously space heaters furnished in electrical equipment.
E. Store fabricated products above ground on blocking or skids, and prevent soiling or staining. Store loose granular materials in well-drained area on solid surface to prevent mixing with foreign matter. Cover products that are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.

F. Store finished products that are ready for installation in dry and well-ventilated areas. Do not subject to extreme changes in temperature or humidity.

G. After installation, provide coverings to protect products from damage due to traffic and construction operations. Remove coverings when no longer needed.


PART 2 PRODUCTS

2.01 GENERAL

A. Provide manufacturer’s standard materials suitable for service conditions, unless otherwise specified in the individual Specifications.

B. Where product specifications include a named manufacturer, with or without model number, and also include performance requirements, named manufacturer’s products must meet the performance specifications.

C. Like items of products furnished and installed in the Work shall be end products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation and maintenance, spare parts and replacement, manufacturer’s services, and implement same or similar process instrumentation and control functions in same or similar manner.

D. Do not use materials and equipment removed from existing premises, except as specifically permitted by Contract Documents.

E. Provide interchangeable components of the same manufacturer, for similar components, unless otherwise specified.

F. Equipment, Components, Systems, and Subsystems: Design and manufacture with due regard for health and safety of operation, maintenance, and accessibility, durability of parts, and shall comply with applicable OSHA, state, and local health and safety regulations.
G. Regulatory Requirement: Coating materials shall meet federal, state, and local requirements limiting the emission of volatile organic compounds and for worker exposure.

H. Safety Guards: Provide for all belt or chain drives, fan blades, couplings, or other moving or rotary parts. Cover rotating part on all sides. Design for easy installation and removal. Use 16-gauge or heavier; galvanized steel, aluminum coated steel, or galvanized or aluminum coated 1/2-inch mesh expanded steel. Provide galvanized steel accessories and supports, including bolts. For outdoors application, prevent entrance of rain and dripping water.

I. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.

2. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark.

J. Equipment Finish:

1. Provide manufacturer’s standard finish and color, except where specific color is indicated.

2. If manufacturer has no standard color, provide equipment with [A: gray] [B: ] finish as approved by [C: Owner] [D: Engineer].

K. Special Tools and Accessories: Furnish to Owner, upon acceptance of equipment, all accessories required to place each item of equipment in full operation. These accessory items include, but are not limited to, adequate oil and grease (as required for first lubrication of equipment after field testing), light bulbs, fuses, hydrant wrenches, valve keys, handwheels, chain operators, special tools, and other spare parts as required for maintenance.

L. Lubricant: Provide initial lubricant recommended by equipment manufacturer in sufficient quantity to fill lubricant reservoirs and to replace consumption during testing, startup, and operation until final acceptance by Owner.

M. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the
maximum lead content standard in accordance with NSF/ANSI 61 and
NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable
certification is prohibited.

2.02 FABRICATION AND MANUFACTURE

A. General:

1. Manufacture parts to U.S.A. standard sizes and gauges.
2. Two or more items of the same type shall be identical, by the same
manufacturer, and interchangeable.
3. Design structural members for anticipated shock and vibratory loads.
4. Use 1/4-inch minimum thickness for steel that will be submerged,
wholly or partially, during normal operation.
5. Modify standard products as necessary to meet performance
Specifications.

B. Lubrication System:

1. Require no more than weekly attention during continuous operation.
2. Convenient and accessible; oil drains with bronze or stainless steel
valves and fill-plugs easily accessible from the normal operating area or
platform. Locate drains to allow convenient collection of oil during oil
changes without removing equipment from its installed position.
3. Provide constant-level oilers or oil level indicators for oil lubrication
systems.
4. For grease type bearings, which are not easily accessible, provide and
install stainless steel tubing; protect and extend tubing to convenient
location with suitable grease fitting.

2.03 SOURCE QUALITY CONTROL

A. Where Specifications call for factory testing to be witnessed by Engineer,
notify Engineer not less than 14 days prior to scheduled test date, unless
otherwise specified.

B. Calibration Instruments: Bear the seal of a reputable laboratory certifying
instrument has been calibrated within the previous 12 months to a standard
endorsed by the National Institute of Standards and Technology (NIST).

C. Factory Tests: Perform in accordance with accepted test procedures and
document successful completion.
PART 3 EXECUTION

3.01 INSPECTION

A. Inspect materials and equipment for signs of pitting, rust decay, or other deleterious effects of storage. Do not install material or equipment showing such effects. Remove damaged material or equipment from the Site and expedite delivery of identical new material or equipment. Delays to the Work resulting from material or equipment damage that necessitates procurement of new products will be considered delays within Contractor’s control.

3.02 MANUFACTURER’S CERTIFICATE OF COMPLIANCE

A. When so specified, a Manufacturer’s Certificate of Compliance, a copy of which is attached to this section, shall be completed in full, signed by entity supplying the product, material, or service, and submitted prior to shipment of product or material or execution of the services.

B. Engineer may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.

C. Such form shall certify proposed product, material, or service complies with that specified. Attach supporting reference data, affidavits, and certifications as appropriate.

D. May reflect recent or previous test results on material or product, if acceptable to Engineer.

3.03 INSTALLATION

A. Equipment Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. No shimming between machined surfaces is allowed.

C. Install the Work in accordance with NECA Standard of Installation, unless otherwise specified.

D. Repaint painted surfaces that are damaged prior to equipment acceptance.

E. Do not cut or notch any structural member or building surface without specific approval of Engineer.

F. Handle, install, connect, clean, condition, and adjust products in accordance with manufacturer’s instructions, and as may be specified. Retain a copy of manufacturers’ instruction at Site, available for review at all times.
G. For material and equipment specifically indicated or specified to be reused in the Work:

1. Use special care in removal, handling, storage, and reinstallation to assure proper function in the completed Work.
2. Arrange for transportation, storage, and handling of products that require offsite storage, restoration, or renovation. Include costs for such Work in the Contract Price.

3.04 FIELD FINISHING

A. In accordance with Section 09 90 00, Painting and Coating, and individual Specification sections.

3.05 ADJUSTMENT AND CLEANING

A. Perform required adjustments, tests, operation checks, and other startup activities.

3.06 LUBRICANTS

A. Fill lubricant reservoirs and replace consumption during testing, startup, and operation prior to acceptance of equipment by Owner.

3.07 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is part of this Specification.

1. Manufacturer’s Certificate of Compliance.

END OF SECTION
MANUFACTURER’S CERTIFICATE OF COMPLIANCE

OWNER: ________________________  PRODUCT, MATERIAL, OR SERVICE
SUBMITTED: ____________________
PROJECT NAME: _________________
PROJECT NO: ____________________

Comments: ________________________________

I hereby certify that the above-referenced product, material, or service called for by the Contract for the named Project will be furnished in accordance with all applicable requirements. I further certify that the product, material, or service are of the quality specified and conform in all respects with the Contract requirements, and are in the quantity shown.

Date of Execution: ________________________, 20___

Manufacturer: ________________________________
Manufacturer’s Authorized Representative (print): __________________________

(Authorized Signature)
PART 1  GENERAL

1.01  DEFINITIONS

A.  Seller: The party under separate contract with Owner to furnish the products or special services specified herein.

B.  [A:]   

1.02  OWNER-FURNISHED PRODUCTS

A.  Pneumatic Gate System:

1.  Components:
    a.  Pneumatic gates.
    b.  Air bladders.
    c.  Gate inclinometers.

2.  Point of Receipt: City of Tulsa, Oklahoma. Contractor responsible to provide and pay for adequate secured indoor storage upon receipt of equipment and until products are incorporated into the Work.

3.  Estimated Date of Arrival: [D: Between ] [E: ].

4.  Equipment or facility necessary for receipt and unloading of product, refer to approved Shop Drawings.

5.  Estimated Weight of Product: Refer to approved Shop Drawings.

6.  Special Handling or Storage Instructions: Refer to approved Shop Drawings.

1.03  INFORMATION FURNISHED BY OWNER

A.  Shop drawings related to Owner-furnished products will be made available for Contractor’s use in performing the Work under this section.

B.  Manufacturer’s installation, operation, and maintenance instructions for Owner-furnished products will be made available.

1.04  SUBMITTALS

A.  Action Submittals:

1.  Shop Drawings:
    a.  Show layout, location, and identification of materials provided by Contractor for installation of Owner-furnished products.
b. Include pipe, fittings, valves, specialties, hangers, supports, equipment, and required specialties.

c. Accurately show openings in floors, walls, and other parts of structure.

d. Provide electrical and instrumentation diagrams to indicate connecting and interconnecting electrical and control work.

e. Submit complete list of materials to be furnished, and include data necessary to allow Owner to determine their fitness for the work.

1.05 TRANSFER OF PRODUCTS

A. Unless indicated otherwise, items will be furnished f.o.b. the Project Site.

B. Upon delivery, conduct with Owner or Engineer a joint inspection for the purpose of identifying product, general verification of quantities, and observation of apparent condition. Such inspection will not be construed as final or as receipt of any product that, as a result of subsequent inspections and tests, are determined to be nonconforming.

C. Damaged or incomplete products to be returned for replacement will not be unloaded, except as necessary to expedite return shipment. Owner will submit claims for transportation damage and expedite replacement of damaged, defective, or deficient items.

D. Indicate signed acceptance of delivery on a copy of the invoice.

E. If Contractor is not prepared to accept delivery of Owner-furnished products by either the specified Estimated Date of Arrival or such Owner-confirmed delivery date, as specified herein, associated costs incurred by Owner shall be borne by Contractor. Such costs may include, but not be limited to, demurrage, interest, insurance costs, additional administrative and engineering costs, additional factory and field technical support, additional storage and reshipping costs, cost escalation, and extended warranty costs due.

1.06 UNLOADING, STORAGE AND MAINTENANCE

A. Subsequent to transfer, Contractor shall have complete responsibility for unloading Owner-furnished products. Unload product in accordance with manufacturers’ instructions, or as specified.

B. Store, protect, and maintain product to prevent damage until final acceptance of completed Work. Damage to or loss of products after date of transfer to Contractor shall be repaired to original condition, or replaced with new identical products, at the discretion of Engineer.
C. Maintain complete inventory of all Owner-furnished products after their transfer to Contractor.

1.07 SCHEDULING AND SEQUENCING

A. Include sequencing constraints specified herein as part of Progress Schedule.

B. Owner will keep Contractor informed of probable delivery date changes.

C. Owner will confirm delivery date with Contractor \([A: 10] [B: ~]\) days prior to scheduled delivery, and within \([C: 24] [D: ~]\) hours of expected delivery time.

D. Where a preinstallation meeting is required by this section, provide a minimum of \([A: 10] [B: ~]\) days’ advance written notice to Owner of the proposed date for starting installation.

E. Provide a minimum of \([A: 10] [B: ~]\) days’ notice to Owner that Owner-furnished product is ready for all special services listed herein to be furnished by Owner through its contract with seller. Contractor shall bear the cost of all damages assessed to Owner by seller resulting from delays caused by Contractor.

1.08 EXTRA MATERIALS

A. Unless otherwise specified, Owner will take acceptance of, and be responsible for storing associated extra materials and special tools upon delivery.

1.09 PREINSTALLATION MEETING

A. Arrange and attend a preinstallation meeting with the \([A: \text{Engineer}] [B: \text{Owner}] [C: \text{seller}]\) to review general procedures, erection and installation instructions, and installation sequence.

B. Additional meetings prior to installation may be required, as determined by Owner, to transmit Owner’s installation instructions to Contractor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in conformance with Owner-furnished product Shop Drawings and installation instructions.
B. Provide all interconnecting structures, equipment, piping, electrical and instrumentation work, finish painting, and appurtenances to achieve a complete and functional system.

C. Provide foundation pads for Owner-furnished products as shown. Verify exact dimensions and configuration of all pads, including penetrations, with Owner-furnished product Shop Drawings.

D. Anchor Bolts:
   1. Where required, provide anchor bolts, fasteners, washers, and templates needed for installation of Owner-furnished equipment.
   2. Size and locate anchor bolts in accordance with Owner-furnished product shop drawings and installation instructions.

E. Mechanical and electrical equipment shall be properly aligned, plumb and level, with no stresses on connecting piping or conduit.

F. Verify direction of motor rotation before starting equipment drives.

G. Verify operability and safety of electrical system needed to operate equipment. Check electrical system for continuity, phasing, grounding, and proper functions.

3.02 FIELD FINISHING

A. Products will be delivered with prime [A: and finish] coat(s) applied.
   1. [B: Finish coat as specified in Section [C: 09 00 00, Painting and Coating] [D: ]]
   2. Touch up or repair damage to coatings resulting from unloading, storage, installation, testing, and startup.
   3. If finish coats are damaged extensively after transfer, completely repaint.
   4. Touch up, repair, or complete repainting shall match color of original paint, and shall be fully compatible with applied primers and finish.

3.03 PRODUCT PROTECTION

A. Immediately after installation, lubricate components in accordance with manufacturer’s instructions.

B. Follow manufacturer’s instructions for protection and maintenance during storage, after installation but prior to testing and startup, and after startup but prior to acceptance.
C. Furnish incidental supplies including lubricants, cleaning fluids, and similar products as needed for protecting and maintaining the Owner-furnished products.

D. [A: .]

3.04 TESTS AND INSPECTION

A. Perform tests and inspections of installed products in accordance with requirements shown herein, Section 01 91 14, Equipment Testing and Facility Startup, and manufacturer’s instructions.

1. Functional Test: [A: .]
2. Performance Test: [A: .]

END OF SECTION
SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Submit prior to application for final payment.
   a. Record Documents: As required in General Conditions.
   b. Approved Shop Drawings and Samples: As required in the General Conditions.
   c. Special Bonds, Special Guarantees, and Service Agreements.
   d. Consent of Surety to Final Payment: As required in General Conditions.
   e. Releases or Waivers of Liens and Claims: As required in General Conditions.
   f. Releases from Agreements.
   g. Final Application for Payment: Submit in accordance with procedures and requirements stated in Section 01 29 00, Payment Procedures.
   h. Extra Materials: As required by individual specification sections.

1.02 RECORD DOCUMENTS

A. Quality Assurance:

1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain record documents.

2. Accuracy of Records:
   a. Coordinate changes within record documents, making legible and accurate entries on each sheet of Drawings and other documents where such entry is required to show change.
   b. Purpose of Project record documents is to document factual information regarding aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive Site measurement, investigation, and examination.

3. Make entries within 24 hours after receipt of information that a change in the Work has occurred.

4. Prior to submitting each request for progress payment, request Engineer’s review and approval of current status of record documents. Failure to properly maintain, update, and submit record documents may
result in a deferral by Engineer to recommend whole or any part of Contractor’s Application for Payment, either partial or final.

1.03 RELEASES FROM AGREEMENTS

A. Furnish Owner written releases from property owners or public agencies where side agreements or special easements have been made, or where Contractor’s operations have not been kept within the Owner’s construction right-of-way.

B. In the event Contractor is unable to secure written releases:

1. Inform Owner of the reasons.
2. Owner or its representatives will examine the Site, and Owner will direct Contractor to complete the Work that may be necessary to satisfy terms of the side agreement or special easement.
3. Should Contractor refuse to perform this Work, Owner reserves right to have it done by separate contract and deduct cost of same from Contract Price, or require Contractor to furnish a satisfactory bond in a sum to cover legal Claims for damages.
4. When Owner is satisfied that the Work has been completed in agreement with Contract Documents and terms of side agreement or special easement, right is reserved to waive requirement for written release if: (i) Contractor’s failure to obtain such statement is due to grantor’s refusal to sign, and this refusal is not based upon any legitimate Claims that Contractor has failed to fulfill terms of side agreement or special easement, or (ii) Contractor is unable to contact or has had undue hardship in contacting grantor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 MAINTENANCE OF RECORD DOCUMENTS

A. General:

1. Promptly following commencement of Contract Times, secure from Engineer at no cost to Contractor, one complete set of Contract Documents. Drawings will be full size.
2. Label or stamp each record document with title, “RECORD DOCUMENTS,” in neat large printed letters.
3. Record information concurrently with construction progress and within 24 hours after receipt of information that change has occurred. Do not cover or conceal Work until required information is recorded.
B. Preservation:

1. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
2. Make documents and Samples available at all times for observation by Engineer.

C. Making Entries on Drawings:

1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
   a. Color Coding:
      1) Green when showing information deleted from Drawings.
      2) Red when showing information added to Drawings.
      3) Blue and circled in blue to show notes.
2. Date entries.
3. Call attention to entry by “cloud” drawn around area or areas affected.
4. Legibly mark to record actual changes made during construction, including, but not limited to:
   a. Depths of various elements of foundation in relation to finished first floor data if not shown or where depth differs from that shown.
   b. Horizontal and vertical locations of existing and new Underground Facilities and appurtenances, and other underground structures, equipment, or Work. Reference to at least two measurements to permanent surface improvements.
   c. Location of internal utilities and appurtenances concealed in the construction referenced to visible and accessible features of the structure.
   d. Locate existing facilities, piping, equipment, and items critical to the interface between existing physical conditions or construction and new construction.
   e. Changes made by Addenda and Field Orders, Work Change Directive, Change Order, and Engineer’s written interpretation and clarification using consistent symbols for each and showing appropriate document tracking number.
5. Dimensions on Schematic Layouts: Show on record drawings, by dimension, the centerline of each run of items such as are described in previous subparagraph above.
   a. Clearly identify the item by accurate note such as “cast iron drain,” “galv. water,” and the like.
   b. Show, by symbol or note, vertical location of item (“under slab,” “in ceiling plenum,” “exposed,” and the like).
c. Make identification so descriptive that it may be related reliably to Specifications.

3.02 FINAL CLEANING

A. At completion of the Work or of a part thereof and immediately prior to Contractor’s request for certificate of Substantial Completion; or if no certificate is issued, immediately prior to Contractor’s notice of completion, clean entire Site or parts thereof, as applicable.

1. Leave the Work and adjacent areas affected in a cleaned condition satisfactory to Owner.
2. Remove grease, dirt, dust, paint or plaster splatter, stains, labels, fingerprints, and other foreign materials from exposed surfaces.
3. Repair, patch, and touch up marred surfaces to specified finish and match adjacent surfaces.
4. Clean all windows.
5. Clean and wax wood, vinyl, or painted floors.
6. Broom clean exterior paved driveways and parking areas.
7. Hose clean sidewalks, loading areas, and others contiguous with principal structures.
8. Rake clean all other surfaces.
9. Remove snow and ice from access to buildings.
10. Replace air-handling filters and clean ducts, blowers, and coils of ventilation units operated during construction.
11. Leave water courses, gutters, and ditches open and clean.

B. Use only cleaning materials recommended by manufacturer of surfaces to be cleaned.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES

A. Detailed information for the preparation, submission, and Engineer’s review of Operations and Maintenance (O&M) Data, as required by individual specification sections.

1.02  DEFINITIONS

A. Preliminary Data: Initial and subsequent submissions for Engineer’s review.

B. Final Data: Engineer-accepted data, submitted as specified herein.

C. Maintenance Operation: As used on Maintenance Summary Form is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.

1.03  SEQUENCING AND SCHEDULING

A. Equipment and System Data:
   1. Preliminary Data:
      a. Do not submit until Shop Drawing for equipment or system has been reviewed and approved by Engineer.
      b. Submit prior to shipment date.
   2. Final Data: Submit Instructional Manual Formatted data not less than 30 days prior to Substantial Completion of Project.

B. Materials and Finishes Data:
   1. Preliminary Data: Submit at least 15 days prior to request for final inspection.
   2. Final Data: Submit within 10 days after final inspection.

1.04  DATA FORMAT

A. Prepare preliminary and final data in the form of an instructional manual. Prepare final data on electronic media.
B. Instructional Manual Format:

1. Binder: Commercial quality, permanent, three-ring or three-post binders with durable plastic cover.
2. Size: 8-1/2 inches by 11 inches, minimum.
3. Cover: Identify manual with typed or printed title “OPERATION AND MAINTENANCE DATA” and list:
   a. Project title.
   b. Designate applicable system, equipment, material, or finish.
   c. Identity of separate structure as applicable.
   d. Identify volume number if more than one volume.
   e. Identity of general subject matter covered in manual.
4. Spine:
   a. Project title.
   b. Identify volume number if more than one volume.
5. Title Page:
   a. Contractor name, address, and telephone number.
   b. Subcontractor, Supplier, installer, or maintenance contractor’s name, address, and telephone number, as appropriate.
      1) Identify area of responsibility of each.
      2) Provide name and telephone number of local source of supply for parts and replacement.
6. Table of Contents:
   a. Neatly typewritten and arranged in systematic order with consecutive page numbers.
   b. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.
8. Text: Manufacturer’s printed data, or neatly typewritten.
9. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.
10. Material shall be suitable for reproduction, with quality equal to original. Photocopying of material will be acceptable, except for material containing photographs.

C. Electronic Media Format:

1. Portable Document Format (PDF):
   a. After all preliminary data has been found to be acceptable to Engineer, submit Operation and Maintenance data in PDF format on CD.
   b. Files to be exact duplicates of Engineer-accepted preliminary data. Arrange by specification number and name.
   c. Files to be fully functional and viewable in most recent version of Adobe Acrobat.
1.05 SUBMITTALS

A. Informational:

1. Data Outline: Submit two copies of a detailed outline of proposed organization and contents of Final Data prior to preparation of Preliminary Data.

2. Preliminary Data:
   a. Submit three copies for Engineer’s review.
   b. If data meets conditions of the Contract:
      1) One copy will be returned to Contractor.
      2) One copy will be forwarded to Resident Project Representative.
      3) One copy will be retained in Engineer’s file.
   c. If data does not meet conditions of the Contract:
      1) All copies will be returned to Contractor with Engineer’s comments (on separate document) for revision.
      2) Engineer’s comments will be retained in Engineer’s file.
      3) Resubmit two copies revised in accordance with Engineer’s comments.

3. Final Data: Submit four copies in format specified herein.

1.06 DATA FOR EQUIPMENT AND SYSTEMS

A. Content for Each Unit (or Common Units) and System:

1. Product Data:
   a. Include only those sheets that are pertinent to specific product.
   b. Clearly annotate each sheet to:
      1) Identify specific product or part installed.
      2) Identify data applicable to installation.
      3) Delete references to inapplicable information.
   c. Function, normal operating characteristics, and limiting conditions.
   d. Performance curves, engineering data, nameplate data, and tests.
   e. Complete nomenclature and commercial number of replaceable parts.
   f. Original manufacturer’s parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.
   g. Spare parts ordering instructions.
   h. Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, terminals).

2. As-installed, color-coded piping diagrams.
3. Charts of valve tag numbers, with the location and function of each valve.

4. Drawings:
   a. Supplement product data with Drawings as necessary to clearly illustrate:
      1) Format:
         a) Provide reinforced, punched, binder tab; bind in with text.
         b) Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2 inches by 11 inches.
         c) Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch envelopes bound in text.
         d) Identify Specification section and product on Drawings and envelopes.
      2) Relations of component parts of equipment and systems.
      3) Control and flow diagrams.
      4) Coordinate drawings with Project record documents to assure correct illustration of completed installation.

5. Instructions and Procedures: Within text, as required to supplement product data.
   a. Format:
      1) Organize in consistent format under separate heading for each different procedure.
      2) Provide logical sequence of instructions for each procedure.
      3) Provide information sheet for Owner’s personnel, including:
         a) Proper procedures in event of failure.
         b) Instances that might affect validity of guarantee or Bond.
   b. Installation Instructions: Including alignment, adjusting, calibrating, and checking.
   c. Operating Procedures:
      1) Startup, break-in, routine, and normal operating instructions.
      2) Test procedures and results of factory tests where required.
      3) Regulation, control, stopping, and emergency instructions.
      4) Description of operation sequence by control manufacturer.
      5) Shutdown instructions for both short and extended duration.
      6) Summer and winter operating instructions, as applicable.
      7) Safety precautions.
      8) Special operating instructions.
   d. Maintenance and Overhaul Procedures:
      1) Routine maintenance.
      2) Guide to troubleshooting.
      3) Disassembly, removal, repair, reinstallation, and re-assembly.
6. Guarantee, Bond, and Service Agreement: In accordance with Section 01 77 00, Closeout Procedures.

B. Content for Each Electric or Electronic Item or System:

1. Description of Unit and Component Parts:
   a. Function, normal operating characteristics, and limiting conditions.
   b. Performance curves, engineering data, nameplate data, and tests.
   c. Complete nomenclature and commercial number of replaceable parts.
   d. Interconnection wiring diagrams, including control and lighting systems.
2. Circuit Directories of Panelboards:
   a. Electrical service.
   b. Control requirements and interfaces.
   c. Communication requirements and interfaces.
   d. List of electrical relay settings, and control and alarm contact settings.
   e. Electrical interconnection wiring diagram, including as applicable, single-line, three-line, schematic and internal wiring, and external interconnection wiring.
   f. As-installed control diagrams by control manufacturer.
3. Operating Procedures:
   a. Routine and normal operating instructions.
   b. Startup and shutdown sequences, normal and emergency.
   c. Safety precautions.
   d. Special operating instructions.
4. Maintenance Procedures:
   a. Routine maintenance.
   c. Adjustment and checking.
   d. List of relay settings, control and alarm contact settings.
5. Manufacturer’s printed operating and maintenance instructions.
6. List of original manufacturer’s spare parts, manufacturer’s current prices, and recommended quantities to be maintained in storage.

C. Maintenance Summary:

1. Compile individual Maintenance Summary for each applicable equipment item, respective unit or system, and for components or sub-units.
2. Format:
   a. Use Maintenance Summary Form bound with this section or electronic facsimile of such.
b. Each Maintenance Summary may take as many pages as required.
c. Use only 8-1/2-inch by 11-inch size paper.
d. Complete using typewriter or electronic printing.

3. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.

4. Recommended Spare Parts:
a. Data to be consistent with manufacturer’s Bill of Materials/Parts List furnished in O&M manuals.
b. “Unit” is the unit of measure for ordering the part.
c. “Quantity” is the number of units recommended.
d. “Unit Cost” is the current purchase price.

1.07 DATA FOR MATERIALS AND FINISHES

A. Content for Architectural Products, Applied Materials, and Finishes:

1. Manufacturer’s data, giving full information on products:
   a. Catalog number, size, and composition.
   b. Color and texture designations.
   c. Information required for reordering special-manufactured products.

2. Instructions for Care and Maintenance:
   a. Manufacturer’s recommendation for types of cleaning agents and methods.
   b. Cautions against cleaning agents and methods that are detrimental to product.
   c. Recommended schedule for cleaning and maintenance.

B. Content for Moisture Protection and Weather Exposed Products:

1. Manufacturer’s data, giving full information on products:
   a. Applicable standards.
   b. Chemical composition.
   c. Details of installation.

2. Instructions for inspection, maintenance, and repair.

1.08 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is part of this Specification.

1. Maintenance Summary Form.
PART 2  PRODUCTS (NOT USED)
PART 3  EXECUTION (NOT USED)

END OF SECTION
MAINTENANCE SUMMARY FORM

PROJECT: ___________________________ CONTRACT NO.: ___________________________

1. EQUIPMENT ITEM ___________________________

2. MANUFACTURER ___________________________

3. EQUIPMENT/TAG NUMBER(S) ___________________________

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS) ___________________________

5. NAMEPLATE DATA (hp, voltage, speed, etc.) ___________________________

6. MANUFACTURER’S LOCAL REPRESENTATIVE ___________________________
   a. Name ___________________________ Telephone No. __________________
   b. Address __________________________

7. MAINTENANCE REQUIREMENTS

<table>
<thead>
<tr>
<th>Maintenance Operation Comments</th>
<th>Frequency</th>
<th>Lubricant (If Applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>List briefly each maintenance operation required and refer to specific information in manufacturer’s standard maintenance manual, if applicable. (Reference to manufacturer’s catalog or sales literature is not acceptable.)</td>
<td>List required frequency of each maintenance operation.</td>
<td>Refer by symbol to lubricant required.</td>
</tr>
</tbody>
</table>
8. LUBRICANT LIST

<table>
<thead>
<tr>
<th>Reference Symbol</th>
<th>Shell</th>
<th>Exxon Mobile</th>
<th>Chevron Texaco</th>
<th>BP Amoco</th>
<th>Or Equal</th>
</tr>
</thead>
<tbody>
<tr>
<td>List symbols used in No. 7 above.</td>
<td>List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. RECOMMENDED SPARE PARTS FOR OWNER’S INVENTORY

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Cost</th>
</tr>
</thead>
</table>

Note: Identify parts provided by this Contract with two asterisks.
PART 1 GENERAL

1.01 SUMMARY

A. This section covers requirements for anchorage and bracing of equipment, distribution systems, and other nonstructural components required in accordance with the ICC 2015 International Building Code (IBC), for seismic, wind, gravity, soil, and operational loads.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:


1.03 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be Owner when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.

B. Designated Seismic System: Architectural, electrical, and mechanical system or their components for which component importance factor is greater than 1.0.

1.04 DESIGN AND PERFORMANCE REQUIREMENTS

A. General:

1. Anchorage and bracing systems shall be designed by a qualified professional engineer registered in the State of [A:].
2. Design anchorage into concrete including embedment in accordance with ACI 318-14; Chapter 17 (or other industry standard approved by Engineer), and Project Specifications.
   a. Unless otherwise noted, design for cracked concrete condition.
3. Design anchorage and bracing of architectural, mechanical, and electrical components and systems in accordance with this section, unless a design is specifically provided within Contract Documents or where exempted hereinafter.
4. Design attachments, braces, and anchors for equipment, components, and distribution systems to structure for gravity, seismic, wind, and operational loading.
5. Anchor and brace piping and ductwork, whether exempt or not exempt for this section, so that lateral or vertical displacement does not result in damage or failure to essential architectural, mechanical, or electrical equipment.
6. Architectural Components: Includes, but are not limited to, nonstructural walls and elements, partitions, cladding and veneer, access flooring, signs, cabinets, suspended ceilings, and glass in glazed curtain walls and partitions.
7. Provide supplementary framing where required to transfer anchorage and bracing loads to structure.
8. Adjust equipment pad sizes or provide additional anchorage confinement reinforcing to provide required anchorage capacities.
9. Design anchorage and bracing for:
   a. Equipment and components that weigh more than 400 pounds and have center of mass located 4 feet or less above adjacent finished floor.
   b. Equipment weighing more than 75 pounds that has center of mass located more than 4 feet above adjacent finished floor.
   c. Distribution systems that weigh more than 5 pounds per foot that are mounted more than 5 feet above adjacent finished floor.
10. For components exempted from design requirements of this section, provide bolted, welded, or otherwise positively fastened attachments to supporting structure.

B. Design Loads:

1. Gravity: Design anchorage and bracing for self-weight and superimposed loads on components and equipment.
2. Wind: Design anchorage and bracing for wind criteria provided on General Structural Notes on Drawings for exposed architectural components and exterior and wind-exposed mechanical and electrical equipment. Alternately, manufacturer certification may be provided for components such as roofing and flashing to verify attachments meet Project-specific design criteria.
3. Operational:
   a. For loading supplied by equipment manufacturer for IBC required load cases.
   b. Loads may include equipment vibration, torque, thermal effects, effects of internal contents (weight and sloshing), water hammer, and other load-inducing conditions.
   c. Locate braces to minimize vibration to or movement of structure.
   d. For vibrating loads, use anchors meeting requirements of Section 05 50 00, Metal Fabrications, for anchors with designated capacities for vibratory loading per manufacturer’s ICC-ES report.

4. Seismic:
   a. In accordance with 2015 IBC, Section 1613, and Chapter 13 of ASCE 7.
   b. Design anchorage and bracing for design criteria listed on General Structural Notes on Drawings.
   c. Risk Category IV, unless noted otherwise. Anchorage and bracing Risk Category shall be same as that for supporting structure as shown on Drawings.
   d. Design forces for anchors in concrete or masonry shall be in accordance with ASCE 7, Section 13.4.2 as applicable for Project Seismic Design Category.

C. Seismic Design Requirements:

1. Analyze local region of body of nonstructural component for load transfer of anchorage attachment if component Ip = 1.5.
2. Fire protection sprinkler systems designed and constructed in accordance with NFPA 13 shall be considered to meet requirements of Chapter 13 of ASCE 7.
3. Provide support drawings and calculations for electrical distribution components if any of the following conditions apply:
   a. Conduit diameter is greater than 2.5-inch trade size.
   b. Total weight of bus duct, cable tray, or conduit supported by trapeze assemblies exceeds 10 pounds per foot.
4. Other seismic design and detailing information identified in ASCE 7, Chapter 13, is required to be provided for new architectural, mechanical and electrical components, systems, or equipment.
1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. List of architectural, mechanical, and electrical equipment requiring Contractor-designed anchorage and bracing, unless specifically exempted.
   b. Manufacturers’ engineered seismic and non-seismic hardware product data.
   c. Attachment assemblies’ drawings including seismic attachments; include connection hardware, braces, and anchors or anchor bolts for nonexempt components, equipment, and systems.
   d. Submittal will be rejected if proposed anchorage method would create excessive stress to supporting member. Revise anchorages and strengthen structural support to eliminate overstressed condition.

B. Informational Submittals:

1. Anchorage and Bracing Calculations: For attachments, braces, and anchorages, include IBC and Project-specific criteria as noted on General Structural Notes on Drawings, in addition to manufacturer’s specific criteria used for design; sealed by a civil or structural engineer registered in the State of Oklahoma.
   2. Manufacturer’s hardware installation requirements.

1.06 SOURCE QUALITY CONTROL

A. Contractor and supplier responsibilities to accommodate Owner-furnished shop fabrication related special inspections and testing are provided in Project’s Statement of Special Inspections and Section 01 45 33, Special Inspection, Observation, and Testing.

B. Provide all other specified, regulatory required, or required repair verification inspection and testing that is not listed in Statement of Special Inspections in accordance with Section 01 45 16.13, Contractor Quality Control.

C. Provide Source Quality Control for welding and hot-dip galvanizing of anchors in accordance with Section 05 50 00, Metal Fabrications.
PART 2 PRODUCTS

2.01 GENERAL

A. Design and construct attachments and supports transferring seismic and non-seismic loads to structure of materials and products suitable for application and in accordance with design criteria shown on Drawings and nationally recognized standards.

B. Provide anchor bolts for anchorage of equipment to concrete or masonry in accordance with Section 05 50 00, Metal Fabrications. Provide anchor bolts of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.

C. Provide post-installed concrete and masonry anchors for anchorage of equipment to concrete or masonry in accordance with Section 05 05 19, Post-Installed Anchors. Provide post-installed anchors of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.

D. Do not use powder-actuated fasteners or sleeve anchors for seismic attachments and anchorage where resistance to tension loads is required. Do not use expansion anchors, other than undercut anchors, for nonvibration isolated mechanical equipment rated over 10 hp.

PART 3 EXECUTION

3.01 GENERAL

A. Make attachments, bracing, and anchorage in such a manner that component lateral force is transferred to lateral force resisting system of structure through a complete load path.

B. Design, provide, and install overall seismic anchorage system to provide restraint in all directions, including vertical, for each component or system so anchored.

C. Provide snubbers in each horizontal direction and vertical restraints for components mounted on vibration isolation systems where required to resist overturning.

D. Provide piping anchorage that maintains design flexibility and expansion capabilities at flexible connections and expansion joints.

1. Piping and ductwork suspended more than 12 inches below supporting structure shall be braced for seismic effects to avoid significant bending
of hangers and their attachments, unless high- or limited-deformability piping is used per ASCE 7, Section 13.6.8 or HVAC ducts have a cross-sectional area of less than 6 square feet or weigh 17 pounds per foot or less.

E. Anchor tall and narrow equipment such as motor control centers and telemetry equipment at base and within 12 inches from top of equipment, unless approved otherwise by Engineer.

F. Do not attach architectural, mechanical, or electrical components to more than one element of a building structure at a single restraint location where such elements may respond differently during a seismic event. Do not make such attachments across building expansion and contraction joints.

3.02 INSTALLATION

A. Do not install components or their anchorages or restraints prior to review and acceptance by Engineer and AHJ.

B. Notify Engineer upon completion of installation of seismic restraints in accordance with Section 01 45 33, Special Inspection, Observation, and Testing.

3.03 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. In accordance with Section 05 50 00, Metal Fabrications, and Section 05 05 19, Post-Installed Anchors.

B. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

C. Provide any other specified, regulatory required, or required repair verification inspection and testing that is not listed in Statement of Special Inspections in accordance with Section 01 45 16.13, Contractor Quality Control.

END OF SECTION
PART 1 GENERAL

1.01 DEFINITIONS

A. Facility: Entire Project, or an agreed-upon portion, including all of its unit processes.

B. Functional Test: Test or tests in presence of Engineer and Owner to demonstrate that installed equipment meets manufacturer’s installation, calibration, and adjustment requirements and other requirements as specified.

C. Performance Test: Test or tests performed after any required functional test in presence of Engineer and Owner to demonstrate and confirm individual equipment meets performance requirements specified in individual sections.

D. Unit Process: As used in this section, a unit process is a portion of the facility that performs a specific process function, such as [A: ] [B: ] and [C: ].

E. Facility Performance Demonstration:
   1. A demonstration, conducted by Contractor, with assistance of Owner, to demonstrate and document the performance of the entire operating facility, both manually and automatically (if required), based on criteria developed in conjunction with Owner and as accepted by Engineer.
   2. Such demonstration is for the purposes of (i) verifying to Owner entire facility performs as a whole, and (ii) documenting performance characteristics of completed facility for Owner’s records. Neither the demonstration nor the evaluation is intended in any way to make performance of a unit process or entire facility the responsibility of Contractor, unless such performance is otherwise specified.

1.02 SUBMITTALS

A. Informational Submittals:
   1. Facility Startup and Performance Demonstration Plan.
   2. Functional and performance test results.
   3. Completed Unit Process Startup Form for each unit process.
1.03  FACILITY STARTUP AND PERFORMANCE DEMONSTRATION PLAN

   A. Develop a written plan, in conjunction with Owner’s operations personnel; to include the following:

      1.  Step-by-step instructions for startup of each unit process and the complete facility.
      2.  Unit Process Startup Form (sample attached), to minimally include the following:
           a.  Description of the unit process, including equipment numbers/nomenclature of each item of equipment and all included devices.
           b.  Detailed procedure for startup of the unit process, including valves to be opened/closed, order of equipment startup, etc.
           c.  Startup requirements for each unit process, including water, power, chemicals, etc.
           d.  Space for evaluation comments.
      3.  Facility Performance Demonstration/Certification Form (sample attached), to minimally include the following:
           a.  Description of unit processes included in the facility startup.
           b.  Sequence of unit process startup to achieve facility startup.
           c.  Description of computerized operations, if any, included in the facility.
           d.  Contractor certification facility is capable of performing its intended function(s), including fully automatic operation.
           e.  Signature spaces for Contractor and Engineer.

PART 2  PRODUCTS (NOT USED)

PART 3  EXECUTION

3.01  GENERAL

   A.  Facility Startup Meetings: Schedule, in accordance with requirements of Section 01 31 19, Project Meetings, to discuss test schedule, test methods, materials, chemicals and liquids required, facilities operations interface, and Owner involvement.

   B.  Contractor’s Testing and Startup Representative:

      1.  Designate and furnish one or more personnel to coordinate and expedite testing and facility startup.
      2.  Representative(s) shall be present during startup meetings and shall be available at all times during testing and startup.
C. Provide temporary valves, gauges, piping, test equipment and other materials and equipment required for testing and startup.

D. Provide Subcontractor and equipment manufacturers’ staff adequate to prevent delays. Schedule ongoing work so as not to interfere with or delay testing and startup.

E. Owner will:

1. Provide water, power, chemicals, and other items as required for startup, unless otherwise indicated.
2. Operate process units and facility with support of Contractor.
3. Provide labor and materials as required for laboratory analyses.
4. [A: Furnish assistance of manufacturer’s representative(s) for Owner-furnished products, as specified in Section 01 64 00, Owner-Furnished Products.]
5. [B: Make available spare parts, special tools, and operation and maintenance information for Owner-furnished products.]

3.02 EQUIPMENT TESTING

A. Preparation:

1. Complete installation before testing.
2. Furnish qualified manufacturers’ representatives, when required by individual Specification sections.
3. Obtain and submit from equipment manufacturer’s representative Manufacturer’s Certificate of Proper Installation Form, in accordance with Section 01 43 33, Manufacturers’ Field Services, when required by individual Specification sections.
4. Equipment Test Report Form:
   a. Provide written test report for each item of equipment to be tested, to include the minimum information:
      1) Owner/Project Name.
      2) Equipment or item tested.
      3) Date and time of test.
      4) Type of test performed (Functional or Performance).
      5) Test method.
      6) Test conditions.
      7) Test results.
      8) Signature spaces for Contractor and Engineer as witness.

   5. Cleaning and Checking:
      a. Prior to beginning functional testing:
         1) Calibrate testing equipment in accordance with manufacturer’s instructions.
2) Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
3) Lubricate equipment in accordance with manufacturer’s instructions.
4) Turn rotating equipment by hand when possible to confirm that equipment is not bound.
5) Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
6) Check power supply to electric-powered equipment for correct voltage.
7) Adjust clearances and torque.
8) Test piping for leaks.

6. Ready-to-test determination will be by [A: Engineer] [B:     ] based at least on the following:
   a. Acceptable Operation and Maintenance Data.
   b. Notification by Contractor of equipment readiness for testing.
   c. Receipt of Manufacturer’s Certificate of Proper Installation, if so specified.
   d. Adequate completion of work adjacent to, or interfacing with, equipment to be tested [C: , including items to be furnished by Owner].
   e. Availability and acceptability of manufacturer’s representative, when specified, to assist in testing of respective equipment.
   f. Satisfactory fulfillment of other specified manufacturer’s responsibilities.
   g. Equipment and electrical tagging complete.
   h. Delivery of all spare parts and special tools.

B. Functional Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Owner and Engineer in writing at least 10 days prior to scheduled date of testing.
4. When, in Engineer’s opinion, equipment meets functional requirements specified, such equipment will be accepted for purposes of advancing to performance testing phase, if so required by individual Specification sections. Such acceptance will be evidenced by Engineer/Owner’s signature as witness on Equipment Test Report.

C. Performance Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Engineer and Owner in writing at least 10 days prior to scheduled date of test.
3. Performance testing shall not commence until equipment has been accepted by Engineer as having satisfied functional test requirements specified.
4. Type of fluid, gas, or solid for testing shall be as specified.
5. Unless otherwise indicated, furnish labor, materials, and supplies for conducting the test and taking samples and performance measurements.
7. When, in Engineer’s opinion, equipment meets performance requirements specified, such equipment will be accepted as to conforming to Contract requirements. Such acceptance will be evidenced by Engineer’s signature on Equipment Test Report.

3.03 STARTUP OF UNIT PROCESSES

A. Prior to unit process startup, equipment within unit process shall be accepted by Engineer as having met functional and performance testing requirements specified.

B. Startup sequencing of unit processes shall [A: be as chosen by Contractor to meet schedule requirements.] [B: be in the following order:]
   1. [C: .]
   2. [D: .]

C. Make adjustments, repairs, and corrections necessary to complete unit process startup.

D. Startup shall be considered complete when, in opinion of Engineer, unit process has operated in manner intended for [A: 5] [B: ] continuous days without significant interruption. This period is in addition to functional or performance test periods specified elsewhere.

E. Significant Interruption:
   1. May include any of the following events:
      a. Failure of Contractor to provide and maintain qualified onsite startup personnel as scheduled.
      b. Failure to meet specified functional operation for more than [A: 2] [B: ] consecutive hours.
      c. Failure of any critical equipment or unit process that is not satisfactorily corrected within [C: 5] [D: ] hours after failure.
      d. Failure of any noncritical equipment or unit process that is not satisfactorily corrected within [E: 8] [F: ] hours after failure.
      e. As determined by Engineer.
F. A significant interruption will require startup then in progress to be stopped. After corrections are made, startup test period to start from beginning again.

3.04 FACILITY PERFORMANCE DEMONSTRATION

A. When, in the opinion of Engineer, startup of all unit processes has been achieved, sequence each unit process to the point that facility is operational.

B. Demonstrate proper operation of required interfaces within and between individual unit processes.

C. After facility is operating, complete performance testing of equipment and systems not previously tested.

D. Document, as defined in Facility Startup and Performance Demonstration Plan, the performance of the facility [A: including its computer system] [B: until all unit processes are operable and under control of computer system].

E. Certify, on the Facility Performance Demonstration/Certification Form, that facility is capable of performing its intended function(s), including fully automatic [A: and computerized] operation.

3.05 SUPPLEMENTS

A. Supplements listed below, following “End of Section,” are a part of this Specification:

1. Unit Process Startup Form.
2. Facility Performance Demonstration/Certification Form.

END OF SECTION
UNIT PROCESS STARTUP FORM

OWNER: ___________________________ PROJECT: ___________________________

Unit Process Description: (Include description and equipment number of all equipment and devices):
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

Startup Procedure (Describe procedure for sequential startup and evaluation, including valves to be
opened/closed, order of equipment startup, etc.):
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

Startup Requirements (Water, power, chemicals, etc.):
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

Evaluation Comments:
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
FACILITY PERFORMANCE DEMONSTRATION/CERTIFICATION FORM

OWNER: ___________________________ PROJECT: ___________________________

Unit Processes Description (List unit processes involved in facility startup):

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Unit Processes Startup Sequence (Describe sequence for startup, including computerized operations, if any):

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Contractor Certification that Facility is capable of performing its intended function(s), including fully automatic operation:

Contractor: ___________________________ Date: ___________________________, 20____

Engineer: ___________________________ Date: ___________________________, 20____

(Authorized Signature)
PART 1  GENERAL

1.01  REFERENCES

A. The following is a list of standards which may be referenced in this Section:

3.  Environmental Protection Agency (EPA), U.S. Code of Federal Regulations (CFR), Title 40:
   b. Part 82—Protection of Stratospheric Ozone.

1.02  DEFINITIONS

A. ACM: Asbestos-containing material.

B. Demolition: Dismantling, razing, destroying, or wrecking of any fixed building or structure or any part thereof. Demolition also includes removal of pipes, manholes tanks, conduit, and other underground facilities, whether as a separate activity or in conjunction with construction of new facilities.

C. Modify: Provide all necessary material and labor to modify an existing item to the condition indicated or specified.

D. Relocate: Remove, protect, clean and reinstall equipment, including electrical, instrumentation, and all ancillary components required to make the equipment fully functional, to the new location identified on Drawings.

E. Renovation: Altering a facility or one or more facility components in any way.

F. Salvage/Salvageable: Remove and deliver, to the specified location(s), the equipment, building materials, or other items so identified to be saved from destruction, damage, or waste; such property to remain that of Owner. Unless
otherwise specified, title to items identified for demolition shall revert to Contractor.

G. Universal Waste Lamp: In accordance with 40 CFR 273, the bulb or tube portion of an electric lighting device, examples of which include, but are not limited to, fluorescent, high-intensity discharge, neon, mercury vapor, high-pressure sodium, and metal halide lamps.

H. Universal Waste Thermostat: A temperature control device that contains metallic mercury in an ampule attached to a bimetal sensing element, and mercury-containing ampules that have been removed from these temperature control devices in compliance with the requirements of 40 CFR 273.

1.03 SUBMITTALS

A. Informational Submittals:

1. Submit proposed Demolition/Renovation Plan, in accordance with requirements specified herein, for approval before such Work is started.
2. Submit copies of any notifications, authorizations and permits required to perform the Work.
3. Copies of reports and other documentation required for abandoning wells.
4. Submit a shipping receipt or bill of lading for all containers of ozone depleting substance (ODS) shipped.
5. Submit a shipping receipt or bill of lading for all containers of ACM shipped.
6. Submit a shipping receipt or bill of lading for all universal waste shipped.

1.04 REGULATORY AND SAFETY REQUIREMENTS

A. When applicable, demolition Work shall be accomplished in strict accordance with 29 CFR 1926-Subpart T.

B. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the General Conditions, Contractor’s safety requirements shall conform to ANSI A10.6.

C. Furnish timely notification of this demolition project to applicable federal, state, regional, and local authorities in accordance with 40 CFR 61-Subpart M.
1.05 DEMOLITION/RENOVATION PLAN

A. Demolition/Renovation Plan shall provide for safe conduct of the Work and shall include:
   1. Detailed description of methods and equipment to be used for each operation.
   2. The Contractor’s planned sequence of operations, including coordination with other work in progress.
   3. Disconnection schedule of utility services.

B. Include statements affirming Contractor inspection of the existing roof deck, floors, walls, and framing members, and their suitability to perform as a safe working platform or, if inspection reveals a safety hazard to workers, state provisions for securing the safety of the workers throughout the performance of the Work.

1.06 SEQUENCING AND SCHEDULING

A. The Work of this Specification shall not commence until Contractor’s Demolition/Renovation Plan has been approved by Engineer.

B. Include the Work of this Specification in the progress schedule, as specified in Section 01 32 00, Construction Progress Documentation.

C. Areas in which the Work is to be accomplished will be available in accordance with the Progress Schedule required under Section 01 32 00, Construction Progress Documentation.

1.07 USE OF EXPLOSIVES

A. 

1.08 ENVIRONMENTAL PROTECTION

A. Take necessary precautions to avoid leakage of hydraulic fluid when demolishing hydraulic power systems associated with bascule gates. Drain hydraulic fluid prior to removal of equipment, and provide spill protection measures.
PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXISTING FACILITIES TO BE DEMOLISHED OR RENOVATED

A. Facilities:
   1. Buildings scheduled for complete demolition are as shown.
   2. Portions of buildings and other areas scheduled for selective demolition, partial demolition, and renovation Work are as shown.

B. Structures:
   1. Existing above-grade structures indicated shall be removed as shown.
   2. Core drill concrete slabs and other concrete improvements scheduled to remain in place below ground, or break holes at the structure’s lowest point to allow water to freely migrate through.
   3. Sidewalks, curbs, gutters and street light bases shall be removed as indicated.

C. Utilities and Related Equipment:
   1. Notify Owner or appropriate utilities to turn off affected services at least 48 hours before starting demolition activities.
   2. Remove existing utilities as indicated and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by Engineer.
   3. When utility lines are encountered that are not indicated on Drawings, notify Owner prior to further work in that area.
   4. Remove meters and related equipment and deliver to a location as determined by the Owner.
   5. Excavate and remove utility lines serving buildings to be demolished to a distance of 10 feet beyond the outside perimeter of the demolition.
   6. Provide a permanent leak-proof closure for water and gas lines.
   7. Plug sewer lines with concrete to a minimum plug length of 10 feet to prevent groundwater infiltration.

D. Gate Removal:
   1. Remove and properly dispose of all electrical and mechanical (hydraulic) equipment associated with bascule gates and sluice gates. Equipment to demolish includes, but is not limited to, the following:
      a. East Gate House, Walkway, and Dam Crest:
         1) 150-gallon hydraulic power unit.
         2) Two sluice gates.
3) Two hydraulic operators on sluice gates.
4) Two bascule gates.
5) Four roto-thrust operator cylinders associated with bascule gates.
6) Associated hydraulic piping.
7) Miscellaneous electrical gear and instruments.

b. West Gate House and West Dam Crest:
1) 100-gallon hydraulic power unit.
2) Bascule gate.
3) Two Roto-thrust crest gate operator cylinders associated with one bascule gate (one beneath floor of west gate house, and one in access tower on east end of gate).
4) Miscellaneous hydraulic lines, electric conduit, and instruments.

E. Paving and Slabs:

1. Remove concrete and asphaltic concrete paving and slabs as indicated.
2. Provide neat sawcuts at limits of pavement removal as indicated.

F. Concrete:

1. Core drill corners of new opening to avoid overcutting adjacent reinforcing in existing concrete to remain. Saw concrete along straight lines to a depth of not less than 2 inches. Make each cut in walls perpendicular to the face and in alignment with the cut in the opposite face. Break out the remainder of the concrete provided that the broken area is concealed in the finished Work, and the remaining concrete is sound.
2. At locations where the broken face cannot be concealed, grind smooth or saw cut entirely through the concrete. Repair exposed rebar ends and embeds as shown on Drawings.
3. Where new concrete adjoins existing concrete, thoroughly clean and mechanically roughen existing concrete surfaces to roughness profile of 3/16 inch. Rebar and small embeds at existing concrete may be required to be left to engage new concrete. Saturate surface with water for 24 hours prior to placing new concrete. The new Work shall tie into the existing construction as shown on Drawings.
4. At submerged locations not to receive new concrete, paint exposed rebar or metal embed ends with System No. 19a at water surfaces per Section 09 90 00, Painting and Coating.
G. Patching:

1. Where removals leave holes and damaged surfaces exposed in the finished Work, patch and repair to match adjacent finished surfaces as to texture and finish.
2. Where new Work is to be applied to existing surfaces, perform removals and patching in a manner to produce surfaces suitable for receiving new Work.
3. Patching shall be as specified and indicated, and shall include:
   a. Fill holes and depressions caused by previous physical damage or left as a result of removals in existing concrete walls with an approved patching material, applied in accordance with the manufacturer’s printed instructions.

H. Cylinders and Canisters: Remove all fire suppression system cylinders and canisters and dispose as specified in Paragraph Ozone Depleting Substances (ODS).

I. Door Locksets: Remove all locksets from all doors indicated to be removed and disposed of. Turn locksets over to Owner immediately after their removal.

J. Electrical:

1. Cut off concealed or embedded conduit, boxes, or other materials a minimum of 3/4 inch below final finished surface.
2. When removing designated equipment, conduit and wiring may require rework to maintain service to other equipment.
3. Rework existing circuits, or provide temporary circuits as necessary during renovation to maintain service to existing lighting and equipment not scheduled to be renovated. Existing equipment and circuiting shown are based upon limited field surveys. Verify existing conditions, make all necessary adjustments, and record the Work on the Record Drawings. This shall include, but is not limited to, swapping and other adjustments to branch circuits and relocation of branch circuit breakers within panelboards as required to accomplish the finished work.
4. Reuse of existing luminaires, devices, conduits, boxes, or equipment will be permitted only where specifically indicated.
5. Raceways and cabling not scheduled for reuse.
6. Inaccessibly Concealed: Cut off and abandon in place.
7. Exposed or Concealed Above Accessible Ceilings: Remove.
9. Relocating Equipment: Extend existing wiring or run new wiring from the source.
10. Where the existing raceway is concealed, the outlet box shall be cleaned, and a blank cover plate installed.
11. Where the concealed raceway is uncovered remove raceway (or extended to new location if appropriate).

K. Universal Waste Lamps and Thermostats: Manage, contain, package, and label in strict accordance with 40 CFR 273.

3.02 PROTECTION

A. Building Occupancy: Refer to Section 01 31 13, Project Coordination, for specific requirements related to concurrent occupancy of facilities to be partially demolished.

B. Dust and Debris Control:

1. Prevent the spread of dust and debris and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.
2. Sweep pavements as often as necessary to control the spread of debris that may result in foreign object damage potential to vehicular traffic.

C. Traffic Control Signs: Where pedestrian and driver safety is endangered in the area of removal Work, use traffic barricades with flashing lights.

D. Existing Work:

1. Survey the site and examine Drawings and Specifications to determine the extent of the Work before beginning any demolition or renovation.
2. Take necessary precautions to avoid damage to existing items scheduled to remain in place, to be reused, or to remain the property of Owner; any Contractor-damaged items shall be repaired or replaced as directed by Engineer.
3. Provide temporary weather protection during interval between removal of existing exterior surfaces and installation of new to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
4. Ensure that structural elements are not overloaded as a result of or during performance of the Work. Responsibility for additional structural elements or increasing the strength of existing structural elements as may be required as a result of any Work performed under this Contract shall be that of the Contractor. Repairs, reinforcement, or structural replacement must have Engineer approval.
5. Do not overload pavements to remain.
E. Weather Protection: For portions of the building scheduled to remain, protect building interior and materials and equipment from weather at all times. Where removal of existing roofing is necessary to accomplish the Work, have materials and workmen ready to provide adequate and temporary covering of exposed areas so as to ensure effectiveness and to prevent loss.

F. Trees: Protect trees within the Site that might be damaged during demolition and are indicated to be left in place, by a 6-foot-high fence. The fence shall be securely erected a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Any tree designated to remain that is damaged during the Work shall be replaced in kind, as approved by the Engineer.

G. Facilities:

1. Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities.
2. Floors, roofs, walls, columns, pilasters, and other structural elements that are designed and constructed to stand without lateral support or shoring, and are determined by Contractor to be in stable condition, shall remain standing without additional bracing, shoring, or lateral support until demolished, unless directed otherwise by the Engineer.
3. Protect all facility elements not scheduled for demolition.
4. Provide interior shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished and adjacent facilities.

H. Protection of Personnel:

1. During demolition, continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site.
2. Provide temporary barricades and other forms of protection to protect Owner’s personnel and the general public from injury due to demolition Work.
3. Provide protective measures as required to provide free and safe passage of Owner’s personnel and the general public to occupied portions of the structure.

3.03 BURNING

A. The use of burning at the Site for the disposal of refuse and debris will not be permitted.
3.04 RELOCATIONS

A. Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Clean all items to be relocated prior to reinstallation, to the satisfaction of Engineer. Repair items to be relocated which are damaged or replace damaged items with new undamaged items as approved by Engineer.

3.05 BACKFILL

A. Do not use demolition debris as backfill material.

B. Fill excavations, open basements and other hazardous openings to existing ground level or foundation level of new construction in accordance with Section 31 23 23, Fill and Backfill.

3.06 TITLE TO MATERIALS

A. All salvaged equipment [A: and materials] will remain the property of Owner.

B. With the exception of the following listed salvaged equipment, all items designated to be removed shall become the property of Contractor:

1. [B: .]
2. [C: .]

C. Title to equipment and materials resulting from demolition is vested in the Contractor upon approval by Engineer of Contractor’s Demolition/Renovation Plan, and the resulting authorization by Engineer to begin demolition.

3.07 DISPOSITION OF MATERIAL

A. Do not remove equipment and materials without approval of Contractor’s Demolition/Renovation Plan by Engineer.

B. Salvage equipment [A: and material] to the maximum extent possible.

C. [A: Remove materials and equipment that are [B: indicated] [C: and] [D: specified] to be removed by Contractor and deliver to a storage site as directed [E: on the Site.] [F: within ___ miles of the Site.]]

D. [A: Remove salvaged items in a manner to prevent damage, and pack or crate to protect the items from damage while in storage or during shipment. Properly identify containers as to contents.]
E. [A: Repair or replace, at the discretion of Engineer, items damaged during removal or storage.]

F. [A: Remove salvaged items designated as the property of Owner in a manner to prevent damage [B: , and pack or crate to protect the items from damage while in storage or during shipment]. [C: Properly identify containers as to contents.]]

G. [A: Repair or replace, at the discretion of Engineer, items damaged during removal or storage.]

H. [A: Deliver salvaged items that are designated as the property of Owner to a storage site as directed [B: on the Site.] [C: within ___ miles of the Site.]]

I. Owner will not be responsible for the condition or loss of, or damage to, property scheduled to become Contractor’s property after Engineer’s authorization to begin demolition. Materials and equipment shall not be viewed by prospective purchasers or sold on the site.

J. Owner will not be responsible for the condition or loss of, or damage to, such property after Engineer’s authorization to begin demolition.

K. [A: Store salvaged items as approved by Engineer and remove them from Owner’s property before completion of the Contract. Materials and equipment shall not be either viewed by prospective purchasers or sold on the Site.]

3.08 REUSE OF MATERIALS AND EQUIPMENT

A. Remove and store materials and equipment listed in Article Title To Materials to be reused or relocated to prevent damage, and reinstall as the Work progresses.

B. Properly store and maintain equipment and materials in same condition as when removed.

C. Store equipment and material designated to be reused in a location designated by [A: Owner] [B: Engineer].

D. Equipment and material designated to be reused shall be cleaned, serviced and checked for proper operability before being put back into service.

E. Engineer will determine condition of equipment and materials prior to removal.
3.09 SPECIALIZED SALVAGE

A. Historical Items:
   1. Remove in a manner to prevent damage.
   2. The following historical items shall be delivered to Owner for disposition:
      a. [A: .]
      b. [B: .]

B. Ozone Depleting Substances (ODS):
   1. Class I and Class II ODS are defined in Section 602(a) and (b), of the Clean Air Act. Prevent discharge of Class I and Class II ODS to the atmosphere. Place recovered ODS in cylinders meeting AHRI Guideline K suitable for the type ODS (filled to no more than 80 percent capacity) and provide appropriate labeling.
   2. Dispose of all Class I and Class II ODS refrigerants in accordance with the Clean Air Act Amendment of 1990.
   3. Products, equipment and appliances containing ODS in a sealed, self-contained system (e.g., residential refrigerators and window air conditioners) shall be disposed of in accordance with 40 CFR 82.

C. Fire Suppression Containers: Fire suppression system cylinders and canisters with electrical charges or initiators shall be deactivated prior to shipment. Also, safety caps shall be used to cover exposed actuation mechanisms and discharge ports on these special cylinders.

3.10 UNSALVAGEABLE MATERIAL

A. Concrete, masonry, and other noncombustible material, except concrete permitted to remain in place, shall be disposed of in the following manner and location.
   1. [A: .]
   2. [B: .]

B. The fill in the disposal area shall remain below elevation [A: ] and after disposal is completed, the disposal area shall be uniformly graded to drain.

C. Combustible material shall be disposed of [A: in the sanitary fill area located [B: ]] [C: off the Site] [D: by burning] [E: ].

3.11 CLEANUP

A. Debris and rubbish shall be removed from basement and similar excavations. Debris and rubbish shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

END OF SECTION
PART 1 GENERAL

1.01 SCOPE OF SUPPLY

A. Coordinate with the Supplying Electric Utility (PSO) for the removal of all existing low-voltage services associated with the existing dam gate operation, pump house, and along the river’s railroad bridge and pedestrian crossing.

B. Electric services associated with the existing trail illumination are to remain. Relocation of these services as shown on Drawings.

1.02 SUBMITTALS

A. Informational Submittals:
   1. Schedule of demolition work.
   2. Copies of any authorizations and permits required to perform the Work.
   3. Coordination with the Supplying Electric Utility (PSO).

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 POLES

A. Do not remove ground wire or pole numbering attached to PSO-owned poles.

B. Remove only City-owned poles for service drops. Backfill, tamp, and mound holes, unless holes will be reused.

3.02 POLE-TOP ASSEMBLIES AND CONDUCTORS

A. Pole-top assemblies, including transformers, are the property of the Supplying Electric Utility, and are to remain.

B. Remove service-drops or service laterals and dispose of offsite.

END OF SECTION
SECTION 02 61 00  
REMOVAL AND DISPOSAL OF CONTAMINATED SOIL

PART 1  GENERAL

1.01 SUMMARY

A. This section describes the Work involved in removal, handling, testing, and disposal of hazardous and nonhazardous soil, debris, excavated waste, and wastewater if such material is encountered or generated during performance of the Work.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

   a. Title 29, Labor, Chapter XVII Occupational Safety and Health Administration (OSHA), Part 1910, Occupational Safety and Health Standards: Part 1910.120, Hazardous Waste Operations and Emergency Response.
   b. Title 40, Protection of Environment, Chapter I Environmental Protection Agency (EPA), Part 261, Identification and Listing of Hazardous Waste:
      1) Part 261.21, Characteristic of Ignitability.
      2) Part 261.22, Characteristic of Corrosivity.
      3) Part 261.23, Characteristic of Reactivity.
   2. [A: {insert appropriate state regulations}]
   4. Toxic Substances Control Act (TSCA).

1.03 DEFINITIONS

A. ACM: Asbestos-containing materials.

B. Excavated Waste: Buried solid waste, refuse, demolition waste, construction waste, and special waste as defined in the [A: ] [B: and] [C: ] regulations. Excavated waste does not include demolition debris, solid waste, refuse, construction waste, or special waste created by Contractor incidental to the Work.

C. Free Product: Free-standing petroleum or chemical liquid product present in excavation or floating on water in excavation.
D. Hazardous Soil and Debris: Material which qualifies as a hazardous or toxic waste as defined by the Resources Conservation and Recovery Act (RCRA) or the Toxic Substances Control Act (TSCA).

E. Nonhazardous Soil and Debris: Material which does not qualify as a hazardous or toxic waste as defined by RCRA or TSCA and includes excavated waste as defined above.

F. Wastewater: Water produced by Contractor’s operation, including groundwater removed, stormwater entering excavation pits despite controls, washdown water, used decontamination water, and other water that requires handling by Contractor to accomplish the Work. Wastewater may be hazardous or nonhazardous and shall require special handling and testing.

1.04 SUBMITTALS

A. Informational Submittals:

1. Prior to commencement of the Work submit the following:
   a. Permits and certification for soil, debris, and waste haulers.
   b. Permits, certification, and acceptance requirements for proposed soil, debris, and wastewater disposal or treatment facilities.
   c. Qualifications:
      1) [A: [B: Contractor] [C: Subcontractor] documentation of experience.]
      2) Contractor’s Personnel: Documentation personnel proposed for Work with contaminated materials have been 40-hour trained in accordance with 29 CFR 1910.120.
      3) [D: [E: Contractor’s] [F: Consultant’s] [G: Licensed Site Professional’s] [H: ] documentation of experience [I: and registration].]
      4) Waste Transporter: Documentation of licensing and equipment capabilities.
      5) Offsite Disposal and Treatment Facilities: Documentation of licensing, disposal requirements, and acceptance of waste.
   d. Soil and Debris Analytical and Physical Characterization Testing Plan within [J: 1] [K: ] week(s) after Notice to Proceed.
   e. Inspection reports, including photographs, and other items requested by Engineer.
   f. Excavation and Water Control Plan demonstrating controls for migration of water into active excavation areas.
   g. Site-specific Health and Safety Plan:
      1) In accordance with 29 CFR 1910.120.
2) Include Contractor-proposed monitoring, personnel protective gear, worker training and certifications, and emergency procedures.

3) State criteria or measures when air monitoring and work by HAZWOPER-trained personnel are no longer necessary.

h. Emergency Response Plan: Details how to handle an emergency during execution of the Work (for example, encountering drums with unknown contents; encountering pockets of hazardous atmospheres; response to spills caused by excavation of materials by Contractor or Contractor’s equipment; response to fire or injured personnel).

2. During excavation and removal activities submit the following:

a. Daily job progress log detailing information on review of progress with respect to previously established milestones and schedules, major problems, corrective actions, injury reports, equipment breakdown, and sampling results.

b. Weekly excavation plans.

c. Copies of manifests or bills of lading, and waste disposal or treatment facility receipts, including weight or volume tickets, for waste materials, solid or liquid, removed from Site and transported to disposal facilities.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. [A: Contractor] [B: Subcontractor]:

   a. Proven history of successfully executing similar projects for a minimum of [C: 3] [D: ] years.

   b. [E: Certifications or licenses if required by state or local authorities.]

   c. Proper equipment and personnel experienced in similar work.

      1) Personnel shall be formally trained in procedures for contaminated soil and water removal (for example, HAZWOPER training).

2. [F: [G: Contractor’s Consultant] [H: Licensed Site Professional] [I: ] [J: , Licensed in the State of ________:] shall have minimum of [K: 3] [L: ] years’ experience in planning, sampling, and performing quality control in remediation of contaminated sites.]

3. Waste Transporter: Licensed waste haulers with trucks equipped with containment and cover systems to transport solid and liquid waste materials on public streets and roads without spillage.

4. Offsite Disposal and Treatment Facilities: Proposed facilities shall be licensed to accept the various waste types and quantities to be generated during the Work.
B. Codes and Regulations:

1. Comply with federal, state, and local regulations in handling, testing, transporting, and disposing materials and in performing the Work.
2. Prior to commencing removal operations, obtain applicable local, state, and federal permits and licenses that directly impact Contractor’s ability to perform the Work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Plastic Sheeting:

2. Thickness: Minimum 10 mils.

B. [A: Tape and Glue: Capable of sealing joints of adjacent sheets of plastic and capable of adhering under wet conditions.]

C. Ballast: Sandbags or other ballast materials of sufficient weight and quantity to maintain polyethylene sheeting securely in place.

PART 3 EXECUTION

3.01 GENERAL

A. Contractor shall be responsible for the following:

1. Providing means, methods, and equipment necessary for sampling, excavating, collecting, handling, processing, loading, and disposing of hazardous and nonhazardous soil, debris, excavated waste, and wastewater generated as part of the Work.
2. Selecting, providing, and coordinating with qualified transporters, disposal facilities, and treatment facilities for transporting, disposing, and documenting hazardous and nonhazardous waste transportation and disposal in accordance with this specification.
3. Complying with federal, state, and local requirements for transporting solid and liquid materials from Site through applicable jurisdictions, and be responsible for associated fines, penalties, and other costs for noncompliance.
4. Obtaining and submitting acceptance letters and receipts for materials disposed at each facility.
5. Including provisions in its construction sequence and schedule for sampling, analysis, and review of sampling results.
B. **Excavation and Water Control Plan:**

1. **Plan shall include, but not be limited to, the following:**
   a. Means and sequencing of excavation.
   b. Proposed locations, layout, and controls for materials stockpile areas.
   c. Numbers and types of proposed equipment.
   d. Methods of handling, segregating, and stockpiling excavated materials.
   e. Methods of controlling water and sediment in excavation and proposed stockpile areas.
   f. Proposed locations, types, and capacities of temporary water storage facilities, if required.
   g. Sheeting, shoring, and bracing, as required.

C. **Soil and Debris Analytical and Physical Characterization Testing Plan:**

1. **Plan shall include, but not be limited to, the following:**
   a. Plan view showing proposed sample locations, depths, and number of samples for characterization and disposal facility acceptance testing, and for confirmatory testing, if required.
   b. Sampling and analysis of areas found to contain hazardous materials. Results shall be used to determine if material should be handled and disposed of as hazardous and to define extent of this material.
   c. Detail sampling and characterization of other materials excavated from Site.
   d. Testing requirements shall include chemical and physical analyses necessary to access the material’s environmental and geotechnical characteristics where appropriate.
   e. Sampling plan shall characterize materials, and conform to treatment and disposal facility acceptance requirements, if any.
   f. Proposed testing laboratory, analyses required, and testing methods.

D. **Provide qualified Licensed Site Professional** to oversee and supervise sampling, excavation, and waste handling operations at Site and to coordinate with proposed disposal and treatment facilities.

3.02 **WASTE CHARACTERIZATION SAMPLING AND ANALYSIS**

A. Prior to commencing **excavation,** perform onsite sampling and laboratory testing to screen Site for potential hazardous waste and to conform to acceptance criteria of proposed disposal or treatment facilities. Sampling and testing shall be done in accordance with
ZINK DAM IMPROVEMENTS

approved Soil and Debris Analytical and Physical Characterization Testing Plan.

B. Allow a minimum of [A: 4] [B: ] weeks in schedule for testing and review by disposal facility and Engineer.

C. Test for ignitability, corrosivity, and reactivity in accordance with 40 CFR 261.21, 40 CFR 261.22, and 40 CFR 261.23, if required by proposed treatment facility or disposal facility.

3.03 WASTE EXCAVATION

A. [A: Hazardous] [B: Nonhazardous] [C: Hazardous and nonhazardous] soil and debris may be encountered during excavation for facilities at Site. Material shall be removed, handled, and disposed in accordance with [D: ] [E: and] [F: ] environmental regulations.

B. Perform waste excavation in accordance with requirements of [A: Section 31 23 16, Excavation, unless otherwise specified in this section] [B: and] [C: approved Excavation and Water Control Plan].

C. Water control shall be provided in accordance with [A: Section 31 23 19.01, Dewatering] [B: and] [C: approved Excavation and Water Control Plan].

D. Sheeting, shoring, and bracing required to support excavation operations shall be provided in accordance with [A: Section 31 41 00, Shoring] [B: and] [C: approved Excavation and Water Control Plan].

E. Conduct Work in excavated area in accordance with Contractor’s Site-specific safety plan.

F. Excavate methodically and submit weekly excavation plans no later than Thursday of week preceding the Work.

G. Excavations shall proceed in lifts no greater than [A: 1] [B: ] foot thick. At Engineer’s request, excavate test pits no greater than [C: 4] [D: ] feet deep in advance of excavation for purpose of sampling and delineating material to be excavated.

H. Immediately stop excavation and notify Engineer upon encountering material unanticipated or outside scope of this Specification. This may include, but is not limited to, free product, tanks, ACM, or solid material other than excavated waste.
I. Overexcavation:

1. Excavate only amount of soil required to construct the Work shown on Drawings.
2. Overexcavation of additional hazardous soil/debris, solid waste, or soil beyond amount required for construction of foundation and subgrade preparation shall not be performed without written authorization by Engineer.
3. Overexcavation of hazardous soil/debris, solid waste, or soil that is not authorized by Engineer shall be disposed and replaced at Contractor’s own expense.

3.04 FREE PRODUCT REMOVAL

A. In the event that free product is encountered during excavation:

1. [A: Immediately notify Engineer to determine appropriate sampling, removal, and disposal requirements.]
2. Remove product in a manner that minimizes spread of contamination into previously uncontaminated zones by using containment recovery and storage system to contain and remove product.
3. Provide onsite storage suitable for recovered material.
4. Material shall remain onsite until Contractor completes a characterization analysis.
5. Material shall not be transported to a disposal facility until analysis is complete.

3.05 CONFIRMATORY SAMPLING AND BACKFILL

A. Upon completion of excavation, [A: Contractor shall] [B: Engineer will] take confirmation samples.

1. Confirmatory samples shall consist of:
   a. [C: ]

B. Do not perform activities such as backfill or installation of foundations in excavated area until confirmation sampling, inspections, or other confirmatory measures have been taken and approval has been given by Engineer to proceed with subsequent work.

C. Backfill, where required to complete the Work, shall be done in accordance with requirements of Section 31 23 23, Fill and Backfill. Other work in completed excavation shall be done in accordance with Drawings and applicable specification section.
3.06 WASTE HANDLING AND DISPOSAL

A. To extent possible, schedule and coordinate Work such that excavated waste and wastewater can be loaded and removed from Site with minimal handling or storage requirements.

B. [A: Where temporary storage or stockpiling is necessary, provide and maintain adequate containment and environmental controls, including but not limited to containers, dikes, linings, covers, erosion and sediment controls, and other measures of sufficient capacity to store materials without unauthorized release of contaminants into ground, air, or surface water.

1. Temporary Stockpile:
   a. Provide with perimeter dike at least 12 inches high and lined with plastic sheeting.
   b. Anchor plastic sheeting with sandbags or other approved ballast over stockpile(s) at end of working day.

2. Liquid Container Storage:
   a. Provide with perimeter dike and plastic lining.
   b. Volume of lined storage area shall be at least the volume of the largest container within the area plus a minimum of 1 foot of freeboard.

3. Seams for diked area linings shall be appropriately sealed to prevent release of contaminated materials or liquids within containment area.

4. Cover systems shall be lapped or sealed as required to prevent leakage of rainwater into stockpiled materials.

5. Inspect containment areas daily, or after each rainfall event, and remove standing water.]

C. [A: No waste stockpile or storage areas are available at Site. Schedule operations in a manner such that excavated materials and wastewater shall be removed immediately from Site to approved disposal facility or treatment facility.]

D. Provide labor, equipment, and materials to stabilize or process waste materials as necessary to meet minimum requirements for offsite transport and disposal.

E. Transportation:

1. Provide sealed or lined vehicles and other measures necessary to prevent spillage or tracking of waste materials, mud, or other debris on local streets or roads.

2. Inspect and document vehicles and containers for proper operation and covering.
3. Inspect vehicles and containers for proper markings, manifests, and other requirements for waste shipment.
4. Perform and document decontamination procedures prior to leaving Site and again before leaving disposal or treatment facility.
5. Obtain and submit receipts of confirmation from disposal or treatment facilities that solid and liquid wastes were accepted for disposal or treatment, including weight tickets or other confirmation of quantities received.

3.07 EQUIPMENT DECONTAMINATION

A. Decontaminate equipment that has come into contact with hazardous soil or debris, solid waste, or impacted water by methods approved by Engineer.

B. Wastewater and sediment generated by decontamination activities shall be contained and treated or disposed of in accordance with provisions stated in this section.

END OF SECTION
SECTION 03 01 32
REPAIR OF VERTICAL AND OVERHEAD CONCRETE SURFACES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 301, Specifications for Structural Concrete.
   b. 506.2, Specification for Shotcrete.

2. ASTM International (ASTM):
   a. A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   c. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   d. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   e. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   f. C78/C78M, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
   n. C882/C882M, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
1.02 DEFINITIONS

A. Abrasive Blasting: Surface preparation method that uses compressed air intermixed with an abrasive medium to clean surface of substrate concrete, exposed steel, and steel reinforcement. Compressed air and abrasive medium is projected at high speed through a nozzle directly at the surface. Method is used to remove corrosion by-products, laitance, or other materials that may inhibit bond of repair concrete.

B. Defective Area: As defined in Section 03 30 00, Cast-in-Place Concrete.

C. High-Pressure Water Blasting: Sometimes referred to as hydro-demolition. Uses water that may contain an abrasive medium, projected under high pressure and high velocity. Used for demolition, cutting, partial or full depth removal, cleaning, scarifying, or roughening of concrete surfaces, or removing existing coatings, for preparation of substrate concrete surfaces.

D. Low-Pressure Spray Mortar: Mortar suitable to be applied by low-pressure spraying, and in small areas may be applied by hand troweling.

E. New Concrete: As defined in Section 03 30 00, Cast-in-Place Concrete.

F. Rebound: Shotcrete material, mostly aggregates, that bounce off a surface against which shotcrete was projected.

G. Shotcrete: Mortar pumped through hose and projected at high velocity.

1.03 SUBMITTALS

A. Action Submittals:

1. Product data sheets for each material supplied.
2. Drawings supplemented by photographs indicating location, size, estimated quantity, and proposed repair mortar for each repair location in existing concrete.

3. Drawings indicating results of sounding for hollow areas, including location, size, and estimated quantity of hollow-sounding areas for each repair location.

B. Informational Submittals:

1. Repair Mortar System: Manufacturer’s preparation and installation instructions.

2. Written description of equipment proposed for concrete removal and surface preparation.

3. Certificates:
   a. Shotcrete Nozzleman: Current ACI Certification for each proposed nozzleman.
   b. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that proposed repair mortar systems are prepackaged, shrinkage compensated, specially designed for use on vertical and overhead surfaces that are exposed to weather.
   c. Mortar Manufacturer’s Certificate of Proper Installation.

4. Statements of Qualification:
   a. Repair mortar system applicator.
   b. Repair mortar system manufacturer’s representative.

5. Field and laboratory test reports.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Repair Mortar System Applicator: For Repair System A – Shotcrete Mortar, trained and experienced applicator recognized or certified by repair mortar system manufacturer.

2. Repair Mortar System Manufacturer’s Representative: Knowledgeable and experienced on technical data and application requirements for specified products.

B. Prerepair Conference:

1. Required Meeting Attendees:
   a. Contractor.
   b. Repair Subcontractor.
   c. Engineer.

2. Schedule and conduct prior to conducting mockups and incorporation of respective products into Project. Notify Engineer of location and time.
3. Agenda shall include, but not limited to:
   a. Review of field conditions. Conduct field observations of Work to be performed.
   b. Based on above observations, confirm material selection and make Project-specific repair method recommendations.
   c. Technical representative for repair material manufacturer shall review proposed surface preparation, material application, consolidation, finishing, curing, and protection of repair material from weather conditions.
   d. Other specified requirements requiring coordination.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package repair mortar system products in moisture-resistant bags, pails, or moisture-resistant bulk bags.

B. Deliver, store, and handle repair materials in accordance with manufacturer’s printed instructions.

PART 2 PRODUCTS

2.01 REPAIR SYSTEM A – SHOTCRETE MORTAR

A. Mortar Materials:
   1. Blend of selected portland cements, microsilica, and specially graded aggregates and fibers applicable for vertical and overhead surfaces.
   2. Materials shall not contain asbestos, chlorides, nitrates, added gypsum, added lime, or high aluminum cements.
   3. Noncombustible before and after cure.
   4. Furnish in factory proportioned unit.
   5. Workability from 1/4 inch in depth and greater.

B. Mixed Mortar Properties:
   1. Working Time: 5 minutes to 10 minutes.
   2. Finishing Time: 10 minutes to 20 minutes.
   3. Color: Dark gray.

C. Cured Mortar Properties:
   1. Compressive strength for 2-inch cubes in accordance with ASTM C109/C109M, or 3-inch cubes in accordance with manufacturer’s modification to ASTM C109/C109M:
      a. 7 Days: 6,000 psi minimum.
      b. 28 Days: 7,000 psi minimum.
2. Flexural Strength (Modulus of Rupture), ASTM C78/C78M or ASTM C348 (Modified) at 28 Days: 1,100 psi minimum.
5. Mortar shall not produce a vapor barrier.

D. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco S 211SP.
2. Sika Corp., Lyndhurst, NJ; SIKACEM 103F.
3. Euclid Chemical Co., Cleveland, OH; Eucoshot F.

2.02 REPAIR SYSTEM B – LOW-PRESSURE SPRAY MORTAR

A. One or two-component, cement based, fiber reinforced, shrinkage compensated, gray in color, with a minimum 30-minute working time.

B. Cured materials mixed in accordance with manufacturer’s instructions shall conform to the following criteria:

2. Flexural Strength, ASTM C348 at 28 Days: 1,100 psi minimum.
3. Slant Shear Bond Strength, ASTM C882/C882M Test Method Modified with No Bonding Agent, at 28 Days: 3,000 psi minimum.
5. Drying Shrinkage, ASTM C157/C157M Modified at 28 Days or ASTM C531: 0.1 percent maximum.
6. Chloride Ion Permeability Based on Charge Passed, ASTM C1202: 1,000 coulombs maximum.
7. System shall not produce a vapor barrier.
8. Sprayable, extremely low permeability, sulfate resistant, easy to use and requiring only addition of water.

C. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco S 488CI.
2. Sika Corp., Lyndhurst, NJ; SikaRepair 224.
3. Euclid Chemical Co., Cleveland, OH; Tamms Structural Mortar.
2.03  REPAIR SYSTEM C – POLYMER-MODIFIED REPAIR MORTAR

A. Polymer-modified, one- or two-component, cementitious based, chloride resistant, flowable, gray in color, working time of 20 minutes minimum, surface renovation mortar.

B. Cured Mortar Properties:

2. Flexural Strength, ASTM C348 at 28 Days: 1,200 psi minimum.
3. Slant Shear Bond Strength, ASTM C882/C882M Test Method Modified with No Bonding Agent at 28 Days: 2,000 psi minimum.
5. Drying Shrinkage, ASTM C596 at 28 Days: 0.12 percent maximum. Not required for small repair areas approximately 1 square foot in area or less.
6. Freeze Thaw Resistance, ASTM C666/C666M, at 300 Cycles: 90 percent RDM.
7. Chloride Ion Permeability Based on Charge Passed, ASTM C1202: 800 coulombs maximum for liquid holding and belowgrade repairs.

C. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco N 300CI.
2. Sika Corp., Lyndhurst, NJ; SikaTop 123 PLUS.
3. Euclid Chemical Co., Cleveland, OH; DuralTop Gel.

2.04  WATER

A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards, as specified in Section 03 30 00, Cast-in-Place Concrete.

2.05  REINFORCEMENT

A. Deformed Steel Reinforcement:

1. Per Section 03 21 00, Steel Reinforcement.
2. ASTM A615/A615M, Grade 60, where welding is not required.
3. ASTM A706/A706M, Grade 60, for steel reinforcement to be welded.

B. Tie Wire: 16-gauge, galvanized.
2.06 EVAPORATION RETARDANT
   A. As specified in Section 03 39 00, Concrete Curing.

2.07 CURING COMPOUND
   A. As specified in Section 03 39 00, Concrete Curing.

PART 3 EXECUTION

3.01 GENERAL
   A. New Concrete Work: Repair deficiencies in new concrete structures constructed under this Contract with applicable repair system. Refer to Section 03 30 00, Cast-in-Place Concrete.

3.02 APPLICATION
   A. General:
      1. Repair System A: Large areas and number of repair areas.
      2. Repair System B: Medium to large areas and number of repair areas.
      3. Repair System C: Small and limited areas and number of repair areas.

3.03 PREPARATION
   A. Identify unsound and deteriorated concrete by sounding techniques, or as directed by Engineer, and review proposed extent of repair with Engineer.
   B. Remove unsound, honeycombed, deteriorated, or otherwise defective areas of concrete from work areas.
      1. Use 8,000 psi minimum high-pressure water or abrasive blasting machine as required for Site conditions.
      2. Remove concrete to abrade substrate concrete surfaces to a minimum amplitude roughness of 3/16 inch measured between high and low points with a 3-foot-long straightedge, in accordance with ASTM D4259.
      3. Where final surface is required to be flush with existing adjacent surface remove existing concrete depth as required for application of minimum thickness of repair mortar.
   C. Do not use power-driven jackhammers, chipping hammers, or scabblers unless water blasting is not permitted or practical because of Site conditions, or may cause other damage to equipment or facilities. In such cases where chipping hammers are required, limit size of chipping hammer to 16 pounds.
or lighter, or use small electric chipping hammer, to reduce formation of micro-fractures in substrate concrete surface.

D. Following removal of unsound or deteriorated concrete, check substrate concrete surface by sounding techniques to identify unsound concrete remaining or resulting from use of chipping hammer.

E. Remove unsound concrete to satisfaction of Engineer.

F. Square edges of patch areas by sawing or chipping to avoid tapered shoulders or featheredges. Avoid cutting embedded steel reinforcement. Roughen polished saw-cut edge by high-pressure water blasting or abrasive blasting.

G. Remove concrete adjacent to steel reinforcement to a minimum of 1-inch clearance around steel reinforcement for application and bonding of new repair mortar to circumference of exposed steel reinforcement if one or more of the following surface conditions exist:

1. 50 percent or more of circumference around steel reinforcement is exposed during concrete removal.
2. 25 percent or more of circumference around steel reinforcement is exposed during concrete removal and corrosion is present to extent that more than 25 percent loss of section has occurred.
3. Otherwise evident that bond between existing concrete and steel reinforcement has been destroyed or has deteriorated as determined by Engineer.

H. Clean exposed steel reinforcement of loose rust and concrete splatter per recommendations of repair material manufacturer and in accordance with ASTM D4258.

I. Keep areas from which concrete has been removed free of dirt, dust, and water blasting waste slurry. Remove laitance and other bond inhibiting contaminates from prepared areas.

J. Dampen repair areas at least 6 inches beyond area to receive repair mortar for at least 24 hours to provide saturated surface dry (SSD) condition without standing water at time of application of mortar as required by and in accordance with repair mortar manufacturer’s printed instructions.

K. Collect and dispose of spent water and concrete debris from removal operations offsite in manner and location acceptable to Owner.
3.04 PROTECTION

A. Protect adjacent surfaces, and equipment, from being damaged by overshooting, rebound, and dust, as applicable for repair mortar system used, from shotcrete mortar or low-pressure spray mortar.

3.05 REPAIR SYSTEM A – SHOTCRETE MORTAR PLACEMENT

A. Apply shotcrete mortar in accordance with manufacturer’s instructions.

B. Do not reuse rebound materials.

C. Apply mortar using dry mix process, in accordance with ACI 506.2.

D. Shotcrete mortar shall emerge from nozzle in a steady, uninterrupted flow. If flow becomes intermittent, direct flow away from the Work until flow of mortar becomes constant.

E. Applied Shotcrete Mortar: Minimum thickness of 1-1/2 inches to 2 inches of cover over existing reinforcement, or to level of surrounding concrete surface, whichever results in thicker coat.

F. Nozzle Position: Hold nozzle approximately at right angles to and at a distance from surface in accordance with shotcrete repair mortar system manufacturer’s instructions for type of application, nozzle, and air pressure used.

G. Steel Reinforcement Encasement:
   1. Modify procedure of shooting shotcrete mortar to better direct material around reinforcement bars.
   2. Prevent shotcrete mortar from building up on reinforcement steel when shooting on, around, through, and behind steel to eliminate voids.
   3. Provide dense void-free encasement of reinforcement steel.

H. Shotcreting More than One Layer: In accordance with shotcrete repair mortar system manufacturer’s printed instructions.

I. Apply finish to exposed shotcrete mortar surface to match existing surface. Steel trowel finish when finish coat is not applied.

J. Rebound Removal: Continuously throughout shotcrete mortar application, remove rebound, sand, and miscellaneous debris, and dispose offsite at an approved disposal facility.

K. Cure as specified in Article Curing.
3.06  REPAIR SYSTEM B – LOW-PRESSURE SPRAY MORTAR PLACEMENT

A. Mix mortar in accordance with manufacturer’s printed instructions.

B. After priming prepared substrate concrete surface per manufacturer’s recommendations, apply mortar by low-pressure spraying equipment, unless noted otherwise.

C. Bonding Agent:
   1. Use bonding agent when manufacture required for hand applied areas, in accordance with repair mortar manufacturer’s instructions.
   2. Application of repair mortar over bonding agent shall be completed within time frame recommended by bonding agent manufacturer.
   3. Consult with manufacturer for optimum and minimum acceptable degrees of surface tackiness of coat.

D. Work mortar firmly and quickly into repair area.

E. Finish repair mortar to match adjacent concrete surface.

F. Cure as specified in Article Curing.

3.07  REPAIR SYSTEM C – POLYMER-MODIFIED REPAIR MORTAR PLACEMENT

A. Mix mortar in accordance with manufacturer’s printed instructions.

B. Bond Coat: Apply to prepared substrate concrete surface before application of mortar in accordance with repair mortar manufacturer’s printed instructions. Do not apply more bond coat than can be covered with mortar before bond coat dries. Do not retemper bond coat.

C. Place mortar by hand or low-pressure spray and trowel to specified surface finish, in accordance with requirements of repair material’s printed instructions.

D. Finish repair mortar to match adjacent concrete surface.

E. Cure as specified in Article Curing, and in accordance with manufacturer’s printed instructions.

3.08  CURING

A. Prior to curing, apply water fog to repair mortar system in accordance with repair mortar system manufacturer’s printed instructions.
B. Cure in accordance with repair mortar manufacturer’s printed instructions.

C. Where permitted by repair mortar manufacturer’s printed instructions, commence watercuring after repair mortar system application and when curing will not cause erosion of mortar.

D. Continuously water fog cure repair mortar system for a period of 7 days.

E. Do not cure using curing compound or membrane, unless method is part of repair mortar system manufacturer’s printed instructions and approval is obtained from Engineer.

F. Cure intermediate layers of repair mortar in accordance with repair mortar manufacturer’s printed instructions.

G. Where curing compound is permitted by repair mortar system manufacturer, apply curing compound in accordance with Section 03 39 00, Concrete Curing.

3.09 FIELD QUALITY CONTROL

A. Sounding for Hollow Areas:
   1. Light hammer tap repaired areas listening for hollow sound to determine areas that have not properly bonded to substrate concrete.
   2. Mark hollow areas for removal and replacement.

B. Compression Strength Test:
   1. Test in accordance with ASTM C109/C109M, except modified by making samples using repair mortar.
   2. Obtain production samples of mixed wet mortar materials from nozzle, or mixer, during construction for compliance with Specifications for testing at 7 days, and 28 days.
   3. Provide a minimum of three samples for each 1,000 square feet of mortar repair, and a minimum of three samples in total, whichever is greater, for testing.
   4. Record location where repair mortar is being applied at time production samples are obtained.

C. Direct Tension Bond Test:
   1. In Situ Bond Testing: Perform tension bond test in accordance with ASTM C1583/C1583M.
   2. Record locations on in situ bond tests on each type of applied repair mortar.
D. Testing laboratory retained by Owner will provide the following:

1. Compression Strength Test:
   a. Testing will follow a “modified” ASTM C109/C109M.
   b. A minimum of three production samples of mixed material will be obtained from each 1,000 square feet of mortar repair, and a minimum of three samples in total, whichever is greater, for testing at 7 days, and 28 days.
   c. Record location where repair mortar is being applied at time production samples are obtained.

2. Direct Tension Bond Test:
   a. Two core samples will be obtained and tested for each 2,000 square feet of repair work.
   b. Cores will be 2-1/2-inch or 3-inch diameter to a total depth equal to at least 2.5 times repair mortar thickness.
   c. Bond Strength of Repair Mortar to Substrate Concrete: 300 psi minimum in direct tension without failure or movement.
   d. Record locations of Bond Tests on each type of applied repair mortar tested.

E. Retest mortar repairs that do not meet test requirements.

F. Repair and fill holes using same repair mortar where core samples have been removed.

3.10 MORTAR REPAIR FAILED TEST

A. Remove and replace unacceptable Work.

B. Hollow Sounding Areas: Saw cut hollow sounding areas to a new square edge. Remove unsound mortar repair. Prepare substrate surface and reapply repair mortar as specified herein above.

C. Failed Compression Strength Test: Remove affected areas of repair mortar represented by failed compression strength test results. Prepare substrate surface and reapply repair mortar as specified herein above.

D. Failed Bond Tests: Remove affected areas of repair mortar represented by failed bond test results. Prepare substrate surface and reapply repair mortar as specified herein above.

E. Retest areas where repair mortar was removed and replaced, in accordance with test requirements specified herein above.
3.11 CLEANING

A. Remove overshot repair mortar and rebound materials as the Work proceeds. Remove waste materials, unsound material from concrete surfaces, material chipped from structure, and water used in preparation of or repair areas, finishing, and curing, and dispose offsite at an approved disposal site.

END OF SECTION
PART 1   GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): T277, Standard Method of Test for Electrical Indication of Concrete’s Ability to Resist Chloride Ion Penetration.

2. ASTM International (ASTM):
   a. A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   c. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   d. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   e. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   f. C78/C78M, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
   n. C882/C882M, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
1.02 DEFINITIONS

A. Abrasive Blasting: Surface preparation method that uses compressed air intermixed with an abrasive medium to clean surface of substrate concrete, exposed steel, and steel reinforcement. Compressed air and abrasive medium is projected at high speed through a nozzle directly at the surface. Method is used to remove corrosion by-products, laitance, or other materials that may inhibit bond of repair concrete.

B. Defective Area: As defined in Section 03 30 00, Cast-in-Place Concrete.

C. High-Pressure Water Blasting (sometimes referred to as hydro-demolition): Uses water that may contain an abrasive medium, projected under high pressure and high velocity. Used for demolition, cutting, partial or full depth removal, cleaning, scarifying, or roughening of concrete surfaces, or removing existing coatings, for preparation of substrate concrete surfaces.

D. New Concrete: As defined in Section 03 30 00, Cast-in-Place Concrete.

1.03 SUBMITTALS

A. Action Submittals:

   1. Product data sheets for each material supplied.
   2. Drawings supplemented by photographs indicating location, size, estimated quantity, and proposed repair mortar system for each repair location in existing concrete.
3. Drawings indicating results of sounding for hollow areas including location, size, estimated quantity, of hollow-sounding areas for each repair location.

B. Informational Submittals:

1. Repair Mortar System: Manufacturer’s preparation and installation instructions.
2. Written description of equipment proposed for concrete removal and surface preparation.
3. Certificates:
   a. Manufacturer’s Certificate of Compliance in accordance with Section 01 61 00, Common Product Requirements, that proposed repair mortar systems meet requirements of ASTM C928/C928M.
   b. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that repair mortar systems are prepackaged, shrinkage compensated, specially designed for use on horizontal surfaces that are exposed to weather.
   c. Mortar Manufacturer’s Certificate of Proper Installation.
4. Statements of Qualification: Repair mortar system applicator.
5. Field and laboratory test results.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Repair Mortar System Applicator: Trained and experienced applicator endorsed by repair mortar system manufacturer.

B. Prerepair Conference:

1. Required Meeting Attendees:
   a. Contractor.
   b. Repair Subcontractor.
   c. Engineer.
2. Schedule and conduct prior to incorporation of respective products into Project. Notify Engineer of location and time.
3. Agenda shall include, but not limited to:
   a. Review of field conditions. Conduct field observations of the Work to be performed.
   b. Based on above observations, confirm material selection and make Project-specific repair method recommendations.
c. Review proposed surface preparation, material application, consolidation, finishing, curing, and protection of repair material from weather conditions.

d. Other specified requirements requiring coordination.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package repair mortar system products in moisture-resistant bags, pails, or moisture-resistant bulk bags.

B. Deliver, store, and handle repair materials in accordance with manufacturer’s printed instructions.

PART 2 PRODUCTS

2.01 REPAIR MORTAR SYSTEM NO. 3—SHRINKAGE COMPENSATED REPAIR MORTAR

A. One or two-component cement-based, flowable, shrinkage compensated repair mortar system.

B. Compressive Strength, ASTM C109/C109M:

1. 1 Day: 2,500 psi minimum.
2. 7 Days: 6,000 psi minimum.
3. 28 Days: 8,000 psi minimum.

C. Flexural Strength, ASTM C348 at 28 Days: 770 psi minimum.

D. Modulus of Elasticity, ASTM C469 at 28 Days: 5.9 by 10^6 psi minimum.

E. Slant Shear Bond Strength, ASTM C882/C882M Modified:

1. 7 Days: 2,150 psi minimum.
2. 28 Days: 3,000 psi minimum.

F. Freeze-thaw Resistance, ASTM C666/C666M, Procedure A, at 300 Cycles: 97.0 percent RDM.

G. Chloride Ion Permeability Based on Charge Passed, ASTM C1202 at 28 Days: 650 coulombs maximum.

H. Sulfate Resistance, ASTM C1012/C1012M after 6 Months: 0.01 percent length change maximum.
I. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco S 466 CI.
2. Euclid Chemical Co., Cleveland, OH; Eucocrete Supreme.

2.02 REPAIR MORTAR SYSTEM NO. 5—POLYMER MODIFIED REPAIR MORTAR

A. One or two-component, fast-setting, polymer modified cementitious based repair mortar system.

B. Compressive Strength, ASTM C109/C109M:

1. 1 Day: 2,500 psi minimum.
2. 7 Days: 5,000 psi minimum.
3. 28 Days: 7,000 psi minimum.

C. Flexural Strength, ASTM C348 at 28 Days: 1,500 psi minimum.

D. Slant Shear Bond Strength, ASTM C882/C882M Modified at 28 Days: 2,000 psi minimum.

E. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 600 psi minimum.

F. Abrasion Resistance Depth of Wear, ASTM C779/C779M, Procedure A, at 60 Minutes: 0.033 inch maximum.

G. Drying Shrinkage, ASTM C157/C157M Modified, at 28 Days: 0.09 percent maximum.

H. Rapid Chloride Ion Permeability Based on Charge Passed, ASTM C1202; 28 Days: Under 850 coulombs maximum.

I. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco T 310 CI.
2. Euclid Chemical Co., Cleveland, OH; Duraltop Flowable Mortar.

2.03 WATER

A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards, as specified in Section 03 30 00, Cast-in-Place Concrete.
ZINK DAM IMPROVEMENTS

2.04 REINFORCEMENT

A. Deformed Steel Reinforcement:
   1. Per Section 03 21 00, Steel Reinforcement.
   2. ASTM A615/A615M, Grade 60, where welding is not required.
   3. ASTM A706/A706M, Grade 60, for steel reinforcement to be welded.

B. Tie Wire: 16-gauge, galvanized.

2.05 EPOXY BONDING AGENT

A. Two-component, moisture insensitive, 100 percent solids epoxy resin.

B. Tensile Strength, ASTM D638, at 14 Days: 4,400 psi minimum.

C. Elongation at Break, ASTM D638: 1.49 percent minimum.

D. Compressive Strength, ASTM D695, at 28 Days for Application Temperature of 73 Degrees F to 77 Degrees F: 8,000 psi minimum.

E. Bond Strength, ASTM C882/C882M, at 14 Days: 1,800 psi minimum.

F. Pot Life, at 73 Degrees F to 77 Degrees F: 75 minutes minimum.

G. Manufacturer and Product: BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco ADH 326 when ambient temperature is 73 degrees F or higher.

2.06 EVAPORATION RETARDANT

A. As specified in Section 03 39 00, Concrete Curing.

2.07 CURING COMPOUND

A. As specified in Section 03 39 00, Concrete Curing.

PART 3 EXECUTION

3.01 GENERAL

A. New Concrete Work: Repair deficiencies in new concrete structures constructed under this Contract with applicable repair system.
3.02 APPLICATION

A. General:
   1. Repair Mortar System No. 1: Not used.
   2. Repair Mortar System No. 2: Not used.
   3. Repair Mortar System No. 3: Patches, joints, or overlays 1 inch thick or greater. Return to service in 7 days or more.
   4. Repair Mortar System No. 4: Not used.
   5. Repair Mortar System No. 5:
      a. Patches and Overlays: 1/4 inch to 3 inches thick.
      b. Return to service for foot traffic in 4 hours; wheel traffic in 7 days.
      c. Working Time: 30 minutes at 70 degrees F.
      d. Application Temperature Range: 45 degrees F to 90 degrees F.

3.03 PREPARATION

A. Identify unsound and deteriorated concrete by sounding techniques, or as directed by Engineer. Review proposed extent of repair with Engineer.

B. Remove unsound, deteriorated, or otherwise defective areas of concrete from Work areas.
   1. Use 8,000 psi minimum high-pressure water or abrasive blasting machine, as appropriate to suit Site conditions.
   2. Remove concrete to abrade substrate concrete surface to a minimum amplitude roughness of 3/16 inch measured between high and low points with a 3-foot-long straightedge, in accordance with ASTM D4259.
   3. Where final surface is required to be flush with existing adjacent surface, remove existing concrete depth as required for application of minimum thickness of repair mortar.

C. Do not use power-driven jackhammers, chipping hammers, scabblers, or scarifiers unless water blasting is not permitted or practical because of Site conditions, or may cause other damage to equipment or facilities. In such cases where chipping hammers are required, limit size of chipping hammer to 16 pounds or lighter, or use small electric chipping hammer, to reduce formation of micro-fractures in substrate concrete surface.

D. Following removal of unsound or deteriorated concrete, check substrate concrete surface by sounding techniques to identify unsound concrete remaining or resulting from use of chipping hammer.

E. Remove unsound concrete to satisfaction of Engineer.
F. Square edges of patch areas by sawing or chipping to avoid tapered shoulders or featheredges. Avoid cutting embedded steel reinforcement. Roughen polished saw-cut edge by high-pressure water blasting or abrasive blasting.

G. Remove concrete adjacent to steel reinforcement to a minimum of 1-inch clearance around steel reinforcement for application and bonding of new repair mortar to entire circumference of exposed steel reinforcement if one or more of the following surface conditions exist:

1. 50 percent or more of circumference around steel reinforcement is exposed during concrete removal.
2. 25 percent or more of circumference around steel reinforcement is exposed during concrete removal and corrosion is present to extent that more than 25 percent loss of section has occurred.
3. Otherwise evident that bond between existing concrete and steel reinforcement has been destroyed or has deteriorated as determined by Engineer.

H. Clean exposed steel reinforcement of loose rust and concrete splatter per recommendations of repair material manufacturer and in accordance with ASTM D4258.

I. Keep areas from which concrete has been removed free of dirt, dust, and water blasting waste slurry. Remove laitance and other bond inhibiting contaminates from prepared areas.

J. Preparation of Substrate Concrete Surface in Areas to Receive Repair Mortar System: Dampen repair areas at least 6 inches beyond area to receive repair mortar for at least 24 hours to provide saturated surface dry (SSD) condition without standing water at time of application of mortar, as required by and in accordance with repair mortar manufacturer’s printed instructions.

K. Spalled Joints:

1. Saw cut edge 1 inch deep and 6 inches back from old joint.
2. Remove unsound concrete and concrete between saw cut and joint.
3. Place wood or fiber spacer to thickness of joint at joint line.

L. Overlays:

1. Square cut edges to a minimum of 1/4 inch deep.
2. Do not feather edge area.
3. Perform special preparation recommended by mortar manufacturer.

M. Collect and dispose of spent water and concrete debris from removal operations offsite in manner and location acceptable to Owner.
3.04 PROTECTION

A. Protect adjacent surfaces, and equipment from spillage of repair mortar and dust, as applicable for repair mortar system used.

3.05 PLACEMENT

A. Repair Mortar System:

1. Remove standing and free water from prepared area.
2. Apply bond scrub coat of mortar to prepared surface in accordance with manufacturer’s instructions. Do not apply more scrub coat of mortar than can be covered with repair mortar before scrub coat begins drying.
3. Immediately place mixed repair mortar into prepared area from one side to the other side.
4. Work material firmly into bottom and sides of patch to ensure a good continuous bond.
5. Level repair mortar and screed to elevation of existing concrete.
6. Finish to same texture as existing concrete around patch.
7. Repair Mortar System No. 5 screed or use self-leveling mixture to obtain a uniform and plane surface.

B. Joint Repair:

1. Remove joint spacer when repair mortar is hard enough that a pointed trowel will penetrate surface less than 1/2 inch.
2. When repair mortar is cured and ready for use, fill joint in accordance with repair mortar system manufacturer’s instructions.

3.06 CURING

A. Repair Mortar System: Apply curing compound in accordance with Section 03 39 00, Concrete Curing.

3.07 FIELD QUALITY CONTROL

A. Sounding for Hollow Areas:

1. Chain drag or light hammer tap repaired areas listening for hollow sound to determine areas that have not properly bonded to substrate concrete.
2. Mark hollow areas for removal and replacement.
B. Compression Strength Test:
   1. Test in accordance with ASTM C109/C109M, except modified by making samples using repair mortar.
   2. Obtain production samples of mixed materials from mixer during construction for compliance with Specifications.
   3. Provide minimum of three samples for each 200 square feet of mortar repair, and a minimum of three samples in total, whichever is greater for testing.
   4. Record location where repair mortar is being applied at time production samples are obtained.

C. Direct Tension Bond Test:
   1. In Situ Bond Testing: Perform tension bond test in accordance with ASTM C1583/C1583M.
   2. Record locations on in situ bond tests on each type of applied repair mortar.

D. Testing laboratory retained by Owner will provide the following:
   1. Compression Strength Test:
      a. Testing will follow a “modified” ASTM C109/C109M.
      b. A minimum of three production samples of mixed material will be obtained from each 200 square feet of mortar repair, and a minimum of three samples in total, whichever is greater, for testing at 7 days, and 28 days. Record location where repair mortar is being applied at time production samples are obtained.
   2. Direct Tension Bond Test:
      a. Two core samples will be obtained and tested for each 2,000 square feet of repair work.
      b. Cores will be 2-1/2-inch or 3-inch diameter to a total depth equal to at least 2.5 times repair mortar thickness.
      c. Bond Strength of Repair Mortar to Substrate Concrete: 300 psi minimum in direct tension without failure or movement.
      d. Record locations of bond tests on each type of applied repair mortar tested.

E. Retest mortar repairs that do not meet test requirements.

F. Repair and fill holes using same repair mortar where core samples have been removed.
3.08 MORTAR REPAIR FAILED TEST

A. Remove and replace unacceptable Work.

B. Hollow Sounding Areas: Saw cut hollow sounding areas to a new square edge, remove unsound mortar repair. Prepare substrate surface and reapply repair mortar as specified herein above.

C. Failed Compression Strength Test: Remove affected areas of repair mortar represented by failed compression strength test results. Prepare substrate surface and reapply repair mortar as specified herein above.

D. Failed Bond Tests: Remove affected areas of repair mortar represented by failed bond test results. Prepare substrate surface and reapply repair mortar as specified herein above.

E. Retest areas where repair mortar was removed and replaced, in accordance with test requirements specified herein above.

3.09 CLEANING

A. Remove excess repair mortar materials as the Work proceeds. Remove waste materials, unsound material from concrete surfaces, material chipped from structure, and water used in preparation of repair areas, finishing, and curing, and dispose offsite at approved disposal site.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 117, Specification for Tolerances for Concrete Construction and Materials.
   a. 350, Code Requirements for Environmental Engineering Concrete Structures.
   b. 350.5, Specifications for Environmental Concrete Structures.

1.02 DEFINITIONS

A. Architectural Concrete: See definition in Section 03 30 00, Cast-in-Place Concrete.

B. Defective Areas: See definition in Section 03 30 00, Cast-in-Place Concrete.

C. Exposed Concrete: See definition in Section 03 30 00, Cast-in-Place Concrete.

1.03 DESIGN REQUIREMENTS

A. Design formwork in accordance with ACI 350 and ACI 350.5 to provide concrete finishes specified in Section 03 30 00, Cast-in-Place Concrete.

B. Unless otherwise specified, limit deflection of facing materials for concrete surfaces to comply with ACI 350.5. Limit deflection of facing materials to comply with tolerance limits established by Contract Documents and with tolerances required by equipment manufacturers. Coordinate tolerance requirements with equipment manufacturers.

C. Form liner and concrete mixtures shall be compatible. Coordinate compatibility between form liner manufacturer and concrete producer.

1.04 SUBMITTALS

A. Action Submittals:

   1. Shop Drawings:
      a. Formwork drawings signed and sealed by a licensed professional engineer in the state of the Project.
2. Product Data:
   a. Form release agent.
   b. Form ties.
   c. Products to be used for sealing tie holes.

B. Informational Submittals: Statement of qualifications for formwork designer.

1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Formwork Designer: Formwork, falsework, and shoring design shall be designed by an engineer licensed in the state of Project.

PART 2 PRODUCTS

2.01 FORM MATERIALS

A. Wall Forms and Underside of Slabs and Beams:
   1. Materials: Plywood, hard plastic finished plywood, overlaid waterproof particle board, or steel in “new and undamaged” condition, of sufficient strength and surface smoothness to produce specified finish.
   2. Where steel forms are used, treat steel surfaces to prevent rusting using products approved for use on steel forms.

B. Column Forms:
   1. Rectangular Columns: As specified for walls.
   2. Circular Columns: Fabricated steel or fiber-reinforced plastic with bolted sections or spirally wound laminated fiber form. Internally treat with release agent for full height of column.

C. Sandblasted Surface Forms: Medium-density overlay plywood for flat concrete surfaces to be sandblasted.

D. Painted Surface Forms: High-density overlay plywood for flat concrete surfaces to be painted.

E. All Other Forms: Materials as specified for wall forms.

2.02 ACCESSORIES

A. Form Release Agent:
   1. Material:
      a. Shall not bond with, stain, or adversely affect concrete surfaces.
b. Shall not impair subsequent treatments of concrete surfaces when applied to forms.

c. Ready-to-use water-based material formulated to reduce or eliminate surface imperfections.

d. Contain no mineral oil or organic solvents.

2. Manufacturers and Products: Not for surfaces exposed to potable water.

a. BASF, Shakopee, MN; MBT MasterFinish RL 211.

b. Cresset Chemical Company; Crete-Lease 20-VOC-Xtra.

B. Rustication Grooves and Beveled Edge Corner Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.

C. Form Snap-Ties:

1. Material: Steel.

2. Spreader Inserts:

   a. Conical or spherical type.

   b. Design to maintain positive contact with forming material.

   c. Furnish units that will leave no metal closer than 1.5 inches to concrete surface when forms, inserts, and tie ends are removed.

3. Wire ties not permitted.

4. Flat bar ties for panel forms; furnish plastic or rubber inserts with minimum 1.5-inch depth and sufficient dimensions to permit patching of tie hole.

D. Form Snap-Ties with Water Stop:

1. For water-holding structures, basements, pipe galleries, and accessible spaces below finish grade, furnish one of the following:

   a. Integral steel waterstop 0.103-inch thick and 0.625-inch diameter tightly and continuously welded to tie.

   b. Neoprene water stop 3/16-inch thick and 15/16-inch diameter whose center hole is one-half diameter of tie, or molded plastic water stop of comparable size.

   c. Orient waterstop perpendicular to tie and symmetrical about center of tie.

   d. Design ties to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along tie.

E. Through-Bolts:

1. At Contractor’s option, may be used as alternate to form snap-tie or form snap-tie with water stop.

2. Tapered minimum 1-inch diameter at smallest end.
PART 3 EXECUTION

3.01 FORM SURFACE PREPARATION

A. Prior to coating surface, thoroughly clean form surfaces that will be in contact with concrete or that have been in contact with previously cast concrete, dirt, and other surface contaminants.

B. Exposed Wood Forms in Contact with Concrete: Apply form release agent as recommended by manufacturer.

C. Steel Forms: Apply form release agent as soon as they are cleaned to prevent discoloration of concrete from rust.

3.02 ERECTION

A. General: In accordance with ACI 301, unless otherwise specified.

B. Beveled Edges (Chamfer):
   1. Form 3/4-inch bevels at concrete edges, unless otherwise shown.
   2. Where beveled edges on existing adjacent structures are other than 3/4 inch, obtain Engineer’s approval of size prior to placement of beveled edge.

C. Wall Forms:
   1. Do not reuse forms with damaged surfaces.
   2. Locate form ties and joints in uninterrupted uniform pattern.
   3. Inspect form surfaces prior to installation to ensure conformance with specified tolerances.

D. Curb, Sidewalk, and Driveway Forms:
   1. Provide standard steel or wood forms.
   2. Set forms to true lines and grades, and securely stake in position.

E. Form Tolerances:
   1. Provide forms in accordance with ACI 117 and ACI 318, and the following tolerances for finishes specified:
      a. See the Schedule of Concrete Finishes in Section 03 30 00, Cast-in-Place Concrete, for beam, column, and wall types related to required form tolerances.
      b. Wall Tolerances:
         1) Straight Vertical or Horizontal Wall Surface: Flat planes within tolerance specified.
2) Wall Type W-A:
   a) Plumb within 1/4 inch in 10 feet or within 1 inch from top to bottom for walls over 40 feet high.
   b) Depressions in Wall Surface: Maximum 5/16 inch when 10-foot straightedge is placed on high points in all directions.
3) Wall Type W-B:
   a) Plumb within 1/8 inch in 10 feet or within 1/2 inch from top to bottom for walls over 40 feet high.
   b) Depressions in Wall Surface: Maximum 1/8 inch when 10-foot straightedge is placed on high points in all directions.
4) Thickness: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
5) Form Offset: Between adjacent pieces of formwork, facing material shall not exceed 1/4 inch.

   c. Beams and Columns Tolerances:
      1) Exposed Straight Horizontal and Vertical Surfaces: Flat planes within tolerances specified.
      2) Lateral Alignment:
         a) Centerlines shall be within plus or minus 1/2 inch from dimensions shown.
         b) At intersections, centerlines shall intersect within plus or minus 1/2 inch of dimensions shown.
      3) Beam Type B-A:
         a) Physical Dimensions: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
         b) Elevations: Within plus or minus 1/2 inch, except where tops of beams become part of finished slab. In this case, refer to slab tolerances.
      4) Column Type C-A:
         a) Physical Dimensions: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
         b) Plumb within 1/4 inch in 10 feet in all directions with maximum 1/2 inch out-of-plumb at top with respect to bottom.

3.03 FORM REMOVAL

   A. Nonsupporting forms, sides of beams, walls, columns, and similar parts of Work, may be removed after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:

      1. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
2. Curing and protection operations are maintained.

B. Elevated Structural Slabs or Beams: In accordance with ACI 318, Chapter 6, and at such time as concrete has reached compressive strength equal to 80 percent of specified 28-day compressive strength as determined by test cylinders.

C. Form Ties: Remove conical inserts or through bolts and plug holes as specified in Section 03 30 00, Cast-in-Place Concrete.

3.04 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

B. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   b. A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   c. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   d. A767/A767M, Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
   g. D227, Specification for Coal-Tar Saturated Organic Felt Used in Roofing and Waterproofing.
   h. D994, Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
   i. D1056, Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
   k. D1751, Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
   l. D1752, Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

2. Corps of Engineers (COE): CRD-C-572, Corps of Engineers Specifications for Polyvinylchloride Waterstop.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Waterstop: Details of splices, method of securing and supporting waterstop in forms to maintain proper orientation and location during concrete placement.
   b. Construction Joints, Expansion Joints, and Control Joints: Layout and location for each type. Include joints locations shown on Drawings, additional required joint locations and any proposed alternate locations.

2. Product Data:
   a. Waterstops.
   b. Bond breaker.
   c. Premolded joint fillers.
   d. Pourable joint fillers.
   e. Preformed control joints.
   f. Roofing felt.
   g. Accessories not specified in other sections.

3. Samples: PVC waterstop splice, joint, and fabricated cross of each size, shape, and fitting of waterstop.

B. Informational Submittals:

1. Certification:
   a. Letter stating compatibility between liquids being contained and materials used for:
      1) Waterstops.
      2) Joint fillers.
   b. Manufacturer’s application instructions for:
      1) Bonding agent.
      2) Bond breaker.

2. Manufacturer’s written instructions for product shipment, storage, handling, installation/application, and repair for:
   a. Waterstops.
   b. Bond breaker.
   c. Bonding agent.
   d. Premolded joint fillers.
   e. Pourable joint fillers (sealant proportions not required as products used only as a filler).
   f. Preformed control joints.
1.03 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site: Verify delivered materials are in accordance with Specifications, regulatory agencies, and Manufacturer’s product data sheets prior to unloading and storing onsite.

B. Storage: Store materials under tarps to protect from oil, dirt, and sunlight or as required by Manufacturer.

PART 2 PRODUCTS

2.01 PLASTIC WATERSTOP

A. Extruded from elastomeric plastic compound of which basic resin shall be prime virgin polyvinyl chloride (PVC). Compound shall not contain scrapped material, reclaimed material, or pigment.

B. Specific Gravity: Approximately 1.37.

C. Shore Durometer Type A Hardness: Approximately 80.


E. Type Required in All Expansion, Contraction, and Control Joints: 6 inches wide or 9 inches wide with center bulb and parallel longitudinal ribs or protrusions on each side of strip center, as indicated on Drawings.

F. Type Required in Construction Joints: Flat ribbed, 6 inches wide or 9 inches wide with parallel longitudinal ribs or protrusions on each side of strip center. Center bulb is optional.

G. Corrugated or tapered type waterstops are not acceptable.

H. Thickness: Constant from bulb edge (or center of waterstop) to outside stop edge.

I. Minimum Weight per Foot of Waterstop:

1. 0.50 pound for 3/16 inch by 4 inches.
2. 1.60 pounds for 3/8 inch by 6 inches.
3. 2.30 pounds for 3/8 inch by 9 inches.

J. Factory Fabrications: Use only factory fabrications for intersections, transitions, and changes of direction.
K. Manufacturers and Products for Center Bulb Type:

1. Use same manufacturers for flat ribbed profile:
   a. Vinylex Corp., St Louis, MO; No. RB638H (6 inches by 3/8 inch) and No. RB938H (9 inches by 3/8 inch).
   b. Greenstreak, St. Louis, MO; Style No. 702 (4 inches by 3/16 inch), Style 732 (6 inches by 3/8 inch), and Style 735 (9 inches by 3/8 inch).
   c. Durajoint, Garretsville, OH; Type 3 (4 inches by 3/16 inch), Type 9 (6 inches by 3/8 inch), and Type 10 (9 inches by 3/8 inch).
   d. BoMetals, Carrollton, GA: No. RCB-4316LB (4 inches by 3/16 inch), No. RCB-638LB (6 inches by 3/8 inch), and No. RCB-938NT (9 inches by 3/8 inch).
   e. Dacon Plastics LLC, Jacksonville, TX; No. RCB11 (4 inches by 3/16 inch), No. RCB17 (6 inches by 3/8 inch), and No. RCB18 (9 inches by 3/8 inch).

2.02 WIRE LOOSED PLASTIC WATERSTOP

A. Furnish as alternative to plastic waterstops.

B. Same material and geometry as plastic waterstops.

C. Furnish with continuous galvanized wire looping at edge for convenience in positioning and securing stop in place in forms.

D. Manufacturer and Product: Paul Murphy Plastics, Roseville, MI; “Wire Stop Waterstop”; geometry numbers ACR 6380, ACR 9380, as shown on Paul Murphy Plastics Co. Drawing No. CCP-120-12M.

2.03 HYDROPHILIC WATERSTOP

A. For use at construction joints only, where new concrete is placed against existing concrete and as shown on Drawings.

B. Material shall be a nonbentonite hydrophilic rubber compound.

C. Manufacturers and Products:

1. Greenstreak Plastic Products, St. Louis, MO; Hydrotite CJ-1020-2K with Leakmaster LV-1 adhesive and sealant.
2.04 INJECTION-TYPE WATERSTOP

A. Reinjectable waterstop hose system for use where shown on Drawings.

B. Reinjectable Water Stop Hose:
   1. Fabricated of polyvinyl chloride (PVC) compound.
   2. Contain discharge openings to allow for disbursement of an injection material into expansion joint.
      a. Discharge openings designed to be sealed tight during concreting operation to prevent entry of mixing water and cement slurry.
   3. Allows free and uniform discharge of injection material over entire length of hose during injection process.
   4. Able to be internally cleaned by using water and vacuum pressure.

C. Injection Material: Hydrophilic or hydrophobic resin grout for use in expansion joints as recommended by reinjectable waterstop hose manufacturer.

D. Manufacturers and Products:
   1. Greenstreak/BBZ, St. Louis, MO; Fuko Injection Hose System with Multigel 850.
   2. Deneef Construction Chemicals, Inc., Houston, TX; TRIOject Injection Hose System with Hydro Active Grout.

2.05 BOND BREAKER

A. Tape for Joints: Adhesive-backed glazed butyl or polyethylene tape. Same width as joint that will adhere to premolded joint material or concrete surface.

B. Use bond prevention material as specified in Section 03 30 00, Cast-in-Place Concrete, except where bond breaker tape is specifically called for on Drawings.

2.06 PREMOLDED JOINT FILLER

A. Bituminous Type: ASTM D994 or ASTM D1751.

B. Sponge Rubber:
   1. Neoprene, closed-cell, expanded; ASTM D1056, Type 2C5, with compression deflection, 25 percent deflection (limits), 119 kPa to 168 kPa (17 psi to 24 psi) minimum. Use in joints for potable and nonpotable water containment structures.

2.07 BUILDING PREFORMED CONTROL JOINT

A. One-Piece, Flexible, Polyvinyl Chloride Joint Former:

B. One-Piece Galvanized Steel Strip with Preformed Groove:
   1. Manufacturer and Product: BoMetals, Inc., Carrollton, GA; QuickKey or ProKey Joint.

C. Furnish in full-length, unspliced pieces.

2.08 POURABLE JOINT FILLERS

A. General: Although product is a sealant, it is being specified as a filler to prevent debris accumulation and allow expansion and contraction under shrinkage and thermal loads. It does not need to meet proportional sealant geometry requirements.

B. Filler for Potable or Nonpotable Water Containment Structures:
   1. Multicomponent sealant, self-leveling or nonsag as required for level, sloping, or vertical joints.
   3. Manufacturer and Product: Sika Corp., Lyndhurst, NJ; Sikaflex-2c SL.

C. Filler for Nonpotable Water Containment Structures Only:
   1. Pourable, two-component, cold-applied compound meeting ASTM C920, Type M, Grade P, Class 25, Use T.
   2. Color: Black.

2.09 ACCESSORIES

A. Joint Sealant: Polyurethane as specified in Section 07 92 00, Joint Sealants.

B. Roofing Felt: ASTM D226, Type II, 30-pound asphalt-saturated or equal weight of ASTM D227 coal-tar saturated felt.

C. Steel Reinforcement: As specified in Section 03 21 00, Steel Reinforcement.
D. Nails: Galvanized, as required for securing premolded joint filler.

E. Galvanized Rebar at Control Joints: ASTM A767/A767M and ASTM A615/A615M Grade 60 prior to galvanizing.

F. Ties for PVC Waterstop: “Hog Rings” or grommets for each edge at 12-inch maximum spacing.

**PART 3 EXECUTION**

3.01 GENERAL

A. Commence concrete placement after joint preparation is complete.

B. Time Between Concrete Pours: As specified in Section 03 30 00, Cast-in-Place Concrete.

3.02 SURFACE PREPARATION

A. Construction Joints: Prior to placement of abutting concrete, clean contact surface.

1. Remove laitance and spillage from steel reinforcement and dowels.
2. Roughen surface to minimum of 1/4-inch amplitude:
   a. Sandblast after concrete has fully cured.
   b. Water blast after concrete has partially cured.
   c. Green cut fresh concrete with high-pressure water and hand tools.
3. Perform cleaning so as not to damage waterstop, if one is present.

B. Contraction Joint and Control Joint:

1. Coat concrete surfaces above and below plastic waterstop with bond breaker.
2. Do not damage or coat waterstop.

C. Construction Joint with Hydrophilic Waterstop:

1. Follow hydrophilic waterstop manufacturer’s written instructions.
2. Clean debris, dirt, dust, and foreign material from concrete surface. Concrete surface must be smooth, clean, and dry. Grind concrete as required.
3.03 INSTALLATION OF WATERSTOPS

A. General:

1. Continuous waterstop shall be installed in all construction joints in walls and slabs of water holding basins and channels and in walls of belowgrade structures, unless specifically noted otherwise.
2. Join waterstop at intersections to provide continuous seal.
3. Center waterstop on joint.
5. Repair or replace damaged waterstop.
6. Place concrete and vibrate to obtain impervious concrete in vicinity of joints.
7. Joints in Footings and Slabs:
   a. Ensure that space beneath horizontal waterstop is completely filled with concrete.
   b. During concrete placement, make visual inspection of waterstop area.
   c. Limit concrete placement to elevation of waterstop in first pass, vibrate concrete under waterstop, lift ribbed waterstop to confirm full consolidation without voids, then place remaining concrete to full height of slab.

B. Plastic Waterstops:

1. Install in accordance with manufacturer’s written instructions.
2. Splice in accordance with waterstop manufacturer’s written instructions using Teflon-coated thermostatically controlled heating iron at approximately 380 degrees F.
   a. Allow at least 10 minutes before new splice is pulled or strained in any way.
   b. Finished splices shall provide cross section that is dense and free of porosity with tensile strength of not less than 80 percent of unspliced materials.
   c. Use only factory made waterstop fabrications for all intersections, changes of directions and transitions.
   d. Field splice permitted only for straight butt welds.
3. Wire looped plastic waterstop may be substituted for plastic waterstop.
C. Hydrophilic Waterstop:

1. Install in accordance with manufacturer’s written instructions.
2. Provide minimum of 2-1/2 inches of concrete cover over waterstop. When structure has two layers of steel reinforcement, locate centered between layers of steel or as shown.
3. Apply adhesive to concrete surface and allow to dry for specified time before applying waterstop strip.
4. Lap ends of waterstop strip together at splices and corners and join with sealant.
5. Verify that waterstop is anchored firmly in place before placing concrete. Do not allow vibrator to come into contact with waterstop.
6. Lap hydrophilic waterstop 2 feet minimum with intersecting plastic waterstops.

D. Injection-Type Waterstop:

1. Install reinjectable waterstop hose in accordance with manufacturer’s instructions.
2. After concrete has been placed and cured for a minimum of 28 days, inject specified injection material into reinjectable waterstop hose in accordance with manufacturer’s instructions.
3. Upon completion of injection process, clean out remaining injection material in hose in accordance with manufacturer’s instructions to allow for future injections.

3.04 CONTRACTION JOINT INSTALLATION

A. Place bond breaker above and below waterstop.

B. Vibrate concrete thoroughly along the joint form to produce a dense, smooth surface. Do not roughen surface.

3.05 CONTROL JOINT INSTALLATION

A. Locate galvanized steel reinforcement as shown.

B. Install waterstop.

C. Vibrate concrete thoroughly along the joint form to produce a dense, smooth surface. Do not roughen surface.

D. Install bond breaker to concrete surfaces above and below waterstop.
3.06 PREFORMED CONTROL JOINTS

A. Use only where specifically shown; do not use in water-holding basins.

B. Locate slightly below top of slab.

C. Install in accordance with manufacturer’s written instructions in straight, full-length pieces.

D. Steel Strip Type with Preformed Groove: Brace to withstand pressure of concrete during and after placement using only approved stakes and other secondary installation materials.

3.07 MANUFACTURER’S SERVICES

A. Provide manufacturer’s representative at Site for installation assistance, inspection, and certification of proper installation for products specified.

3.08 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

B. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

END OF SECTION
PART 1   GENERAL

1.01   GENERAL

   A. Steel reinforcement shall comply with ACI 301 and as modified in the following.

1.02   REFERENCES

   A. The following is a list of standards which may be referenced in this section:

   1. American Concrete Institute (ACI):
      a. 117, Specification for Tolerances for Concrete Construction and Materials.
      b. 301, Specifications for Structural Concrete.


   3. ASTM International (ASTM):
      b. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
      e. A1064/A1064M, Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

   4. Concrete Reinforcing Steel Institute (CRSI):
      a. Placing Reinforcing Bars.


1.03   SUBMITTALS

   A. Action Submittals:

      1. Shop Drawings prepared in accordance with ACI 301 and ACI SP-66:
         a. Bending lists.
         b. Placing drawings.
2. Welded, metallic sleeve splice, and mechanical threaded connection.

B. Informational Submittals:

1. Lab test reports for steel reinforcement showing stress-strain curves and ultimate strengths.
2. Mechanical Threaded Connections:
   a. Current ICC Evaluation Services Report or equivalent code agency report listing findings to include acceptance, special inspection requirements, and restrictions.
   b. Verification device threads have been tested and meet requirements for thread quality, in accordance with manufacturer’s published methods.
   c. Manufacturer’s instructions.
3. Welding Qualification: Prior to welding, submit welder qualifications and nondestructive testing procedures in accordance with Section 05 05 23, Welding.
4. Test results of field testing.

1.04 QUALITY ASSURANCE

A. Welder Qualifications: Certified in accordance with AWS D1.4/D1.4M.

1.05 DELIVERY, STORAGE, AND HANDLING

A. In accordance with ACI 301 and recommendations of CRSI Placing Reinforcing Bars.

PART 2 PRODUCTS

2.01 MATERIALS

A. Reinforcing Bars:

1. Includes stirrups, ties, and spirals.
2. ASTM A615/A615M, Grade 60, where welding is not required.
3. ASTM A706/A706M, Grade 60, for reinforcing to be welded.
4. ASTM A767/767M, Grade 60, for galvanized bars.

B. Mechanical Splices and Connections:

1. Metal Sleeve Splice:
   a. Furnish with cast filler metal, capable of developing, in tension or compression, 125 percent of minimum tensile strength of bar.
   b. Manufacturer and Product: Erico Products, Inc., Cleveland, OH; Cadweld T-Series.
2. Mechanical Threaded Connections:
   a. Furnish metal coupling sleeve with internal threads engaging threads of bars developing in tension or compression 125 percent of yield strength of bar.
   b. Manufacturers and Products:
      1) Erico Products, Inc., Cleveland, OH; Lenton Reinforcing Steel Couplers.
      2) Erico Products, Inc., Cleveland, OH; Lenton Lock Mechanical Rebar Splicing System.
      3) Richmond Screw Anchor Co., Inc., Fort Worth, TX; Richmond DB-SAE Dowel Bar Splicers.

C. Welded Wire Fabric:
   1. ASTM A1064, using wire of 75 ksi minimum tensile strength.
   2. Furnish flat sheets only, rolled sheets not permitted.

2.02 ACCESSORIES

A. Tie Wire:
   1. Black, soft-annealed 16-gauge wire.
   2. Nylon-, epoxy-, or plastic-coated wire.

B. Bar Supports and Spacers:
   1. Use precast concrete bar supports or all-plastic bar supports and side form spacers, unless noted otherwise. Do not use other types of supports or spacers.
   2. Bar supports shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports.
   3. Use only precast concrete bar supports where concrete surfaces are exposed to weather, earth, water, chloride intrusion, or corrosive chemicals. Bar supports shall be nonconductive and have geometry and bond characteristics that deter movement of moisture from the surface to the reinforcement.
   4. Precast concrete supports shall have same minimum strength and shall be made from same materials as that of the concrete in which they are to be embedded. Precast concrete supports shall be cast and properly cured for at least 7 days before use and shall have a wire or other device cast into each block for the purpose of attaching them securely to steel reinforcement.
5. In Beams, Columns, Walls, and Slabs Exposed to View after Form Removal: Use small precast concrete blocks made of same color as concrete in which they are embedded. All-plastic bar supports and side form spacers may be used, except where surface is exposed as described above.

6. Design and fabricate special bar supports for top reinforcing bars in slabs where standard bar supports do not possess necessary geometry, strength, or stiffness.

7. Plastic Bar Supports: Manufactured by Aztec Concrete Accessories, Bloomington, CA.

8. Precast Concrete Supports:
   a. Total bond precast, high-performance concrete bar supports as supplied by:
      1) Dayton Superior, Miamisburg, OH, Dobies.

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Engineer when reinforcing is ready for inspection and allow sufficient time for inspection prior to placing concrete.

B. Clean reinforcing bars of loose mill scale, oil, earth, and other contaminants.

3.02 INSTALLATION

A. Bundle or space bars, instead of field bending where construction access through reinforcing is necessary.

B. Splicing:

   1. Minimum length of lap splices shall comply with table in Contract Documents.
   2. Use lap splices, unless otherwise shown or permitted in writing by Engineer.
   3. Welded Splices: Accomplish by full penetration groove welds and develop a minimum of 125 percent of yield strength of bar.
   4. Stagger splices in adjacent bars where indicated.

C. Mechanical Splices and Connections:

   1. Use only in areas specifically approved in writing by Engineer.
   2. Install threaded rods as recommended by manufacturer with threads totally engaged into coupling sleeve and in accordance with ICC Evaluation Services Report or equivalent code agency report.
3. For metal sleeve splice, follow manufacturer’s installation recommendations.
4. Maintain minimum edge distance and concrete cover.

D. Tying Reinforcing Bars:
   1. Tie every other intersection on mats made up of Nos. 3, 4, 5, and 6 bars to hold them firmly at required spacing.
   2. Bend tie wire away from concrete surface to provide clearance of 1 inch from surface of concrete to tie wire.

E. Reinforcement Around Openings: On each side and above and below pipe or opening, place an equivalent area of steel bars to replace steel bars cut for opening. Extend steel reinforcing a standard lap length beyond opening at each end.

F. Welding Reinforcement:
   1. Only ASTM A706/A706M bars may be welded.
   2. Do not perform welding until welder qualifications are approved.

G. Straightening and Rebending: Field bending of steel reinforcement bars is not permitted.

H. Unless permitted by Engineer, do not cut reinforcing bars in field.

3.03 WELDED WIRE FABRIC INSTALLATION

A. Use only where specifically shown.

B. Extend fabric to within 2 inches of edges of slab and lap splices at least 1-1/2 courses of fabric or minimum 8 inches.

C. Tie laps and splices securely at ends and at least every 24 inches with tie wire.

D. Place welded wire fabric on concrete blocks and rigidly support equal to that provided for reinforced bars. Do not use broken concrete, brick, or stone.

E. Do not use fabric that has been rolled. Install flat sheets only.
3.04 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

B. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

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

PART 1   GENERAL

1.01   REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 117, Specification for Tolerances for Concrete Construction and Materials.
   b. 301, Specifications for Structural Concrete.
   c. 305.1, Specification for Hot Weather Concreting.
   e. 350.1, Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures.
   f. CP-1, Technical Workbook for ACI Certification of Concrete Field Testing Technician – Grade 1.

2. ASTM International (ASTM):
   j. C231/C231M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
n. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
s. C1017/C1017M, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
t. C1074, Standard Practice for Estimating Concrete Strength by the Maturity Method.
y. C1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
aa. C1582/C1582M, Standard Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete.
cc. D4580, Standard Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding.
e. E1155, Standard Test Method for Determining Ft Floor Flatness and Fl Floor Levelness Numbers.
3. National Ready Mixed Concrete Association (NRMCA).
1.02 DEFINITIONS

A. Architectural Concrete: Concrete indicated as such in Contract Documents. Requires specified care in selection of concrete materials, forming, placing, and finishing in order to obtain desired architectural appearance.

B. Basin Train: Series of interconnected basins that operate as a unit with same water level.

C. Cold Weather: When ambient temperature is below 40 degrees F or is approaching 40 degrees F and falling.

D. Contractor’s Licensed Design Engineer: Individual representing Contractor who is licensed to practice engineering as defined by statutory requirements of professional licensing laws in state or jurisdiction in which Project is to be constructed.

E. Defective Area: Surface defects that include honeycomb, rock pockets, indentations, and surface voids greater than 3/16-inch deep, surface voids greater than 3/4 inch in diameter, cracks in liquid containment structures and below grade habitable spaces that are 0.005-inch wide and wider, and cracks in other structures that are 0.010-inch wide and wider, spalls, chips, embedded debris, sand streaks, mortar leakage from form joints, deviations in formed surface that exceed specified tolerances and include but are not limited to fins, form pop-outs, and other projections. At exposed concrete, defective areas also include texture irregularities, stains, and other color variations that cannot be removed by cleaning.

F. Exposed Concrete: Concrete surface that can be seen inside or outside of structure regardless of whether concrete is above water, dry at all times, or can be seen when structure is drained.

G. Hot Weather: As defined in ACI 305.1.

H. Hydraulic Structure: Liquid containment structure.

I. New Concrete: Less than 60 days old.

J. Slurry Mixture: Mixture of sand, 3/8-inch maximum nominal aggregate size, cement, and water for wall construction joints with waterstop.
1.03 SUBMITTALS

A. Action Submittals:

1. Mix Designs:
   a. Contain proportions of materials and admixtures to be used on Project, signed by mix designer.
   b. Documentation of average strength for each proposed mix design in accordance with ACI 301.
   c. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for the following:
      1) Portland cement.
      2) Fly ash.
      3) Slag cement.
      4) Silica Fume.
      5) Aggregates, including specified class designation for coarse aggregate.
      6) Admixtures.
      7) Concrete producer has verified compatibility of constituent materials in design mix.
   d. Test Reports:
      1) Cement: Chemical analysis report.
      2) Supplementary Cementitious Materials: Chemical analysis report and report of other specified test analyses.
      3) Water-Soluble Chloride-Ion Content in Hardened Concrete: Unless otherwise permitted, in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.
   e. Aggregates:
      1) Coarse Aggregate Gradation: List gradings and percent passing through each sieve.
      2) Fine Aggregate Gradation: List gradings and percent passing through each sieve.
      3) Deleterious substances in fine aggregate per ASTM C33/C33M, Table 2.
      4) Deleterious substances in coarse aggregate per ASTM C33/C33M, Table 4.
      5) Test Reports:
         a) Alkali Aggregate Reactivity: Aggregate shall be classified as nonpotentially reactive in accordance with Article Concrete Mix Design. Include documentation of test results per applicable standards.
f. Admixtures: Manufacturer’s catalog cut sheets and product data sheets for each admixture used in proposed mix designs.
3. Detailed plan for curing and protection of concrete placed and cured in cold weather. Details shall include, but not be limited to, the following:
   a. Procedures for protecting subgrade from frost and accumulation of ice or snow on reinforcement, other metallic embeds, and forms prior to placement.
   b. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
   c. Methods for temperature protection during placement.
   d. Types of covering, insulation, housing, or heating to be provided.
   e. Curing methods to be used during and following protection period.
   f. Use of strength accelerating admixtures.
   g. Methods for verification of in-place strength.
   h. Procedures for measuring and recording concrete temperatures.
   i. Procedures for preventing drying during dry, windy conditions.
4. Detailed plan for hot weather placements, including curing and protection for concrete placed in ambient temperatures over 80 degrees F. Plan shall include, but not be limited to, the following:
   a. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
   b. Use of retarding admixture.
   c. Methods for controlling temperature of reinforcement and other embedded items and concrete materials before and during placement.
   d. Types of shading and wind protection to be provided.
   e. Curing methods, including use of evaporation retardant.
   f. Procedures for measuring and recording concrete temperatures.
   g. Procedures for preventing drying during dry, windy conditions.
5. Thermal Control Plan: For concrete sections with a minimum specified dimension that is greater than 2 feet 6 inches.

B. Informational Submittals:

1. Preinstallation Conference minutes.
2. Manufacturer’s application instructions for bonding agent and bond breaker.
4. Statement of Qualification:
   a. Batch Plant: Certification as specified herein.
   b. Mix designer.
   c. Installer.
   d. Testing agency.
5. Field test reports.
6. Recorded temperature data from concrete placement where specified.
7. Concrete Delivery Tickets:
   a. For each batch of concrete before unloading at Site.
   b. In accordance with ASTM C94/C94M, including requirements 14.2.1 through 14.2.10.
   c. Indicate amount of mixing water withheld and maximum amount that may be permitted to be added at Site.

1.04 QUALITY ASSURANCE

A. Concrete construction shall conform to requirements of ACI 117 and ACI 301, except as modified herein.

B. Qualifications:

1. Batch Plant: NRMCA Program for Certification of Ready-Mixed Concrete Production Facilities or approved equivalent program.
2. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level 2 or DOT certified mix designer in jurisdiction of the Work. Requirement may be waived if individual is Contractor’s Licensed Design Engineer.
3. Testing Agency: Unless otherwise permitted, an independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
   a. Where field testing is required of Contractor, personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
   b. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

C. Thermal Control Plan:

1. When required, shall include the following minimum requirements:
   a. Calculated or measured adiabatic temperature rise of concrete.
   b. Upper limit for concrete temperature at time of placement.
c. Description of specific measures and equipment that will be used to ensure maximum temperature in placement will not exceed specified maximum temperature limit.
d. Calculated maximum temperature in placement based on expected conditions at time of placement and use of proposed measures to control temperatures.
e. Description of specific measures and equipment that will be used to ensure temperature difference will not exceed specified temperature difference limit.
f. Calculated maximum temperature difference in placement based on expected conditions at time of placement and use of proposed measures to control temperature differences.
g. Description of equipment and procedures that will be used to monitor and log temperatures and temperature differences.
h. Drawing showing locations for temperature sensors in placement.
i. Description of format and frequency of providing temperature data to Engineer.
j. Description of measures to address and reduce excessive temperatures and temperature differences, if they occur.
k. Description of curing procedures, including materials and methods, and curing duration.
l. Description of formwork removal procedures to ensure temperature difference at temporarily exposed surface will not exceed temperature difference limit, and how curing will be maintained.
m. Alternate temperature limits when permitted by Engineer.
   1) Determination of alternate temperature limits shall be based on detailed thermal and crack analyses.
   2) Analyses shall be stamped by Contractor’s Licensed Design Engineer.
n. If concrete design mixture is changed, thermal control plan must be updated.

D. Preinstallation Conference:

1. Required Meeting Attendees:
   a. Contractor, including pumping, placing and finishing, and curing subcontractors.
   b. Ready-mix producer.
   c. Admixture representative.
   d. Testing and sampling personnel.
   e. Engineer who authored Statement of Special Inspection Plan or Engineer’s designee.
2. Schedule and conduct prior to incorporation of respective products into Project. Notify Engineer of location and time.

3. Agenda shall include:
   a. Admixture types, dosage, performance, and redosing at Site.
   b. Mix designs, test of mixes, and Submittals.
   c. Placement methods, techniques, equipment, consolidation, and form pressures.
   d. Slump and placement time to maintain slump.
   e. Finish, curing, and water retention.
   f. Thermal control plan.
   g. Protection procedures for weather conditions.
   h. Other specified requirements requiring coordination.

4. Conference minutes as specified in Section 01 31 19, Project Meetings.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cementitious Materials:

1. Cement:
   a. Portland Cement: Unless otherwise specified, conform to requirements of ASTM C150/C150M.
   b. Blended Hydraulic Cement:
      1) Unless otherwise specified, conform to requirements of ASTM C595/C595M.
      2) Portland cement used in blended hydraulic cement, conform to requirements of ASTM C150/C150M.
   c. Furnish from one source.

2. Supplementary Cementitious Materials (SCM):
   a. Fly Ash (Pozzolan):
      1) Class F fly ash in accordance with ASTM C618, except as modified herein:
         a) ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.
      b. Slag Cement: In accordance with ASTM C989, Grade 100 or Grade 120.

B. Aggregates: Unless otherwise permitted, furnish from one source for each aggregate type used in a mix design.

1. Normal-Weight Aggregates:
   a. In accordance with ASTM C33/C33M, except as modified herein.
      1) Class Designation: 4S unless otherwise specified.
b. Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
c. Alkali Silica Reactivity: See Article Concrete Mix Design.

2. Fine Aggregates:
a. Clean, sharp, natural sand.
b. ASTM C33/C33M.
c. Limit deleterious substances in accordance with ASTM C33/C33M, Table 2 and as follows:
   1) Limit material finer than 75-μm (No. 200) sieve to 5 percent mass of total sample.
   2) Limit coal and lignite to 1.0 percent.

3. Coarse Aggregate:
a. Natural gravels, combination of gravels and crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension).
b. Limit deleterious substances in accordance with ASTM C33/C33M, Table 4 for specified class designation.

C. Admixtures: Unless otherwise permitted, furnish from one manufacturer.

1. Characteristics:
a. Compatible with other constituents in mix.
b. Contain at most, only trace amount chlorides in solution.
c. Furnish type of admixture as recommended by manufacturer for anticipated temperature ranges.


3. Water-Reducing Admixture: ASTM C494/C494M, Type A or Type D.
a. Manufacturers and Products:
   1) BASF Admixtures, Inc., Shakopee, MN; Pozzolith Series or PolyHeed Series.
   2) Euclid Chemical Co., Cleveland, OH; Eucon Series.
   3) W. R. Grace & Co., Cambridge, MA; Daracem Series or Mira Series.

4. Retarding Admixture: ASTM C494/C494M, Type B.

5. Accelerating Admixture: ASTM C494/C494M, Type C.

6. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F or Type G.
a. Manufacturers and Products:
   1) BASF Admixtures, Inc., Shakopee, MN; Glenium Series, PS 1460, or Rheobuild 1000.
   2) Euclid Chemical Co., Cleveland, OH; Eucon Series or Plastol Series.
3)  W. R. Grace & Co., Cambridge, MA; ADVA Series, Daracem Series, or EXP 950.

7. Plasticizing Admixture: ASTM C1017/C1017M, Type I or Type II.

D. Water and Ice: Mixing water for concrete and water used to make ice shall be potable water, unless alternative sources of water are permitted.

1. Water from alternative sources shall comply with requirements of ASTM C1602/C1602M, and concentration of chemicals in combined mixing water shall be less than:
   a. Chloride Content: 1,000 ppm.
   b. Sulfate Content as SO₄: 3,000 ppm.
   c. Alkalis as (Na₂O + 0.658 K₂O): 600 ppm.
   d. Total Solids by Mass: Less than 50,000 ppm.

2.02 ANCILLARY MATERIALS

A. Bonding Agent:

1. Unless otherwise specified, in accordance with the following:
   a. ASTM C881/C881M, Type V.
   b. Two-component, moisture insensitive, 100 percent solids epoxy.
   c. Consult manufacturer for surface finish, pot life, set time, vertical or horizontal application, and forming restrictions.
   d. Manufacturers and Products:
      1) BASF Building Systems, Inc., Shakopee, MN; Concresive Standard LV1.
      2) Euclid Chemical Co., Cleveland, OH; Euco # 352 Epoxy System LV.
      3) Prime Resins, Conyers, GA; Prime Bond 3000 to 3900 Series.
      4) Sika Chemical Corp., Lyndhurst, NJ; Sikadur 32 Hi-Mod.

B. Bond Breaker:

1. Nonstaining type, providing positive bond prevention.

2. Manufacturers and Products:
   a. Dayton Superior Corporation, Kansas City, KS; EDOCO Clean Lift Bond Breaker.
   b. Nox-Crete Products Group, Omaha, NE; Silcoseal Select.

C. Repair Material:

1. In accordance with requirements of Section 03 01 32, Repair of Vertical and Overhead Concrete Surfaces.
2. In accordance with requirements of Section 03 01 33, Repair of Horizontal Concrete Surfaces.

D. Crack Repair: In accordance with requirements of Section 03 64 23, Epoxy Resin Injection Grouting.

2.03 CONCRETE MIX DESIGN

A. General:

1. See Supplement at the end of this section for mix design requirements for each class of concrete used on Project.

2. Prepare design mixtures for each type and strength of concrete, selecting and proportioning ingredients in accordance with requirements of ACI 301, unless otherwise specified.

3. Selection of constituent materials and products in mix design are optional, unless specified otherwise.

4. Unless otherwise permitted, use water-reducing admixture or water-reducing admixture and high-range, water-reducing admixture, or plasticizing admixture in pumped concrete, in concrete with a water-cementitious materials ratio below 0.50, and in concrete that is part of a liquid-containment structure.

5. Unless otherwise permitted, use water-reducing admixture and high-range, water-reducing admixture, or plasticizing admixture in columns, piers, pilasters, and walls.

6. Use water-reducing admixture or high-range, water-reducing admixture, or plasticizing admixture to achieve fresh properties that facilitate handling, placing, and consolidating of concrete, and specified hardened properties.

7. Use water-reducing and retarding admixture when anticipated high temperatures, low humidity, or other adverse placement conditions can adversely affect fresh properties of concrete.

8. Unless otherwise specified, desired fresh properties of concrete shall be determined by Contractor and coordinated with concrete producer. Fresh properties of concrete shall remain stable to satisfaction of Contractor, for duration of placement and consolidation, and shall remain in conformance with requirements of Contract Documents.

9. Contractor is encouraged to consider using environmentally sustainable concrete mix design technologies such as use of supplementary cementitious materials and aggregate packing.

B. Potential Alkali-Aggregate Reactivity of Concrete:

1. Do not use aggregates known to be susceptible to alkali-carbonate reaction (ACR).
2. Aggregates shall have been tested to determine potential alkali-aggregate reactivity in concrete in accordance with ASTM C1260 or ASTM C1567.
   a. Aggregates that indicate expansion greater than 0.10 percent at 16 days after casting shall not be used unless they have been shown to be nondeleteriously reactive in accordance with ASTM C227 or ASTM C1293, with less than 0.04 percent expansion at 1 year for cement-aggregate combinations or less than 0.04 percent expansion at 2 years for combinations with pozzolan or slag.
   b. Alkali content of cement used in proposed concrete mixture shall not be greater than alkali content of cement used in test for potential alkali-aggregate reactivity.
   c. Use low-alkali cement or incorporate pozzolans into concrete mixture as necessary to satisfy testing for potential alkali reactivity.

C. Proportions:
   1. Design mix to meet aesthetic, durability, and strength requirements.
   2. Where fly ash is included in mix, minimum fly ash content shall be a minimum of 15 percent of weight of total cementitious materials.

D. Slump Range at Site:
   1. Prior to submitting mix design, consult with concrete producer and select a target slump value at point of delivery, for each application of each design mix. Unless otherwise permitted, target slump value will then be enforced for duration of Project.
   2. Design mixes that include a high-range, water-reducing or a plasticizing admixture shall have a minimum slump of 2 inches prior to addition of admixture. Unless otherwise permitted, slump shall be 8 inches maximum at point of delivery, for concrete with a high-range, water-reducing admixture.
   3. Slump tolerance shall meet requirements of ACI 117.

E. Combined Aggregate Gradation:
   1. Combined Gradation Limits: Fine aggregate shall be in range of 36 percent to 40 percent of total aggregate weight.

2.04 CONCRETE MIXING

A. General: In accordance with ACI 301, except as modified herein.
B. Truck Mixers:

1. For every truck, test slump of samples taken per ASTM C94/C94M, paragraph 12.5.1.
2. Where specified slump is more than 4 inches, and if slump tests differ by more than 2 inches, discontinue use of truck mixer, unless causing condition is corrected and satisfactory performance is verified by additional slump tests.

2.05 TEMPERATURE LIMITS

A. For concrete sections with a minimum specified dimension that is greater than 2 feet 6 inches, and unless otherwise permitted:

1. Provide documentation that maximum concrete temperature in structure will not exceed 158 degrees F, and maximum temperature differential between center of section and external surfaces of concrete will not exceed 35 degrees F.

2.06 SOURCE QUALITY CONTROL

A. Source Quality Control Inspection: Engineer shall have access to and have right to inspect batch plants, cement mills, and supply facilities of suppliers, manufacturers, and Subcontractors, providing products included in this section.

PART 3 EXECUTION

3.01 PLACING CONCRETE

A. Preparation: Meet requirements ACI 301, except as modified herein.

B. Inspection: Notify Engineer and Special Inspector at least 1 full working day in advance before starting to place concrete.

C. Placement into Formwork:

1. Where vapor retarder or barrier is required, coordinate subgrade preparation with requirements in Division 07 of Specifications.
2. Reinforcement: Secure in position before placing concrete.
3. Place concrete as soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel above, and in layers not over 1.5 feet deep, except for slabs which shall be placed full depth. Place and consolidate successive layers prior to initial set of first layer to prevent cold joints.
4. Placement frequency shall be such that lift lines will not be visible in exposed and architectural concrete finishes.
5. Use placement devices, for example chutes, pouring spouts, and pumps as required to prevent segregation.
6. Vertical Free Fall Drop to Final Placement:
   a. Forms 8 Inches or Less Wide: 5 feet.
   b. Forms Wider than 8 Inches: 8 feet, except as specified.
7. For placements where drops are greater than specified, use placement device such that free fall below placement device conforms to required value.
   a. Limit free fall to prevent segregation caused by aggregates hitting steel reinforcement.
8. Do not use aluminum conveying devices.
9. Provide sufficient illumination in the interior of forms so concrete deposition is visible, permitting confirmation of consolidation quality.
10. Joints in Footings and Slabs:
    a. Ensure space beneath plastic waterstop completely fills with concrete.
    b. During concrete placement, make visual inspection of entire waterstop area.
    c. Limit concrete placement to elevation of waterstop in first pass, vibrate concrete under waterstop, lift waterstop to confirm full consolidation without voids, and place remaining concrete to full height of slab.
    d. Apply procedure to full length of waterstop.
11. Trowel and round off top exposed edges of walls with 1/4-inch radius steel edging tool.
12. Cure concrete as specified in Section 03 39 00, Concrete Curing.

D. Conveyor Belts and Chutes:

1. Design and arrange ends of chutes, hopper gates, and other points of concrete discharge throughout conveying, hoisting, and placing system for concrete to pass without becoming segregated.
2. Do not use chutes longer than 50 feet.
3. Minimum Slopes of Chutes: Angled to allow concrete to readily flow without segregation.
4. Conveyor Belts:
   a. Approved by Engineer.
   b. Wipe clean with device that does not allow mortar to adhere to belt.
   c. Cover conveyor belts and chutes.

E. Retempering: Not permitted for concrete where cement has partially hydrated.
F. Pumping of Concrete:

1. Provide standby pump, conveyor system, crane and concrete bucket, or other system onsite during pumping, for adequate redundancy to ensure completion of concrete placement without cold joints in case of primary placing equipment breakdown.
3. Replace pumping equipment and hoses (conduits) that are not functioning properly.

G. Concrete sections with a minimum specified dimension that is greater than 2 feet 6 inches:

1. Cure and protect concrete in accordance with accepted thermal control plan and as follow:
   a. Minimum curing period shall be 14 days.
   b. Unless otherwise permitted, preserve moisture by maintaining forms in place.
2. Strength measurement shall be representative of in-place concrete within 2 inches of concrete surface.
3. Concrete strength shall be verified through correlation of concrete temperature and compressive strengths established by cylinder compressive tests and in accordance with ASTM C1074.
4. Unless otherwise specified, control concrete temperatures to within specified limits from time concrete is placed until time internal temperature has cooled from its maximum, such that difference between average daily ambient and maximum internal concrete temperature at time of protection removal, is less than specified temperature difference limit.
5. Unless otherwise specified, place one temperature sensor at center of mass of placement and one temperature sensor at a depth 2 inches from center of nearest exterior surface. Place additional sensor at each location to serve as a backup in event that other temperature sensor fails. In addition, provide temperature sensor in shaded location for monitoring ambient onsite temperature.
   a. Unless otherwise specified, monitor temperatures hourly using electronic sensors capable of measuring temperature from 32 degrees F to 212 degrees F to an accuracy of 2 degrees F.
   b. Ensure temperature sensors are operational before placing concrete.
   c. Unless otherwise specified, provide data from sensors to Engineer on a daily basis, until requirements are met.
d. Compare temperatures and temperature differences with maximum limits specified in Article Temperature Limits every 12 hours, unless otherwise permitted. If either exceeds specified limits, take immediate action as described in accepted thermal control plan to remedy situation. Do not place additional mass concrete until cause of excessive temperature or temperature difference has been identified and corrections are accepted.

H. Maximum Size of Concrete Placements:

1. Limit size of each placement to allow for strength gain and volume change as a result of shrinkage.
2. Locate expansion, control, and contraction joints where shown on Drawings.
3. Construction Joints:
   a. Unless otherwise shown or permitted, locate construction joints as follows:
      1) Locate construction joints as shown on Drawings or where approved in joint location submittal required in Section 03 15 00, Concrete Joints and Accessories.
      2) Provide vertical construction joints in walls and slabs at maximum spacing of 40 feet, unless shown or approved otherwise.
      3) When vertical expansion, contraction, or control joint spacing does not exceed 60 feet, intermediate construction joints are not required.
      4) Uniformly space vertical construction joints within straight sections of walls and slabs, avoiding penetrations.
4. Consider beams, girders, brackets, column capitals, and haunches as part of floor or roof system and place monolithically with floor or roof system.
5. Should placement sequence result in cold joint located below finished water surface, install waterstop in joint.

I. Minimum Time between Adjacent Placements:

1. Construction or Control Joints: 7 days unless otherwise specified.
2. Construction Joint between Top of Footing or Slab, and Column or Wall: As soon as can safely be done without damaging previously cast concrete or interrupting curing thereof, but not less than 24 hours.
3. Expansion or Contraction Joints: 1 day.
4. For columns and walls with a height in excess of 10 feet, wait at least 2 hours before depositing concrete in beams, girders, or slabs supported thereon.
5. For columns and walls 10 feet in height or less, wait at least 1 hour prior to depositing concrete in beams, girders, brackets, column capitals, or slabs supported thereon.

J. Consolidation and Visual Observation:

1. Consolidation Equipment and Methods: ACI 301.
2. Provide at least one standby vibrator in operable condition at Site prior to placing concrete.
3. Provide sufficient windows in forms or limit form height to allow for concrete placement through windows and for visual observation of concrete.
4. Vibrate concrete in vicinity of joints to obtain impervious concrete.

K. Hot Weather:

1. Prepare ingredients, mix, place, cure, and protect in accordance with ACI 301, ACI 305.1, and as follows:
   a. Maintain concrete temperature below 90 degrees F at time of placement, or furnish test data or other proof that admixtures and mix ingredients do not produce flash set plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.
   b. Provide for windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.
2. Concrete Curing: As specified in Section 03 39 00, Concrete Curing.

L. Cold Weather Placement:

1. Unless otherwise permitted, shall be in accordance with requirements of ACI 306.1 and as follows:
   a. Cold weather requirements shall apply when ambient temperature is below 40 degrees F or approaching 40 degrees F and falling.
   b. Do not place concrete over frozen earth or against surfaces with frost or ice present. Frozen earth shall be thawed to acceptance of Engineer.
   c. Unless otherwise permitted, do not place concrete in contact with surfaces less than 35 degrees F; requirement is applicable to all surfaces, including reinforcement and other embedded items.
   d. Provide supplemental external heat as needed when other means of thermal protection are unable to maintain minimum surface temperature of concrete as specified in ACI 306.1.
e. Maintain minimum surface temperature of concrete as specified in ACI 306.1 for no less than 3 days during cold weather conditions.
f. Cure concrete as specified in Section 03 39 00, Concrete Curing.
   1) Protect concrete from freezing until end of curing period and until concrete has attained a compressive strength of 3,500 psi or design compressive strength if less than 3,500 psi.

2. Provide maximum and minimum temperature sensors placed on concrete surfaces spaced throughout Work to allow monitoring of concrete surface temperatures representative of Work. Unless otherwise permitted, record surface temperature of concrete at least once every 12 hours during specified curing period.

3. External Heating Units: Do not exhaust heater flue gases directly into enclosed area as it causes concrete carbonation as a result of concentrated carbon dioxide.

4. Maintain curing conditions as specified in Section 03 39 00, Concrete Curing.

3.02 CONCRETE BONDING

A. Construction Joints in New Concrete Members:

1. Prepare surface of construction joint as specified in Section 03 15 00, Concrete Joints and Accessories.

2. Horizontal Construction Joints Containing Waterstop in New Concrete Walls:
   a. Use positive measuring device such as bucket or other device that will contain only enough slurry mixture for depositing in visually measurable area of wall to ensure that portion of form receives appropriate amount of slurry mixture to satisfy placement thickness requirements.
   b. Do not deposit slurry mixture from pump hoses or large concrete buckets, unless specified placement thickness can be maintained and verified through inspection windows close to joint, or by other means.
   c. Limit concrete placed immediately on top of slurry mixture to 12 inches thick. Thoroughly vibrate to mix concrete and slurry mixture together.

B. Construction Joints at Existing Concrete:

1. Thoroughly clean and mechanically roughen existing concrete surfaces to roughness profile of 1/4 inch.
2. Saturate surface with water for 24 hours prior to placing new concrete.
3.03 REPAIRING CONCRETE

A. General:

1. Inject cracks that leak with crack repair epoxy as specified in Section 03 64 23, Epoxy Resin Injection Grouting.
2. Repair defective areas of concrete.
3. Repair horizontal concrete surfaces in accordance with Section 03 01 33, Repair of Horizontal Concrete Surfaces.
4. Repair vertical and overhead concrete surfaces in accordance with Section 03 01 32, Repair of Vertical and Overhead Concrete Surfaces.
5. Develop repair techniques with material manufacturer on surface that will not be visible in final construction prior to starting actual repair work and show how finish color will blend with adjacent surfaces. Obtain approval from Engineer.
6. Obtain quantities of repair material and manufacturer’s detailed instructions for use to provide repair with finish to match adjacent surface or apply sufficient repair material adjacent to repair to blend finish appearance.
7. Repair of concrete shall provide structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to Engineer.

B. Tie Holes:

1. Unless otherwise specified, fill with specified repair material.
   a. Prepare substrate and mix, place, and cure repair material per manufacturer’s written recommendations.
2. When required, color of tie-hole patch shall match adjacent concrete.
   a. Demonstrate patch of tie hole on mockup panels.
   b. Clean and dampen tie holes before applying mortar. Do not use separate bonding agent.
   c. Fill with site-mixed portland-cement repair mortar per ACI 301.
   d. Cure repair mortar with water.

C. Alternate Form Ties, Through-Bolts:

1. Mechanically roughen entire interior surface of through hole.
2. Apply bonding agent to roughened surface and drive elastic vinyl plug to half depth.
3. Dry pack entire hole from both sides of plug with nonshrink grout, as specified in Section 03 62 00, Grouting.
4. Use only enough water to dry pack grout.
5. Dry pack while bonding agent is still tacky.
6. If bonding agent has dried, remove bonding agent by mechanical means and reapply new coat of bonding agent.
7. Compact grout using steel hammer and steel tool to drive grout to high density.
8. Cure grout with water.

D. Exposed Metal Objects:
   1. Remove metal objects not intended to be exposed in as-built condition of structure, including wire, nails, and bolts, by chipping back concrete to depth of 1 inch and then cutting or removing metal object.
   2. Repair area of chipped-out concrete as specified for defective areas.

E. Blockouts at Pipes or Other Penetrations: Where shown install in accordance with requirements of Drawings.

3.04 CONCRETE WALL FINISHES

A. Type W-1 (Ordinary Wall Finish):
   1. Patch tie holes.
   2. Knock off projections.
   3. Repair defective areas.
   4. Inject cracks in accordance with requirements of Section 03 64 23, Epoxy Resin Injection Grouting.

B. Type W-2 (Smooth Wall Finish):
   1. Patch tie holes.
   2. Grind off fins and other projections.
   3. Repair defective areas to provide smooth uniform appearance.
   4. Inject cracks in accordance with requirements of Section 03 64 23, Epoxy Resin Injection Grouting.

C. Type W-4 (Finish for Cementitious Coatings):
   1. In accordance with requirements for Type W-2 except as follows:
      a. Leave surface ready for cementitious coating specified in Section 09 97 26, Cementitious Coatings.

D. Type W-7 (Smooth Rubbed Wall Finish):
   1. Only water curing will be permitted on walls scheduled to be rubbed.
2. Perform rubbing while green concrete can be physically worked and smoothed without adding other materials, if structurally possible, the day following placement. Finish no later than 3 days after placement has been completed.

3. Remove forms at such a rate that finishing, form tie filling, fin removal, and patching can be completed on same day forms are removed while curing wall.

4. After patches have set sufficiently to permit working on surface, thoroughly saturate entire surface with water for period of 3 hours and rub until uniform surface is obtained.

5. Rub either by hand with carborundum stone of medium-coarse grade or abrasive of equal quality, or mechanically operated carborundum stone.

6. Mechanically operated carborundum stones shall be approved by Engineer before concrete finishing.

7. No cement grout, other than cement paste drawn from concrete itself by rubbing process shall be used.

8. Finish paste formed by rubbing by either brushing or floating as follows:
   a. Brushing:
      1) Carefully strike with clean brush.
      2) Brush in long direction of surface being finished.
   b. Floating:
      1) Spread uniformly over surface and allow to reset.
      2) Finish by floating with canvas, carpet face, or cork float, or rub down with dry burlap.

9. Continue water curing of wall during finishing operation in areas not being rubbed.

10. Move water curing onto rubbed areas as soon as water will not erode rubbed surface.

E. Type W-8 (Rubbed Wall Finish):

   1. Meet requirements for Type W-7, except allow paste obtained from rubbing to set at least 24 hours.

   2. After thoroughly saturating with water, coat surface with mixture of 85 percent cement and 15 percent lime with sufficient water to give creamy consistency. Demonstrate on sample panel prior to production finishing.

   3. Rub this mixture into surface with coarse carborundum stone and brush with damp brush.

   4. Brush in long direction of surface being finished.

   5. Latex bonding admixture may be used. Consult with Euclid Chemical Co., Cleveland, OH or BASF Building Systems, Inc., Shakopee, MN.
3.05 CONCRETE SLAB FINISHES

A. General:
   1. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.
   2. Do not use “jitterbugs” or other special tools designed for purpose of forcing coarse aggregate away from surface and allowing layer of mortar, which will be weak and cause surface cracks or delamination, to accumulate.
   3. Finish slab in accordance with specified slab finish.
   4. Do not dust surfaces with dry materials nor add water to surfaces.
   5. Cure concrete as specified in Section 03 39 00, Concrete Curing.

B. Type S-1 (Steel Troweled Finish):
   1. Finish by screeding and floating with straightedges to bring surfaces to required finish elevation.
   2. Wood float to true, even plane with no coarse aggregate visible.
   3. Use sufficient pressure on wood floats to bring moisture to surface.
   4. After surface moisture has disappeared, hand steel trowel concrete to produce smooth, smooth dense surface, free from trowel marks.
   5. Provide light steel-troweled finish (two trowelings) at air-entrained slabs. Provide hard steel-troweled finish (ringing sound from the trowel) for nonair-entrained slabs.
   6. Do not use dry cement or additional water during troweling, nor will excessive troweling be permitted.
   7. Power Finishing:
      a. Approved power machine may be used in lieu of or in addition to hand finishing in accordance with directions of machine manufacturer.
      b. Do not use power machine when concrete has not attained necessary set to allow finishing without introducing high and low spots in slab.
      c. Do first steel troweling for slab S-1 finish by hand.

C. Type S-2 (Wood Float Finish):
   1. Finish slab to receive fill and mortar setting bed by screeding with straightedges to bring surface to required finish plane.
   2. Wood float finish to compact and seal surface.
   3. Remove laitance and leave surface clean.
   4. Coordinate with other finish procedures.
D. Type S-4 (Exposed Aggregate Finish):

1. Embed single layer of selected aggregates at surface of concrete slab immediately after it has been placed, screeded, and smoothed.
2. Embed aggregates by tamping with wood float, darby, or rolling device.
3. Accomplish exposure of selected aggregates by removing surface matrix by washing with water and brushing with stiff plastic bristled brush as soon as concrete has set sufficiently to support weight of a person.
4. Exposure: No greater than 1/3 the average diameter of aggregate, nor less than 1/4.
5. Next day acid wash until there is no noticeable cement film on aggregate exposed.
6. Apply clear sealer per manufacturer’s recommendations.

E. Type S-5 (Broomed Finish):

1. Finish as specified for Type S-1 floor finish, except use only a light-steel troweled finish, and then finish surface by drawing fine-hair broom lightly across surface.
2. Broom in same direction and parallel to expansion joints, or, in case of inclined slabs, perpendicular to slope, except for round roof slab, broom surface in radial direction.

F. Type S-6 (Sidewalk Finish):

1. Slope walks down 1/4 inch per foot away from structures, unless otherwise shown.
2. Strike off surface by means of strike board and float with wood or cork float to true plane, then flat steel trowel before brooming.
3. Broom surface at right angles to direction of traffic or as shown.
4. Lay out sidewalk surfaces in blocks, as shown or as directed by Engineer, with grooving tool.

G. Concrete Curbs:

1. Float top surface of curb smooth and finish all discontinuous edges with steel edger.
2. After concrete has taken its initial set, remove front form and give exposed vertical surface an ordinary wall finish, Type W-1.
3.06 CONCRETE SLAB TOLERANCES

A. Slab Tolerances:
   1. Exposed Slab Surfaces: Comprise of flat planes as required within tolerances specified.
   2. Slab Finish Tolerances and Slope Tolerances: Crowns on floor surface not too high as to prevent 10-foot straightedge from resting on end blocks, nor low spots that allow block of twice the tolerance in thickness to pass under supported 10-foot straightedge.
   3. Slab Type S-A: Steel gauge block 5/16 inch thick.
   4. Slab Type S-B: Steel gauge block 1/8 inch thick.
   5. Slab Type S-A and S-B:
      a. Finish Slab Elevation: Slope slabs to floor drain and gutter, and shall adequately drain regardless of tolerances.
   6. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from thickness shown. Where thickness tolerance will not affect slope, drainage, or slab elevation, thickness tolerance may exceed 1/2 inch plus.

B. Slab Elevation and Thickness:
   1. Finish Slab Elevation: Slope slabs to floor drains and gutter. Slabs shall adequately drain regardless of tolerances.
   2. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from thickness shown. Where thickness tolerance will not affect slope, drainage, or slab elevation, thickness tolerance may exceed 1/2 inch plus.

3.07 BACKFILL AGAINST STRUCTURES

A. Do not backfill against walls until concrete has obtained specified 28-day compressive strength.

B. Refer to General Structural Notes on Drawings for additional requirements, including elevated slab and diaphragm completion prior to backfill.

C. Unless otherwise permitted, place backfill simultaneously on both sides of structure, where such fill is required, to prevent differential pressures.

3.08 FIELD QUALITY CONTROL

A. General:
   1. Provide adequate facilities for safe storage and proper curing of concrete test specimens onsite for first 24 hours, and for additional time as may be required before transporting to test lab.
2. Unless otherwise specified, sample concrete for testing for making test specimens, from point of delivery.
3. When concrete is pumped, sample and test air content at point of delivery and at point of placement.
4. Evaluation will be in accordance with ACI 301 and Specifications.
5. Test specimens shall be made, cured, and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
6. Frequency of testing may be changed at discretion of Engineer.
8. If measured air content at delivery is greater than specified limit, check test of air content will be performed immediately on a new sample from delivery unit. If check test fails, concrete has failed to meet requirements of Contract Documents. If measured air content is less than lower specified limit, adjustments will be permitted in accordance with ASTM C94/C94M, unless otherwise specified. If check test of adjusted mixture fails, concrete has failed to meet requirements of Contract Documents. Concrete that has failed to meet requirements of Contract Documents shall be rejected.

B. Concrete Strength Test:
   1. Unless otherwise specified, one specimen at age of 7 days for information, and two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 28 days for acceptance.
   2. Concrete with specified 56-day strength, test one specimen at age of 7 days for information, two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 28 days for acceptance, and two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 56 days for acceptance. Should results of 28-day tests meet specified requirement for 56-day strength, 56-day tests will not be required.
   3. Provide a minimum of one spare test specimen per sample. Test spare cylinder as directed by Engineer.

C. High-Range, Water-Reducer (Superplasticizer) Admixture Segregation Test:
   Test each truck prior to use on Project.
   1. Segregation Test Objective: Concrete with 4-inch to 8-inch slump shall stay together when slumped. Segregation is assumed to cause mortar to flow out of mix even though aggregate may stay piled enough to meet slump test.
   2. Test Procedure: Make slump test and check for excessive slump and observe to see if mortar or moisture flows from slumped concrete.
   3. Reject concrete if mortar or moisture separates and flows out of mix.
D. Cold Weather Placement Tests:

1. During cold weather concreting, cast cylinders for field curing as follows. Use method that will produce greater number of specimens:
   a. Six extra test cylinders from last 100 cubic yards of concrete.
   b. Minimum three specimens for each 2 hours of placing time or for each 100 cubic yards.
2. These specimens shall be in addition to those cast for lab testing.
3. Protect test cylinders from weather until they can be placed under same protection provided for concrete of structure that they represent.
4. Keep field test cylinders in same protective environment as parts of structure they represent to determine if specified strength has been obtained.
5. Test cylinders in accordance with applicable sections of ASTM C31/C31M and ASTM C39/C39M.
6. Use test results to determine specified strength gain prior to falsework removal or for prestressing.

E. Tolerances:

1. Walls: Measure and inspect walls for compliance with tolerances specified in Section 03 10 00, Concrete Forming and Accessories.
2. Slab Finish Tolerances and Slope Tolerances:
   a. Make floor flatness measurements day after floor is finished and before shoring is removed to eliminate effects of shrinkage, curing, and deflection.
   b. Support 10-foot long straightedge at each end with steel gauge blocks of thicknesses equal to specified tolerance.
   c. Compliance with designated limits in four of five consecutive measurements is satisfactory, unless defective conditions are observed.

3.09 MANUFACTURER’S SERVICES

A. Provide representative at Site in accordance with Section 01 43 33, Manufacturers’ Field Services, for installation assistance, inspection, and certification of proper installation for concrete ingredients, mix design, mixing, and placement.

1. Concrete Producer Representative:
   a. Assist with concrete mix design, performance, placement, weather problems, and problems as may occur with concrete mix throughout Project, including instructions for redosing.
   b. Establish control limits on concrete mix designs.
c. Provide equipment for control of concrete redosing for air entrainment or high-range, water-reducing admixture, superplasticizers, at Site to maintain proper slump and air content if needed.

2. Admixture Manufacturer’s Representative: Available for consultations as required to ensure proper installation and performance of specified products.

3. Bonding Agent Manufacturer’s Representative: Available for consultations as required to ensure proper installation and performance of specified products.

3.10 PROTECTION OF INSTALLED WORK

A. After curing as specified in Section 03 39 00, Concrete Curing, and after applying final floor finish, cover slabs with plywood or particle board or plastic sheeting or other material to keep floor clean and protect it from material and damage as a result of other construction work.

B. Repair areas damaged by construction, using specified repair materials and approved repair methods.

3.11 SCHEDULE OF CONCRETE FINISHES

A. Form Tolerances: As specified in Section 03 10 00, Concrete Forming and Accessories.

B. Special Floor Finishes: As specified in Section 03 35 00, Concrete Finishing.

C. Provide concrete finishes as scheduled:

<table>
<thead>
<tr>
<th>Area</th>
<th>Type of Finish</th>
<th>Required Form Tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exterior Wall Surfaces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abovegrade/exposed (above point 6” below finish grade)</td>
<td>W-2</td>
<td>W-B</td>
</tr>
<tr>
<td>Abovegrade/covered with brick veneer or other finish material</td>
<td>W-1</td>
<td>W-A</td>
</tr>
<tr>
<td>Backfilled/waterproofed (below point 6” below finish grade)</td>
<td>W-1</td>
<td>W-A</td>
</tr>
<tr>
<td>Backfilled/not waterproofed (below point 6” below final grade)</td>
<td>W-1</td>
<td>W-A</td>
</tr>
<tr>
<td>Area</td>
<td>Type of Finish</td>
<td>Required Form Tolerances</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>----------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Walls to receive cementitious coatings</td>
<td>W-4</td>
<td>W-B</td>
</tr>
<tr>
<td>Dam Structure</td>
<td>W-1</td>
<td>W-A</td>
</tr>
<tr>
<td><strong>Interior Wall Surfaces</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buildings, pipe galleries, and other dry areas/not painted or coated</td>
<td>W-2</td>
<td>W-A</td>
</tr>
<tr>
<td>Buildings, pipe galleries, and other dry areas/painted or coated</td>
<td>W-5</td>
<td>W-A</td>
</tr>
<tr>
<td><strong>Exterior Slabs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top of wall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top of footing</td>
<td>S-2</td>
<td>S-A</td>
</tr>
<tr>
<td>Stairs and landings</td>
<td>S-5</td>
<td>S-B</td>
</tr>
<tr>
<td>Sidewalks</td>
<td>S-6</td>
<td>S-B</td>
</tr>
<tr>
<td>Aggregate exposed sidewalks</td>
<td>S-4</td>
<td>S-B</td>
</tr>
<tr>
<td>Other exterior slabs</td>
<td>S-5</td>
<td>S-A</td>
</tr>
<tr>
<td><strong>Interior Slabs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buildings, pipe galleries, and other dry areas</td>
<td>S-1</td>
<td>S-B</td>
</tr>
<tr>
<td><strong>Flume and Wave Shaper</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drop Structures and Sculpted Concrete</td>
<td>S-4</td>
<td>S-A</td>
</tr>
</tbody>
</table>

### 3.12 SUPPLEMENTS

#### A. Requirements of concrete mix designs following “End of Section,” are a part of this Specification and supplement requirements of Part 1 through Part 3 of this section:

1. Concrete Mix Design, Class 5000F3S1P2C2.
2. Concrete Mix Design, Class 4500F2S1P1C1.
3. Concrete Mix Design, Class 4500F1S1P0C1.
4. Concrete Mix Design, Class 4500F3S1P1C2.

**END OF SECTION**
CONCRETE MIX DESIGN, CLASS 5000F3S1P2C2

A. Mix Locations: Hydraulic structures.


C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.40.
2. Minimum concrete compressive strength (f’c) shall be 4,000 psi at 28 days and 5,000 psi at 56 days.
3. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

<table>
<thead>
<tr>
<th>Nominal Maximum Aggregate Size in:‡</th>
<th>Air Content (%)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8</td>
<td>7.5</td>
</tr>
<tr>
<td>1/2</td>
<td>7.0</td>
</tr>
<tr>
<td>3/4</td>
<td>6.0</td>
</tr>
<tr>
<td>1</td>
<td>6.0</td>
</tr>
<tr>
<td>1-1/2</td>
<td>5.5</td>
</tr>
<tr>
<td>2§</td>
<td>5.0</td>
</tr>
</tbody>
</table>

‡See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations.

*Tolerance of air content is +1-1/2 percent.

§Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on the sieved fraction passing the 1-1/2-inch sieve in accordance with ASTM C231/C231M.

4. Limit supplementary cementitious materials measured as a percent of weight of total cementitious materials in mix design, as follows:
   a. Fly Ash and other Pozzolans: 25 percent.
   b. Slag Cement: 50 percent.
   c. Silica Fume: 10 percent.
d. Total cementitious materials include ASTM C150/C150M and ASTM C595/C595M cement.
   1) Fly ash and other pozzolans in Type IP, blended cement, ASTM C595/C595M.
   2) Slag used in the manufacture of an IS blended cement, ASTM C595/C595M.
   3) Silica fume, ASTM C1240, present in blended cement.

5. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
      2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
   c. ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).
      1) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.

6. Limit water-soluble, chloride-ion content in hardened concrete to 0.10 percent, unless otherwise specified.
   a. Limits are stated in terms of chloride ions in percent by weight of cement.
   b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

D. Refer to Part 1 through Part 3 of this section for additional requirements.
CONCRETE MIX DESIGN, CLASS 4500F2S1P1C1

A. Mix Locations: Building structures.

B. Exposure Categories and Classifications: F2S1P1C1.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.45.
2. Minimum concrete compressive strength (f’c) shall be 4,000 psi at 28 days and 4,500 psi at 56 days.
   a. Designed to conform to shrinkage limits.
   b. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

<table>
<thead>
<tr>
<th>Nominal Maximum Aggregate Size</th>
<th>Air Content (%)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>in. ‡</td>
<td></td>
</tr>
<tr>
<td>3/8</td>
<td>7.5</td>
</tr>
<tr>
<td>1/2</td>
<td>7.0</td>
</tr>
<tr>
<td>3/4</td>
<td>6.0</td>
</tr>
<tr>
<td>1</td>
<td>6.0</td>
</tr>
<tr>
<td>1-1/2</td>
<td>5.5</td>
</tr>
<tr>
<td>2§</td>
<td>5.0</td>
</tr>
</tbody>
</table>

‡See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations.

*Tolerance of air content is +1-1/2 percent.

§Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on sieved fraction passing 1-1/2-inch sieve in accordance with ASTM C231/C231M.

3. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
   1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
   2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
   3) ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).

4. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent, unless otherwise specified.
   a. Regardless of assigned C Exposure Class, for prestressed and post-tensioned concrete: 0.06 percent.
   b. Limits are stated in terms of chloride ions in percent by weight of cement.
   c. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

D. Refer to Part 1 through Part 3 of this section for additional requirements.
ZINK DAM IMPROVEMENTS

CONCRETE MIX DESIGN, CLASS 4500F1S1P0C1

A. Mix Locations:
   1. Electrical duct banks.
   2. Pipe encasements that are not cast monolithically with concrete base mats or slabs.

B. Exposure Categories and Classifications: F1S1P0C1.

C. Mix Properties:
   1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.45.
   2. Minimum concrete compressive strength (f’c) shall be 3,500 psi at 28 days and 4,500 psi at 56 days.
   3. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

<table>
<thead>
<tr>
<th>Nominal Maximum Aggregate Size in. ‡</th>
<th>Air Content (%)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8</td>
<td>6.0</td>
</tr>
<tr>
<td>1/2</td>
<td>5.5</td>
</tr>
<tr>
<td>3/4</td>
<td>5.0</td>
</tr>
<tr>
<td>1</td>
<td>4.5</td>
</tr>
</tbody>
</table>

‡ See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations.

* Tolerance of air content is ±1-1/2 percent.

§ Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on the sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on the sieved fraction passing the 1-1/2-inch sieve in accordance with ASTM C231/C231M.

4. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
   1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
   2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
   3) ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).
      a) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.

5. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent, unless otherwise specified.
   a. Limits are stated in terms of chloride ions in percent by weight of cement.
   b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

D. Refer to Part 1 through Part 3 of this section for additional requirements.
CONCRETE MIX DESIGN, CLASS 4500F3S1P1C2

A. Mix Locations: Concrete curbs and sidewalks.

B. Exposure Categories and Classifications: F3S1P1C2.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.42.
2. Minimum concrete compressive strength (f’c) shall be 3,500 psi at 28 days and 4,500 psi at 56 days.
3. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

<table>
<thead>
<tr>
<th>Nominal Maximum Aggregate Size</th>
<th>Air Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8</td>
<td>7.5</td>
</tr>
<tr>
<td>1/2</td>
<td>7.0</td>
</tr>
<tr>
<td>3/4</td>
<td>6.0</td>
</tr>
<tr>
<td>1</td>
<td>6.0</td>
</tr>
<tr>
<td>1-1/2</td>
<td>5.5</td>
</tr>
</tbody>
</table>

‡See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations.

*Tolerance of air content is +1-1/2 percent.

§Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on the sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on the sieved fraction passing the 1-1/2-inch sieve in accordance with ASTM C231/C231M.

4. Limit supplementary cementitious materials measured as a percent of weight of total cementitious materials in a mix design, as follows:
   a. Fly Ash and other Pozzolans: 25 percent.
   b. Slag Cement: 50 percent.
   c. Silica Fume: 10 percent.
d. Total cementitious materials include ASTM C150/C150M and ASTM C595/C595M cement.
   1) Fly ash and other pozzolans in Type IP, blended cement, ASTM C595/C595M.
   2) Slag used in the manufacture of an IS blended cement, ASTM C595/C595M.
   3) Silica fume, ASTM C1240, present in blended cement.

5. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II.
   b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
      2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
   c. ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).
      1) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.

6. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent, unless otherwise specified.
   a. Limits are stated in terms of chloride ions in percent by weight of cement.
   b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

D. Refer to Part 1 through Part 3 of this section for additional requirements.
PART 1  GENERAL

1.01  DESCRIPTION

A. This work consists of constructing pneumatically applied concrete onto designated surfaces at locations and thicknesses with the lines and dimensions shown on Drawings or as designated by the Engineer.

B. Inform Engineer at least 2 weeks in advance of time and places at which Contractor intends to place pneumatically applied concrete. All preparation work for concrete placements shall be substantially completed at least 2 workdays prior to the scheduled start of concrete placement to allow for the Engineer's review and any necessary corrections.

1.02  RELATED WORK

A. Section 03 30 00, Cast-in-Place Concrete.

B. Section 03 37 14, Faux Rock.

C. Section 31 38 00, Rock.

1.03  REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI): 301, Specification for Structural Concrete for Buildings, paragraph 5.7.1 and Chapter 9.

2. ASTM International (ASTM):
   a. A185, Specification for Wire Fabric, Plain, Welded Steel for Concrete Reinforcement.
   b. A615, Specification for Bars, Deformed and Plain, Billet-Steel, for Concrete Reinforcement.
   c. A820, Specifications for Steel Fibers for Fiber Reinforced Concrete.
   d. C31, Practice for Making and Curing Concrete Test Specimens in the field.
   e. C33, Specification for Concrete Aggregates.
1.04 SUBMITTALS

A. The following documents and Shop Drawings shall be submitted in accordance with project specifications. Shotcrete shall not be placed on the project before the submittals have been reviewed and approved by the Engineer.

1. Mix Design: A shotcrete mix design meeting the requirements of Section 03 30 00, Cast-in-Place Concrete.

2. Shotcrete Application Method Statement: The Shotcrete Application Method Statement shall be a wet-mix process and shall include Drawings and notes describing equipment, procedures and sequences for shotcrete production, application, curing plan, and applicable manufacturer’s literature and recommendations. The Shotcrete Application Method Statement shall also include written documentation that verifies the qualifications of the nozzlemen that will be performing...
the work. All nozzlemen shall have had at least 1 year of experience in the application of shotcrete and hold a current certification for ACI Shotcrete Nozzleman for the methods and orientations to be used.

3. Faux Rock Applications: Where faux rock is specified or shown on Drawings, the Contractor shall submit in accordance with Section 03 37 14, Faux Rock.

1.05 QUALITY ASSURANCE

A. Preconstruction Testing (Shotcrete Quality): Onsite preconstruction testing shall be completed by the Owner. The Contractor shall provide all materials, labor and equipment to produce test panels in accordance with this specification.

1. Prepare preconstruction test panels for examination by Engineer prior to job shotcrete placement. Preparation and testing shall comply with ASTM C1140.
2. Produce test panels for each proposed mix proportion, each anticipated shooting orientation, and each proposed nozzlemam. Mixes shall meet requirements of Article Concrete Materials, of this specification. In half of the test panels, provide reinforcement of the same size and spacing required for the work. Obtain six test specimens from each panel, three nonreinforced specimens and three with reinforcing steel.
3. Test the nonreinforced specimens for compliance with the specified physical properties in accordance with ASTM C1604.
4. Visually grade the reinforced specimens for compliance with specified core grade (Article Shotcrete Core Grades).
5. Test admixtures for compatibility with cement in accordance with ASTM C1141.
6. Unless otherwise specified, only nozzlemen with a test panel mean core grade less than or equal to 2.5 (Article Quality Assurance) shall be allowed to place job shotcrete. When the prequalification test panel is rejected, a second panel may be shot. If the nozzlemam’s second mean core grade is greater than 2.5, the nozzlemam shall not be permitted to shoot on the project.

B. Construction Testing (Shotcrete Quality): Construction testing will be completed by the Owner. The Owner reserves the right to test all panels or a reduced number (i.e., every other) based on results of previous tests.

1. Produce a material test panel for each mix and each work day or every 50 cubic yards placed, whichever is less. Test panels shall be produced in accordance with ASTM C1140 with a minimum size of 18 inches by 18 inches. Test panels shall be constructed in the same manner as that being used on the project, including distance from nozzle, angle and
orientation. Test panels shall be cured in similar conditions to what is anticipated in the field and shall be field cured until test specimens are taken. Test specimens from test panels in compliance with ASTM C1140.

2. The field compressive strength shall be determined from at least three test specimens from each test panel in accordance with ASTM C1140 and tested at 28 days. The mean compressive strength of a set of three cores shall equal or exceed the required compressive strength with no individual core less than 0.85 of the required compressive strength.

3. The Contractor shall remove and replace shotcrete that exhibits segregation, honeycombing, delamination, voids, sand pockets, excessive cracking, or does not meet the specified material properties, at the Contractor’s expense. If there is a dispute between the Contractor and Engineer in regard to the quality of in-place shotcrete, the following procedure shall be applied:

   a. Three cores shall be taken for each 100 square feet of shotcrete identified with defects in accordance with ASTM C1604 at locations designated by the Engineer. The shotcrete shall be at least 28 days old. Cores containing reinforcing steel shall not be tested.

   b. Cores will be immediately tested for compressive strength. A core break during coring operations such that it cannot be tested in accordance with ASTM C1604 will be assigned a compressive strength of 0 psi.

   c. If a set of cores does not produce an average compressive strength equal or in excess of the required compressive strength (28 days), the shotcrete represented by the cores shall be removed and replaced at the Contractor’s expense.

   d. All costs associated with coring and testing shall be at the Contractor’s expense, regardless of the outcome.

   e. The Contractor shall patch areas used for sampling and testing immediately after samples have been removed in accordance to Chapter 9 of ACI 301. Do not fill holes by shooting.

1.06 SHOTCRETE CORE GRADES

   A. Grade 1: Shotcrete specimens are solid; there are no laminations, sandy areas or voids. Small air voids with a maximum diameter of 1/8 inch and maximum length of 1/4 inch are normal and acceptable. Sand pockets, or voids behind continuous reinforcing steel are unacceptable. The surface against the form or bond plane shall be sound, without a sandy texture or voids.

   B. Grade 2: Shotcrete specimens shall have no more than two laminations or sandy areas with dimensions not to exceed 1/8-inch-thick by 1 inch long. The height, width and depth of void shall not exceed 3/8 inch. Porous areas behind
reinforcing steel shall not exceed 1/2 inch in any direction except along the length of the reinforcing steel. The surface against the form or bond plane shall be sound, without a sandy texture or voids.

C. Grade 3: Shotcrete specimens shall have no more than two laminations or sandy areas with dimensions exceeding 3/16-inch-thick by 1-1/4-inch-long, or one major void, sand pocket, or lamination containing loosely bonded sand not to exceed 5/8-inch-thick and 1-1/4-inch in width. The surface against the form or bond plane may be sandy with voids containing overspray to a depth of 1/16 inch.

D. Grade 4 Core: The core shall meet, in general, the requirements of Grade 3 cores, but may have two major flaws such as described for Grade 3 or may have on flaw with a maximum dimension of 1 inch perpendicular to the face of the core with a maximum width of 1-1/2 inch. The end of the core that was shot against the form may be sandy and with voids containing overspray to a depth of 1/8 inch.

E. Grade 5 Core: A core that does not meet the criteria of core Grade 1 through Grade 4, by being of poorer quality, shall be classified as Grade 5.

F. Determination of grade shall be by computing the mean of a minimum of three test specimens.

G. A mean grade of 2.5 or less is acceptable unless otherwise specified. Individual shotcrete cores with a grade greater than 3 are unacceptable.

H. The above core grades are based on cores with a surface area of 50 square inches for cores with greater or lesser area than 50 square inches, adjust allowable flaws relative to 50 square inches.

1.07 ACCEPTANCE

A. Acceptable shotcrete shall consist of a dense and uniform mixture without rebound, inclusions, segregations, or discernible weakness of bond between the rock or structure and the shotcrete. Acceptance will be based on the requirements of this section and the visual inspection and sounding of the shotcrete.

B. Shotcrete that exhibits movement or settlement after placement while still in the plastic state shall be repaired or replaced at the Contractor’s expense.

C. Shotcrete work that meets applicable requirements will be accepted by the Engineer.
D. Shotcrete work that has previously failed to meet one or more requirements, but which has been repaired to bring it into compliance, will be accepted by the Engineer.

E. Shotcrete work that fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected by the Engineer. Modifications may be required to assure that remaining work complies with the requirements.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Shotcrete materials, proportioning and placement shall comply with the requirements of ACI 506.2, “Specifications for Materials, Proportioning and Application of Shotcrete,” the requirements of Section 03 30 00, Cast-in-Place Concrete, and this Section.

B. Prepackaged material shall meet the requirements of ASTM C1480 and meet the sulfate resistance requirements indicated in Section 03 30 00, Cast-in-Place Concrete.

C. Strength and General Requirements.

1. Design and proportion Shotcrete to meet the following minimum compressive strengths and other criteria:

<table>
<thead>
<tr>
<th>Location</th>
<th>Aggregate Size (inch)</th>
<th>Design Strength 28-Day (psi)</th>
<th>Required Strength 7-Day (psi)</th>
<th>Minimum Cement Content* (lbs/yd)</th>
<th>Flyash Content %</th>
<th>Air Content % Range (Total)</th>
<th>Maximum Water Cement Ratio*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shotcrete**</td>
<td>1/2</td>
<td>4,500</td>
<td>3,000</td>
<td>N/A</td>
<td>20 max.</td>
<td>7-10***</td>
<td>0.38</td>
</tr>
<tr>
<td>Plaster**</td>
<td>3/8 max.</td>
<td>4,500</td>
<td>3,000</td>
<td>NA</td>
<td>20 max.</td>
<td>7-10***</td>
<td>0.38</td>
</tr>
</tbody>
</table>

*The maximum water-cementitious materials ratio by weight, which shall be based on all water in the mix, including correction for moisture in aggregates, and shall be based on the total cementitious materials including cement and fly ash.

**Add FIBERMESH Synthetic fiber reinforcement. See Admixtures Section 03 30 00, Cast-in-Place Concrete.

***Prior to pumping.
D. Admixtures shall meet the requirements of Section 03 30 00, Cast-in-Place Concrete.

   1. Admixtures for use in shotcrete shall meet the requirements of ASTM C1141.
   2. Integral Color Additives for shotcrete, where indicated on Drawings, shall be in accordance with Section 03 30 00, Cast-in-Place Concrete.

2.02 REINFORCEMENT

   A. Reinforcement for shotcrete shall be in accordance with Section 03 21 00, Steel Reinforcement.

2.03 CONCRETE ACCESSORY MATERIALS

   A. Accessory materials for shotcrete shall be in accordance with Section 03 30 00, Cast-in-Place Concrete.

2.04 SEALANTS AND CURING MATERIALS

   A. Sealants and curing materials for shotcrete shall be in accordance with Section 03 30 00, Cast-in-Place Concrete.

PART 3 EXECUTION

3.01 GENERAL

   A. Shotcrete shall be applied at the locations and to the thicknesses shown on Drawings. The thickness of shotcrete shall not be less than the dimensions shown on Drawings.

   B. For rock and soil cuts, surfaces shall be prepared to the line and grade shown on Drawings. The Contractor shall provide documentation, including survey data, to show that the excavated face conforms to Drawings so that the minimum thickness is achieved. If the Engineer determines that irregularities are excessive, additional reinforcing may be required. All costs associated with additional shotcrete required to bring an over excavated cut to the proper line and grade shall be borne by the Contractor. The Contractor shall fill all voids, holes, and pits created during the excavation process. Where additional shotcrete in excess of the plan thickness is required to make the final shotcrete face conform to Drawings, the Contractor shall provide a plan and method statement for applying the additional shotcrete. The work shall not proceed until the proposed plan and methods have been reviewed and approved by the Engineer.
3.02 BATCHING AND MIXING

A. Per Section 03 30 00, Cast-in-Place Concrete.

B. Shoot shotcrete materials within 90 minutes after batching.

3.03 SURFACE PREPARATION

A. General: Do not apply shotcrete to frozen surfaces. De-icing compounds shall not be used to thaw ice, snow, or frost.

B. Earth: Prepare surfaces to line and grade. Dampen surface immediately prior to shooting.

C. Concrete, Masonry, and Shotcrete: When bonding is required, remove all deteriorated, loose, unsound material or contaminants that may inhibit bonding. Chip areas to be repaired to remove offsets causing abrupt changes in thickness. Taper edges to eliminate square shoulders at the perimeter of a cavity. Surfaces shall be a saturated surface dry condition immediately prior to shooting.

   1. When multiple layers of shotcrete are to be applied, each layer of shotcrete shall be cleaned. If curing compound is used, the curing compound shall be removed by sandblasting or a method approved by the Engineer.

D. Structural/Reinforcement: The surface shall be free of deleterious materials that inhibit bonding. For new construction, reinforcement laps shall be separated with a clearance of at least three times the diameter of largest aggregate. Reinforcement shall be secured to prevent movement. Existing rebar and metals shall be sandblasted clean prior to shotcrete placement.

E. Rock: Remove loose material, mud, or other foreign material that will prevent bonding. Clean surface. Prewet surface and apply epoxy immediately prior to shooting.

F. Forms: Use form-release coating material on removable forms. Secure forms to minimize the effects of vibration. Construct forms to allow escape of placement air and rebound.

3.04 JOINTS

A. Construction Joints: Taper construction joints at a 1 to 1 slope where joint is not subject to compression loads. Surface preparation of joints shall comply with Article Surface Preparation, Paragraph Concrete, Masonry, and Shotcrete. Continue reinforcement through construction joint.
3.05 ALIGNMENT CONTROL

A. Install taut ground wires or other means to establish thickness and plane of required surface. Install taut ground wires or other means at corners of offsets not established by forms.

3.06 APPLICATION

A. Placement Techniques: Provide a platform that permits nozzleman unobstructed access to the receiving surface. Place shotcrete first in corners, recesses, and other areas where rebound and overspray cannot escape easily. Remove rebound and overspray from previously prepared surfaces prior to shotcrete placement.

1. Place shotcrete with nozzle held approximately perpendicular to the receiving surface. In corners, direct nozzle at approximately 45-degree angle or bisect the corner angle. Apply shotcrete so sags or sloughing do not occur. Discontinue shooting or shield the nozzle stream if wind causes separation of ingredients during shooting.

2. Do not reuse rebound or overspray. Remove laitance from shotcrete surfaces to receive additional shotcrete layers. Surface preparation after final set shall comply with Article Surface Preparation, Paragraph Concrete, Masonry, and Shotcrete. Do not apply shotcrete on surfaces with standing water from adjacent surfaces, including exposed reinforcement.

B. Encasement of Reinforcement: Place shotcrete to completely encase reinforcing steel. Encase reinforcement by shooting with enough velocity and plasticity so material flows around and behind the reinforcement. Front face of reinforcement shall remain clean during encasement.

1. Place shotcrete to provide the cover over reinforcement required by ACI 301. Minimum slump of shotcrete is 1 inch.

C. When reinforcing fibers are required, the fibers shall be uniformly dispersed in the shotcrete. Production shall be suspended when visible fiber clumps are observed.

3.07 FINISHES

A. Surface finishes for shotcrete shall be as indicated on Drawings and shall meet the following requirements:

1. Unfinished (Gunned Finish): Finished surface created from the shotcrete process with no additional finishing work.
2. Shotcrete Type I: Type I finish shall consist of floating and smooth troweling to a uniform surface, followed by staining/dry-shake coloring and sealing. Portions of this surface will be under water at all times.

3. Shotcrete Type II: Type II finish consist of floating and placing foil over the surface to create minor (1/8-inch deep) irregular lines in the surface. Texture mats or stamps to create irregular lines will also be allowed. Surface shall be colored using staining/dry-shake coloring and sealed.

B. Faux Rock Plaster Finishes per Section 03 37 14, Faux Rock.

3.08 CURING

A. Per requirements of Section 03 30 00, Cast-in-Place Concrete.

B. Natural curing shall be permitted if ambient relative humidity is maintained above 95 percent.

C. Curing method shall be compatible with and not cause any discoloration or damage to surface finishes and color treatments.

D. The following procedures shall be followed if the temperature of the shotcrete structure falls below 32 degrees F before the minimum curing period is complete:

1. Cores shall be taken following the procedures of ASTM C1604 at locations designated by the Engineer.

2. The Engineer will take immediate possession of the cores and submit the cores for a petrographic examination in accordance with ASTM C856.

3. All costs associated with coring, transmittal of cores, and petrographic examination shall be borne by the Contractor regardless of the outcome of the petrographic examination.

4. Shotcrete damaged by frost as determined from petrographic examination shall be removed and replaced at the Contractor’s expense.

5. The Contractor shall patch areas used for sampling and testing immediately after samples have been removed.

3.09 COLD/HOT WEATHER SHOTCRETING

A. Cold and hot weather shotcreting shall be performed per requirements of Section 03 30 00, Cast-in-Place Concrete.

B. Do not place shotcrete when material temperature is above 90 degrees F.
C. Shooting may proceed when ambient temperature is 40 degrees F and rising. 50 degrees F for latex modified shotcrete. Shooting shall be discontinued when ambient temperature is 40 degrees F and falling unless protective measures are taken to protect shotcrete. Shotcrete shall not be placed against frozen surfaces.

3.10 PROTECTION

A. Protect surfaces not intended for shotcrete placement against deposit of rebound and overspray or impact from nozzle stream.

B. Remove rebound and hardened overspray from final shotcrete surfaces and from areas not intended for shotcrete placement.

3.11 TOLERANCES

A. Thickness of shotcrete as indicated on Drawings shall be a minimum.

END OF SECTION
PART 1   GENERAL

1.01 DESCRIPTION

A. This work consists of constructing faux rock or simulated rock with pneumatically applied concrete, coloring, texturing, and finishing onto designated surfaces at locations and thicknesses with the lines and dimensions shown on the plans or as designated by the Engineer.

B. Inform Engineer at least 2 weeks in advance of time and places at which Contractor intends to place pneumatically applied concrete. All preparation work for concrete placements shall be substantially completed at least 2 workdays prior to the scheduled start of concrete placement to allow for the Engineer's review and any necessary corrections.

1.02 RELATED WORK

A. Section 03 10 00, Concrete Forming and Accessories.

B. Section 03 21 00, Steel Reinforcement.

C. Section 03 30 00, Cast-in-Place Concrete.

D. Section 03 37 13, Shotcrete.

E. Section 03 45 39, Sculpted Concrete.

F. Section 31 38 00, Rock.

1.03 SPECIFICATION PRECEDENCE

A. This specification section is supplemental to Section 03 37 13, Shotcrete. Work shall be completed per the requirements of Section 03 37 13, Shotcrete, and additional or revised requirements as described in this section. Should a conflict exist between sections, the requirements of this section shall govern.
1.04 SUBMITTALS

A. The following documents shall be submitted in accordance with project specifications. Faux rocks shall not be constructed on the project before the submittals and quality assurance items have been reviewed and approved by the Engineer.

1. See Section 03 37 13, Shotcrete, for submittal requirements for pneumatically applied concrete.
2. Submit integral color pigment samples or colored concrete chip and appropriate technical information on color pigments, dry-shake color hardeners, stains, texture mat patterns, and sealants.
3. Other appropriate technical information for placing and finishing faux rock.
4. Shop drawings for faux rock features indicating sizes, spacing, locations, and quantities of reinforcing steel, bending and cutting schedules, splicing, supporting and spacing devices, and other accessories.

1.05 QUALITY ASSURANCE

A. Subcontractor Qualifications: In order to be considered an acceptable subcontractor for placement of shotcrete and faux rock surfaces, the Contractor shall meet the requirements of this Specification. Documentation must be provided to the Engineer, prior to any work on site, supporting the following requirements.

1. The subcontractor must have successfully completed at least three demonstration projects, totaling at least 10,000 square feet, utilizing the methods proposed for this project to replicate natural surfaces with hand-carved shotcrete. The nozzleman for the project must be certified as an ACI shotcrete nozzleman for the process to be used on the project and have worked on the majority of at least two of the demonstration projects. Subcontractor shall submit a statement detailing related experience and in meeting stated requirements.

2. The subcontractor’s project manager must have project management experience with at least three faux rock (carved shotcrete or simulated rock projects), experience in the management of project crews of at least five persons, experience with hand-carved shotcrete construction techniques, and experience in coordinating with other trades in the completion of the carved shotcrete and simulated rock projects. Subcontractor shall submit a statement detailing related experience and in meeting stated requirements.
3. The subcontractor shall submit a list of three demonstrated projects completed in the last 5 years including photographs as noted below. The list shall include project name, location and the name, address and phone number of an Owner’s representative who can be contacted as a reference. Also included shall be the name of the project’s manager and other key individuals.

4. The subcontractor shall submit at least three 8-inch by 10-inch color photographs of each of the demonstrated projects listed in Item 3 above to demonstrate their ability to replicate natural surfaces.

B. The Engineer will review all submittals described above and will either approve or reject the subcontractor’s qualifications for performing the work on this project.

1. Three samples of colored and stained shotcrete for each faux rock finish type measuring at least 24 inches by 24 inches by 2 inches shall be submitted to the Engineer for the purpose of approving the selected colors, shades, hues and surface texture. The Engineer will have 15 calendar days to either approve or reject the submittal. Production shotcrete shall use the same shotcrete materials, colorants and mix proportion as the approved samples.

2. At least 10 working days prior to beginning the work, the Contractors shall submit to the Engineer for review and approval all working drawings and calculations required to complete the work. The working drawings shall clearly show all shotcrete features, embedded rocks, and all visible elements of the work. The working drawings shall also show reinforcing details and details of connections to the previously completed shotcrete.

C. Preconstruction Test Panels (Shotcrete Quality): Per Section 03 37 13, Shotcrete, requirements.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Faux rock shotcrete materials shall meet the requirements of Section 03 37 13, Shotcrete, Section 03 30 00, Cast-in-Place Concrete, and as follows.

B. Faux rock plaster is the outer finished layer of concrete that is non-reinforced. Aggregates shall be Grading No. 1 per Section 03 37 13, Shotcrete.

C. Faux rock shotcrete shall be applied using a wet mix process. Dry mix processes are prohibited.
D. Faux Rock Admixtures:

1. Fibrous Concrete Reinforcement: For all concrete used in shotcrete and faux rock, add 100 percent virgin polypropylene fibrillated fibers to concrete. Application per cubic yard shall equal a minimum of 0.1 percent by volume (1.5 lbs/CY). Fiber length shall be graded per manufacturer. Fiber manufacturer must document evidence of 5 year satisfactory performance history, compliance with applicable building codes, ASTM C1399, and ASTM C1116/C1116 M, Type III fiber reinforced concrete. Fibrous concrete reinforcement shall be Fibermesh 300 or Fibercast 500 manufactured by Propex Concrete Systems, Chattanooga, TN, “or-equal.” Product use shall be in accordance with manufacturer’s instructions and recommendations and be compatible with shotcrete application.

2. Color Additives for Faux Rock Concrete/Plaster: Faux rock concrete shall have integral color pigments added to the mix and be as manufactured by Davis Colors, “or-equal,” at the rates indicated as acceptable following sample panel installation.
   a. Colored additives shall contain pure, concentrated mineral pigments specially processed for mixing into concrete and complying with ASTM C979.
   b. Color additives containing carbon black are not acceptable. Black and Gray coloring shall be obtained using black iron oxide pigments.
   c. The following color(s) are suggested for this project. Contractor to determine exact colors to be added to mimic the natural rock of the project and construct sample panel for approval by the Engineer:
      1) Faux Rock: Davis Color #
   d. Dosage rates shall typically be between 1 percent and 5 percent and shall not exceed 10 percent of weight of cementitious materials in mix. Contractor shall determine the exact dosage required to produce Faux Rock to mimic the natural rock of the project.
E. Surface Treatments and Finishes:

1. Dry Shake Color Hardeners: Color hardeners, where indicated on Drawings, in the Specifications, or selected by the Contractor, shall be as manufactured by Brickform, “or-equal,” at the rates indicated as acceptable following sample panel(s) installation.
   a. The following colors are suggested for this project. Contractor to determine exact colors to be added to mimic the natural rock of the project and construct sample panel for approval by the Engineer:
      1) **Faux Rock**: Brickform Color Hardener #

2. Stain and Sealant: Concrete stain, where required by Drawings, shall be as recommended by the Contractor to meet the following requirements.
   a. Create base colors, and color variations that are deemed acceptable following test panel production.
   b. Accurately simulate hues, streaking and coloration matching on-site bedrock and boulders.
   c. Must maintain color (little to no fading) in submerged conditions or direct sunlight.
   d. Following staining, the finish shall be sealed with sealant recommended by the Contractor, and shall meet the following requirements:
      1) No discoloration with exposure to sunlight.
      2) Increase durability by limiting water penetration.
      3) Preserve color of original stain.

2.02 CONCRETE PRODUCTION

A. Faux rock shotcrete and plaster production and proportioning shall meet the requirements of Section 03 37 13, Shotcrete, and Section 03 30 00, Cast-in-Place Concrete.

PART 3 EXECUTION

3.01 SHOTCRETE

A. Faux rock shotcrete shall be applied using a wet mix process and requirements of Section 03 37 13, Shotcrete.

3.02 PREPARATION OF SURFACE FOR PLASTER COAT

A. Shotcrete: Remove all deteriorated, loose, unsound material or contaminants that may inhibit bonding. Chip areas to be repaired to remove offsets causing abrupt changes in thickness. Taper edges to eliminate square shoulders at the perimeter of a cavity.
B. Cracks shall be opened, cleaned, and repaired with a 3:1 mix of sharp sand and portland cement mixed with a solution of 1 part bonding agent to 5 parts water. Moving or dynamic cracks should be repaired with Sikaflex 1-a in accordance with manufacturer’s recommendations.

3.03 FAUX ROCK PLASTER FINISHES

A. Finishes shall meet or exceed the quality of faux rock at the Ocoee River Olympic Whitewater Venue in Tennessee. Photos of expected Faux Rock finish quality are as follows:

Photo #1 - Ocoee River Faux Rock
(center-left of photo, dark brown color)

Photo #2 - Ocoee River Faux Rock (center and left, dark brown color)
B. Prior to plaster placement, clean and treat underlying shotcrete surfaces in accordance with the requirements of Drawings and these specifications. The plaster shall have surface stain/dry-shake color hardener or surface stain/dry-shake color hardener and integral color to simulate on-site rock outcrops or individual boulders as designated by the Engineer. The surface shall have a character similar to surrounding surfaces and blend harmoniously with other portions of the work.

C. Plaster shall be placed within 12 hours of underlying shotcrete placement or underlying shotcrete shall be pressure washed, allowed to air dry and coated with Sikadur 32 epoxy prior to plaster placement.

D. Plaster finishes shall be the result of hand carving and smoothing of plaster by experts provided by the subcontractor and approved by the Engineer, based on previous work examples and approved test panels for this project.

1. Faux Rock Type I Finish: Type I finish shall consist of a minimum of a 2-inch plaster layer with 1-1/2-inch sculpted joints resulting with a smooth, rounded surface. Plaster shall be stained/dry shake colored to match appearance of onsite rock and shall extend a minimum of 1 foot below finished grade. The finish shall be zoo quality. The finish will be partially submerged and in direct contact by people. Final sealing, as recommended by the subcontractor, shall not allow effervescence unless deemed by the Engineer to enhance the quality of the work.

2. Faux Rock Type II Finish: Type II Finish shall consist of a minimum of a 4-inch plaster layer with 3-1/2-inch sculpted joints resulting with a smooth, rounded surface. Plaster shall be integrally colored and stained/dry shake colored to match appearance of onsite rock and shall extend a minimum of 1 foot below finished grade. The finish shall be best zoo quality. The finish will be partially submerged and in direct contact by people. Final sealing, as recommended by the subcontractor, shall not allow effervescence unless deemed by the Engineer to enhance the quality of the work.

3.04 CURING

A. Per requirements of Section 03 37 13, Shotcrete, and Section 03 30 00, Cast-in-Place Concrete.

B. Curing method shall be compatible with and not cause any discoloration or damage to surface finishes and color treatments.
3.05 TOLERANCES

A. Thicknesses of shotcrete and plaster as indicated on Drawings shall be a minimum. Elevations of faux rock shall meet the requirements for boulder placement defined in Section 31 38 00, Rock.

END OF SECTION
SECTION 03 39 00
CONCRETE CURING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI): 308.1, Specification for Curing Concrete.
2. ASTM International (ASTM):

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturers’ data indicating compliance with the requirements specified herein for the following products:
   a. Exposed aggregate finish retardant on formed surface.
   b. Evaporation retardant.
   c. Curing compound.
   d. Penetrating water repellent sealer.
   e. Clear liquid densifier.

2. Curing methods proposed for each type of element such as slab, walls, beams, and columns in each facility.

B. Informational Submittals:

1. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for the following:
   a. Curing compound showing moisture retention requirements.
   b. Retardants for exposed aggregate finish.
PART 2 PRODUCTS

2.01 MATERIALS

A. Curing Compound:

1. Water-based, high-solids content, nonyellowing, curing compound meeting requirements of ASTM C1315, Class A.

2. Manufacturers and Products:
   a. Euclid Chemical Co., Cleveland, OH; Super Diamond Clear VOX.
   b. WR Meadows, Inc., Hampshire, IL; VOCOMP-30.
   c. Vexcon Chemical, Inc.; Philadelphia, PA; Starseal 1315.
   d. Dayton Superior; Safe Cure and Seal 1315 EF.
   e. BASF Construction Chemicals, Shakopee, MN; MasterKure CC 200WB.
   f. Euclid Chemical Co., Cleveland, OH; EucoCure VOX.
   g. Euclid Chemical Co., Cleveland, OH; Kurez VOX White Pigmented.

B. Evaporation Retardant:

1. Optional: Fluorescent fugitive dye color tint that disappears completely upon drying.

2. Manufacturers and Products:
   a. BASF Construction Chemicals, Shakopee, MN; MasterKure ER 50.
   b. Euclid Chemical Co.; Eucobar.

C. Penetrating Water Repellent Sealer: Water based, ready to use, single component, silane/siloxane, penetrating, clear water repellent sealer.

1. Viscosity: 50 cps.
2. Flash Point: 200 degrees F.
3. NCHRP No. 244 Reduction in Chloride Content:
   a. Average: 82 percent.
   b. Minimum Required: 75 percent.
4. NCHRP No. 244 Reduction in Weight Gain:
   a. 21 Days: 85 percent.
   b. VOCs: 50 g/L.
   c. Depth of Penetration: 1/4 inch.
5. Manufacturers and Products:
   a. BASF Construction Chemicals, Shakopee MN; MasterProtect H 400.
   b. Euclid Chemical Co.; Baracade WB 244.
D. Water: Clean and potable, containing less than 500 ppm of chlorides.

PART 3 EXECUTION

3.01 CONCRETE CURING

A. General:

1. Cure all concrete in accordance with Project Specifications and ACI308.1.
2. Where surfaces are to receive coatings, painting, cementitious material, or other similar finishes, use only water curing procedures. Refer to Interior Finish Schedule for surfaces to receive coatings.
3. Use only water curing on potable water structures.
4. Where curing compound cannot be used, water curing as described below or special methods using moisture shall be agreed upon by Engineer prior to placing concrete.
5. As required in Section 03 30 00, Cast-in-Place Concrete, if result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing specified below, by 7 additional days.

B. Use one of the following methods as approved by Engineer:

1. Vertical Surfaces:
   a. Method 1: Leave concrete forms in place and keep surfaces of forms and concrete wet for 7 days.
   b. Method 2: Continuously sprinkle with water 100 percent of exposed surfaces for 7 days starting immediately after removal of forms.
   c. Method 3: Apply curing compound, where allowed, immediately after removal of forms.
2. Horizontal Surfaces:
   a. Method 1: Protect surface by water ponding for 7 days.
   b. Method 2: Cover with burlap or cotton mats and keep continuously wet for 7 days.
   c. Method 3: Cover with 1-inch layer of wet sand, earth, or sawdust, and keep continuously wet for 7 days.
   d. Method 4: Continuously sprinkle exposed surface for 7 days.
   e. Method 5: Apply curing compound, where allowed, immediately after final finishing when surface will no longer be damaged by traffic.
3.02 EVAPORATION RETARDANT APPLICATION

A. Use on flatwork when environmental conditions are anticipated to cause rapid drying of the concrete surface. Do not use evaporation retardant on potable water structures, unless product is NSF 61 approved.

B. Spray onto surface of fresh flatwork concrete immediately after screeding to react with surface moisture.

C. Reapply as needed to ensure a continuous moist surface until final finishing is completed.

3.03 PRESTRESSED TANK CONCRETE CURING

A. Keep concrete surfaces and form continuously wet for 7 days where portland cement is used, or 3 days where high-early-strength cement is used.

B. Begin curing immediately after initial concrete set has occurred.

C. Do not use curing compounds.

3.04 PENETRATING WATER REPELLENT SEALER APPLICATION

A. Apply where indicated on Interior Finish Schedule.

B. Before application and with Work above completed, water cure concrete walls and floors for a minimum of 28 days to receive sealer, keep clean, unpainted, and free from membrane curing compounds.

C. Concrete to receive penetrating sealer shall be dry for a minimum 24 hours immediately prior to application.

D. Apply per manufacturer’s recommendations utilizing low pressure airless spray equipment.

1. Actual coverage and number of coats to be determined by field test sample application and water absorption testing. Final approval by Owner is required.

E. Apply at a coverage rate of 125 square feet per gallon to 200 square feet per gallon. Cure penetrating sealer on slabs for the minimum time recommended by manufacturer prior to allowing foot or vehicular traffic.
3.05 MANUFACTURER’S SERVICES

A. Provide manufacturer’s representative at Site for installation assistance, inspection, and certification of proper installation for products specified.

B. Provide penetrating water repellent sealer manufacturer’s representative to demonstrate proper application of product.

C. Provide clear liquid densifier manufacturer’s representative to demonstrate proper mixing and application of product.

D. Provide curing compound manufacturer’s representative to demonstrate proper application of curing compound to show coverage in one coat.

E. Provide retardant for exposed aggregate surfaces manufacturer’s representative to demonstrate proper application and surface mortar removal procedures.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION

A. This section covers concrete that is stamped, textured, colored, and finished to create sculpted concrete (may also be referred to as sculpted rock) to mimic the appearance of natural rock, including furnishing materials, transporting, placing, finishing, curing and other appurtenant items of construction.

1.02 RELATED WORK

A. Section 03 10 00, Concrete Forming and Accessories.

B. Section 03 21 00, Steel Reinforcement.

C. Section 03 30 00, Cast-in-Place Concrete.

D. Section 31 38 00, Rock.

1.03 SUBMITTALS

A. The following documents shall be submitted in accordance with project specifications. Sculpted rock shall not be constructed on the project before the submittals and quality assurance items have been reviewed and approved by the Engineer.

1. See Section 03 30 00, Cast-in-Place Concrete, for submittal requirements for concrete.

2. Submit integral color pigment samples or colored concrete chip and appropriate technical information on color pigments, dry-shake color hardeners, stains, texture mat patterns, and sealants.

3. Other appropriate technical information for placing and finishing sculpted rock.

4. Three samples of colored, stained, textured, or stamped concrete for each sculpted rock finish type on the project measuring at least 24 inches by 24 inches by 2 inches shall be submitted to the Engineer for the purpose of approving the selected colors, shades, hues and surface texture. The Engineer will have 15 calendar days to either approve or reject the submittal. Production sculpted rock shall use the same materials, colorants, finishing and mix proportion as the approved samples.
1.04 QUALITY ASSURANCE

A. Subcontractor Qualifications:

1. In order to be considered the subcontractor for placement of sculpted concrete surfaces, the Contractor shall meet the requirements of this Specification. Documentation must be provided to the Engineer, prior to any work onsite, supporting the following requirements:

   a. The subcontractor must have successfully completed at least three demonstrated projects, totaling at least 5,000 square feet within the last 5 years, utilizing the methods proposed for this project to replicate natural rock surfaces with textured or stamped and colored concrete. Demonstrated projects shall include projects such as zoos, golf courses, waterways, and other high-end rock simulations. Portions of demonstrated projects submitted (or area accounted in these qualification requirements) shall not include any work related to residential construction, driveways, paths, curbs, etc. Subcontractor shall submit a statement detailing related experience and in meeting stated requirements.

   b. The subcontractor shall submit a list of these three demonstrated projects as specified above, including photographs as noted below. The list shall include project name, location, and the name, address, and phone number of an Owner’s representative who can be contacted as a reference. Also included shall be the name of the project’s manager and other key individuals.

   c. The subcontractor shall submit the name of the crew chief of the work to be performed and their experience must include at least one of the demonstrated projects acting in the same role. The crew chief shall be onsite during placement of sculpted rock and shall direct all finishing and sculpting efforts.

   d. The subcontractor shall submit at least three 8-inch by 10-inch color photographs of each of the demonstrated projects listed in Item 2 above to demonstrate the subcontractor’s ability to replicate natural surfaces.

B. The Engineer will review the submittals described above and will either approve or reject the subcontractor’s qualifications for performing the work on this project.

C. The Contractor shall construct sample areas for each type of sculpted rock used on the project. Each area shall measure not less than 50 square feet. The sample area shall represent the finished surface texturing, coloring, and etching of the sculpted concrete features. The Engineer or other representatives of the Owner shall observe and approve the sample panel prior to the construction of any sculpted concrete features. The location of each
sample area will be determined with the Engineer, if acceptable, the sample area may remain in place, if not the sample area will be removed and a second sample area be constructed.

D. At least 10 working days prior to beginning the work, the Contractors shall submit to the Engineer for review and approval all working drawings and calculations required to complete the work. The working drawings shall clearly show all sculpted rock features, embedded rocks, and all visible elements of the work. The working drawings shall also show reinforcing details and details of connections to any previously completed work.

E. Small (4-inch to 6-inch square) areas of sculpted rock will be removed and sampled after initial placement for visual testing purposes by the Engineer during installation. Verification of surface treatment mixing and penetration will be made. Contractor shall replace and repair these areas immediately so that no cold joints or color variations occur. Approximate tests may be one per 3 square yards to 10 square yards.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Concrete, admixtures, surface treatments, and finishes for sculpted rock shall meet the requirements of Section 03 30 00, Cast-in-Place Concrete, as modified below.

1. Fibrous Concrete Reinforcement: Per Section 03 30 00, Cast-in-Place Concrete.

2. Color Additives for Sculpted Rock: When indicated on Drawings or Specifications, sculpted rock shall have integral color pigments added to the mix and be as manufactured by Davis Colors, “or-equal,” at the rates indicated as acceptable following sample panel installation.
   a. Colored additives shall contain pure, concentrated mineral pigments specially processed for mixing into concrete and complying with ASTM C979.
   b. Color additives containing carbon black are not acceptable. Black and Gray coloring shall be obtained using black iron oxide pigments.
   c. The Contractor shall determine exact color or combination of colors to be added to mimic the natural rock of the project and construct sample panel for approval by the Engineer. Color samples shall be submitted to the Engineer prior to sample panel construction.
d. Contractor shall determine the exact dosage required to produce grout to mimic the natural rock of the project as per manufacturer recommendations and Engineer approval.

e. Meter and dispense colors using computer-controlled automated color weighing and dispensing systems provided by the manufacturer of the color additive. As an alternative manual dispensing may be used and accomplished by addition of premeasured disintegrating bags. Particular attention must be given to thorough mixing of concrete after addition of the color additives.

f. Do not retemper mix by adding water in the field.

B. Surface Treatment and Finishes:

1. Dry Shake Color Hardeners:
   a. Color hardeners, where indicated on Drawings or in the Specifications shall be as manufactured by Brickform, or approved equal at the manufacturer recommended application rates or as approved following sample panel(s) installation:
      1) The Contractor shall determine exact color or combination of colors to be applied to mimic the natural rock of the project and construct sample panel for approval by the Engineer. Color samples shall be submitted to the Engineer prior to sample panel construction.
      2) Grout Color: Dry shake color hardener shall be applied to the 75 percent of the grout surface area above “Low Water Level” and as shown on Drawings. Coloring shall be applied randomly to create variegation of colors, hues, and shades similar to natural rock. Apply per manufacturer’s recommendations and approved sample panel installation.

2. Stain and Sealant:
   a. Concrete stain, where required by Drawings or Specifications, shall be as recommended by the Contractor to meet the following requirements:
      1) Create base colors, and color variations that are deemed acceptable following test panel production.
      2) Accurately simulate hues, streaking and coloration matching onsite bedrock and boulders.
      3) Must maintain color (little to no fading) in submerged conditions or direct sunlight.
      4) Following staining, the finish shall be sealed with sealant recommended by the Contractor and stain manufacturer, and shall meet the following requirements:
          a) No discoloration with exposure to sunlight.
          b) Increase durability by limiting water penetration.
c) Preserve color of original stain.

5) Stain and sealants shall be applied per manufacturer’s recommendations.

3. Copper Shake: Areas where required by Drawings or Specifications shall have powdered copper evenly worked within the upper 1/2 inch of the sculpted rock finish. The copper shall be from 98 percent to 99.999 percent pure electrolytic copper powder -325 Mesh. The application shall be at no less than 3 pounds per square yard.

4. Coloring and Finishes Summary: See the information in the following table for a summary of the coloring and finishes requirements for this project.

C. Sculpted Rock Color Admixtures and Finishing Requirements:

1. See admixture and finishing requirements in Section 31 38 00, Rock. Project requirements for sculpted rock coloring and finishing per table:

<table>
<thead>
<tr>
<th>Finish</th>
<th>Integral Concrete Color</th>
<th>Dry-Shake Surface Color Hardeners</th>
<th>Surface Stain</th>
<th>Copper Shake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sculpted Rock – All Types</td>
<td>Yes</td>
<td>Yes</td>
<td>None</td>
<td>Include on 10% of total area of the Sculpted Rock – Areas are generally located within and adjacent to the Drops and WaveShapers as directed by Engineer. Apply in addition to other finish treatments.</td>
</tr>
</tbody>
</table>

2.02 CONCRETE ACCESSORY MATERIALS

A. Concrete Accessory Materials for Sculpted Rock shall be in accordance with Section 03 30 00, Cast-in-Place Concrete.

B. Colored powder release agent shall be Antique Release as manufactured by Brickform, “or-equal” by Engineer.

C. Liquid Membrane: Membrane-curing compound shall be in accordance with ASTM C309. Membrane curing compound shall be sprayable, 18 percent minimum solids content, MasterKure 123, “or-equal” acceptable to the Engineer. Membrane curing compound used on colored concrete shall be BASF Kure 1315, “or-equal” acceptable to the Engineer. When used on colored or stained concrete, curing compound shall be approved by color additive/stain manufacturer and compatible with the color additives, stains, and any surface treatments/finishes used.
2.03 REINFORCEMENT

A. Reinforcement for sculpted rock shall be in accordance with Section 03 21 00, Steel Reinforcement.

B. Dowels shall be embedded in the grouted core rock and attached to sculpted rock reinforcement as per lap length and embedment requirements as shown on Drawings. Dowels shall be installed at a rate of 1 dowel per 5 square feet, unless shown otherwise on Drawings.

PART 3 EXECUTION

3.01 GENERAL

A. Concrete placement, conveyance, and consolidation shall meet the requirements of Section 03 30 00, Cast-in-Place Concrete.

B. Contractor shall have all subgrade and surface preparations, reinforcement, and form installation completed 24 hours prior to the pour to allow inspection and approval by Engineer.

3.02 SURFACE PREPARATION

A. General:

1. Moisten subgrade prior to placement, but do not cause water to pond, nor muddy or soft spots to appear.
2. Designate limits of each placement and obtain Engineer's review of entire installation prior to proceeding.

B. Concrete Placed Against Rock:

1. Remove all loose pieces of rock.
2. Thoroughly clean all rock surfaces in accordance with Section 31 38 00, Rock.
3. Dampen rock surfaces prior to concrete placement.

C. Concrete Placed Against Hardened or Existing Concrete:

1. Prior to placing fresh concrete against surface of hardened concrete, complete the following:
   a. Remove all laitance, foreign substances (including curing compound), wash with clean water, and thoroughly wet hardened surface before placing fresh concrete.
3.03 JOINTS

A. Concrete joints for Sculpted Rock shall meet the requirements of Section 03 30 00, Cast-in-Place Concrete.

B. Expansion and contraction (control) joints shall be placed at locations shown or indicated on Drawings.

C. Construction joints shall be at locations shown on Drawings and as required between placements. Engineer shall approve the location of all construction joints not shown on Drawings.

3.04 SCULPTED ROCK FINISHES

A. Sculpted rock shall have a combination of surface stain, dry-shake color hardener and integral concrete color to simulate onsite rock outcrops or individual boulders as designated by the Engineer. The surface shall have a character similar to surrounding surfaces and blend harmoniously with other portions of the work. Sculpted rock work shall be performed to match the approved sample panel and use the same construction procedures and techniques employed to assemble the approved sample panel. Photos of expected sculpted rock finish quality are as follows:

Photo #1 - Sculpted Rock Example During Construction
ZINK DAM IMPROVEMENTS

Photo #2 - Sculpted Rock Example During Construction

Photo #3. Sculpted Rock During Construction
Photo #4 - Type I Sculpted Rock Concrete Boulder

Photo #5 - Type II Sculpted Rock
Olympic Venue, Ocoee River after 20 Years
B. General:

1. Concrete shall be poured at a slump appropriate to the slope of the slab being placed. Slopes steeper than 3 to 1 (horizontal to vertical) shall be placed using irregular step forms or as shown on Drawings.
2. During and immediately after placement, thoroughly compact and work around all reinforcements, embedments, and into corners of forms, eliminating all air or stone pockets that may cause honeycombing, pitting, or planes of weakness. Mechanical vibrators shall be used to consolidate concrete.
3. The Contractor shall use trowels, floats, brushes/brooms, and other concrete finishing tools to consolidate, buildup, sculpt, and texture the slab.
4. Finished surfaces must be slip resistant.
5. Do not dampen finishing tools when integral colored concrete is used.
6. Do not over-trowel or start troweling late when integral colored concrete is used.
7. Use dry shake Color Hardeners and stains to create color accents. Apply per manufacturer recommendations.
8. Stain shall be applied once the grout has cured 28 days. A sealant shall be applied per manufacturer recommendations that is compatible with the stain used.
9. Texture mats or stamps may be used when approved by the Engineer. Final sculpted rock surface finishes shall not be uniform or repeatable. Colored powdered releasing agents may be used to enhance the finish.

C. Sculpted rock finishes shall be the result of hand carving, texturing, stamping, and smoothing of concrete by experts provided by the subcontractor and approved by the Engineer, based on previous work examples and approved test panels for this project.

1. Appearance of the sculpted rock shall be like that shown in Photo #4, above. Colors and shading shall be determined in the submittal process.
2. Sculpted Rock Type I Finish: Finish shall consist of a minimum 6-inch concrete layer with 1-1/2-inch sculpted joints in an irregular pattern resulting with a smooth, rounded surface. Finish shall also consist of placing foil or “rubber skin” over the surface to create minor (1/8-inch deep) irregular lines in the surface. Texture mats/stamps may be used to create surface texture. Concrete shall be integrally colored and surface colored with dry-shake color hardener to match appearance as described above. Apply surface stains and/or copper shake when required by the project. Final sealing, as recommended by the subcontractor and coloring product manufacturers, shall not allow effervescence unless deemed by the Engineer to enhance the quality of the work.
3. Sculpted Rock Type II Finish (with foil, mats, and stain): Type II finish shall consist of a minimum of a 9-inch concrete layer with 1-1/2-inch sculpted joints in an irregular pattern resulting in a smooth, rounded surface. Finish shall also consist of placing foil over the surface to create minor (1/8-inch deep) irregular lines in the surface. Texture mats/stamps may be used to create surface texture. Concrete shall be integrally colored and surface colored with dry-shake color hardener and stained to match appearance as described above. The finish will be partially submerged and in direct contact by people. Final sealing, as recommended by the subcontractor, shall not allow effervescence unless deemed by the Engineer to enhance the quality of the work.

4. If not identified on Drawings or in these Specifications, a Type I finish is to be used.

3.05 CURING

A. Per requirements of Section 03 30 00, Cast-in-Place Concrete.

B. Curing method shall be compatible with and not cause any discoloration or damage to surface finishes and color treatments.

3.06 TOLERANCES

A. Thicknesses of sculpted rock as indicated on Drawings shall be a minimum. Elevations of sculpted rock shall meet the requirements for boulder placement defined in Section 31 38 00, Rock.

END OF SECTION
PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. The Contractor shall furnish all labor, materials, equipment, and incidentals required for, and perform all operations in connection with, the installation of the ArmorFlex® Articulating Concrete Block (ACB) system in accordance with the lines, grades, design and dimensions shown on Drawings and as specified herein.

1.02 RELATED SECTIONS

A. Section 03 61 00, Cementitious Grouting.
B. Section 31 22 00, Grading.
C. Section 31 35 19.16, Geotextile Slope Protection.

1.03 SUBMITTALS

A. Submit under provisions of Section 01 30 00, Administrative Requirements.
B. Product Data:

1. Manufacturer's data sheets on each product to be used, including:
   a. Certification of successful completion of full-scale laboratory testing in accordance with the current version of ASTM D7277, Standard Test Method for Performance Testing of Articulating Concrete Block (ACB) Revetment Systems for Hydraulic Stability in Open Channel Flow. This certification shall comprise a final test report from the testing facility, or a summary test report from the testing facility providing the test procedure and the obtained Critical Shear Stress parameters of the tested block. Third-party testimonies of compliance shall not be sufficient to satisfy this requirement.
   b. Certified analysis and interpretation of the test data shall conform to the guidance contained in the current version of ASTM D7276, Standard Guide for Analysis and Interpretation of Test Data for Articulating Concrete Block (ACB) Revetment Systems in Open Channel Flow.
c. The following information obtained from the above testing, analysis, and interpretation:
   1) Tested bed slope.
   2) Maximum discharge attained prior to failure.
   3) Measured water surface elevation.
   4) Calculated energy grade line (EGL).
   5) Plot of the applied shear and velocity by station.
   6) An illustration of the selected control volume on a profile of the test slope.
   7) Calculated design Manning’s.
   8) Calculated block system coefficient of lift.
   9) Characteristic block properties including weight and moment arms.
   10) Extrapolation of tested values to thicker block (if required).

C. Factor of Safety (FoS) Calculations in Support of the Proposed ACB System:

   1. In accordance with the Factor-of-Safety design methodology as described in “Moment Stability Analysis Method for Determining Safety Factors for Articulated Concrete Blocks”, by Amanda L. Cox, 2010.
   2. Stamped and signed by a Professional Engineer licensed to practice in the state where the project is located.
   3. The following project specific hydraulic requirements are to be utilized:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel Bottom Width (ft)</td>
<td></td>
</tr>
<tr>
<td>Channel Side Slopes (H:1V)</td>
<td></td>
</tr>
<tr>
<td>Channel Bed Slope (ft/ft)</td>
<td></td>
</tr>
<tr>
<td>Design Volumetric Flow Rate (cfs)</td>
<td></td>
</tr>
</tbody>
</table>

   4. The analysis shall be performed based upon the stability of the ACBs due to gravity alone, conservatively neglecting any stabilizing forces potentially provided by cabling, mechanical anchorage, contact with adjacent blocks, or other restraints not attributable to gravity alone.
   5. The analysis must account for a 0.5-inch block projection, in accordance with ASTM D6884, Standard Practice for Installation of Articulating Concrete Block (ACB) Revetment Systems, Section 6.3.3. Site grading requirements may not be used to omit this requirement for standard (non-tapered) block. For block that is tapered (i.e., the block thickness is greater on the downstream edge than on the upstream edge, by at least 0.5 inch), this block projection value may be 0 inch for analysis purposes.
D. An appropriate geotextile, selected for the site being protected on the basis of the gradation and permeability of the surface soils.

E. Manufacturer's certificates of compliance for ACB/mats, revetment cable, geotextile, and any revetment cable fittings and connectors in accordance with the current version of ASTM D6884, Standard Practice for Installation of Articulating Concrete Block (ACB) Revetment Systems.

F. Shop Drawings for the layout of the mats, installation, and safety instructions, and any recommendations, if applicable, that are specifically related to the Project.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Suppliers must own and operate their own manufacturing facility.
   2. Suppliers shall directly employ a minimum of five registered Professional Engineers.
   3. A list of five comparable projects, in terms of size and applications, in the United States, where the satisfactory performance of the specific ACB system can be verified after a minimum of 5 years of service life.
   4. The names and contact information (phone numbers and e-mail addresses, at a minimum) for the suppliers’ representatives, for technical, production or logistics questions, at least one of whom must reside in the state where the project is located.

B. Installer Qualifications: Minimum 2-year experience installing similar products.

1.05 PRE-INSTALLATION MEETINGS

A. Supplier’s representative shall be available for pre-installation meeting a minimum 2 weeks prior to starting work of this section.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Materials delivered to the site shall be inspected for damage, unloaded and stored with the minimum of handling. Material shall be kept free of dirt and debris.

B. Storage shall be in accordance with manufacturer’s requirements.

C. Handling: Materials shall be handled in such a manner as to ensure delivery to the site in sound, undamaged condition.
PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:

1. ArmorFlex® as manufactured and sold by:
   ARMORTEC, a Contech Company
   9025 Centre Pointe Dr., Suite 400
   West Chester, OH 45069
   Telephone: (800) 645-7000; Fax: (513) 645-7993
   www.conteches.com/Products/Erosion-Control/Hard-Armor/ArmorFlex

B. Substitutions: Not permitted.

2.02 MATERIALS

A. Articulating Concrete Blocks:


2. Cementitious Materials: Materials shall conform to the following applicable ASTM specifications:
   d. Pozzolans: Specification C618, for Fly Ash and Raw or Calcined Natural Pozzolans for use in Portland Cement Concrete.
   e. Aggregates: Specification C33, for Concrete Aggregates, except that grading requirements shall not necessarily apply.

3. Casting: The ACB units shall be produced using a dry cast method. Dry cast units obtain strength more quickly than wet cast blocks, and will also achieve a greater uniformity of quality and greater durability.
4. Physical Requirements: At the time of delivery to the work site, the ACB units shall conform to the physical requirements prescribed in Table listed below.

<table>
<thead>
<tr>
<th>PHYSICAL REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive Strength Net Area</td>
</tr>
<tr>
<td>Min. psi (mPa)</td>
</tr>
<tr>
<td>Avg. of 3 units</td>
</tr>
<tr>
<td>4,000 (27.6)</td>
</tr>
</tbody>
</table>

5. Visual Inspection:
   a. All units shall be sound and free of defects which would interfere with the proper placement of the unit, or which would impair the performance of the system. Surface cracks incidental to the usual methods of manufacture, or surface chipping resulting from customary methods of handling in shipment and delivery, shall not be deemed grounds for rejection.
   b. Cracks exceeding 0.25 inches (0.635 cm) in width and/or 1.0 inch (2.54 cm) in depth shall be deemed grounds for rejection. Chipping resulting in a weight loss exceeding 10 percent of the average weight of a concrete unit shall be deemed grounds for rejection.
   c. Blocks rejected prior to delivery from the point of manufacture shall be replaced at the manufacturer's expense. Blocks rejected at the job site shall be repaired with structural grout or replaced upon request at the expense of the Contractor.

6. Sampling and Testing:
   a. The purchaser (or their authorized representative) shall be afforded access to the relevant manufacturing facility or facilities, if desired, in order to inspect and/or sample the ACB units from lots ready for delivery prior to release for delivery to the job site. Such inspections are at the sole expense of the requesting entity.
   b. Purchaser may request additional testing other than that provided by the manufacturer as needed. Such requested testing will extend any stated lead times for manufacturing and delivery, if the results of such testing are a prerequisite to approval (i.e., approval for release to manufacturing). Costs associated with such testing shall be borne by the purchaser.
B. Revetment Cables and Fittings:

1. Option 1 - Polyester Revetment Cable and Fittings:
   a. Revetment cable shall be constructed of high tenacity, low elongating, and continuous filament polyester fibers. Cable shall consist of a core construction comprised of parallel fibers contained within an outer jacket or cover.
   b. The size of the revetment cable shall be selected such that the minimum acceptable strength is at least five times that required for lifting of the mats, in accordance with ASTM D6684 paragraph 5.5.2. This design shall include a reduction factor for splicing of 60 percent, unless a larger factor can be substantiated by laboratory testing.
   c. The revetment cable shall exhibit resistance to most concentrated acids, alkalis and solvents. Cable shall be impervious to rot, mildew and degradation associated with marine organisms. The materials used in the construction of the cable shall not be affected by continuous immersion in fresh or salt water.
   d. Selection of cable and fittings shall be made in a manner that ensures a safe design factor for mats being lifted from both ends, thereby forming a catenary. Consideration shall be taken for the bending of the cables around hooks or pins during lifting. Fittings such as sleeves and stops shall be aluminum and washers shall be plastic unless otherwise shown on Drawings.

2. Option 2 - Galvanized Steel Revetment Cable and Fittings:
   a. Revetment cable shall be constructed of preformed galvanized aircraft cable (GAC). The cables shall be made from individual wires and strands that have been formed during the manufacture into the shape they have in finished cable.
   b. Cable shall consist of a core construction comprised of seven wires wrapped within seven or 19 wire strands.
   c. The size of the revetment cable shall be selected such that the minimum acceptable strength is at least five times that required for lifting of the mats, in accordance with ASTM D6684 paragraph 5.5.2. This design shall include a reduction factor for splicing of 75 percent, unless a larger factor can be substantiated by laboratory testing.
   d. The revetment cable shall exhibit resistance to mild concentrations of acids, alkalis, and solvents. Fittings such as sleeves and stops shall be aluminum, and the washers shall be galvanized steel or plastic. Furthermore, depending on material availability, the cable type (7 by 7 or 7 by 19) can be interchanged while always ensuring the required factor of safety for the cable.
   e. Selection of cable and fittings shall be made in a manner that ensures a safe design factor for mats being lifted from both ends,
thereby forming a catenary. Consideration shall be taken for the bending of the cables around hooks or pins during lifting. Fittings such as sleeves and stops shall be aluminum and washers shall be plastic unless otherwise shown on Drawings.

C. Filter Fabric:

1. The standard for sizing geotextile for these applications is AASHTO M288, Permanent Erosion Control, Class 2. Either woven monofilament or nonwoven geotextile are acceptable; woven slit-film geotextiles are not acceptable.

2. Geotextile shall be sized for the soil subgrade permeability per Section 31.35.19.16, Geotextile Slope Protection.

3. Under no circumstances shall the filter fabric be permanently affixed or otherwise adhered to the blocks or mats; i.e., the filter fabric shall be independent of the block system.

4. During all periods of shipment and storage, the filter fabric shall be protected from direct sunlight, UV radiation, and temperatures greater than 140 degrees F. To the extent possible, the fabric shall be maintained wrapped in its protective covering. Geotextile exposure to sunlight or UV radiation shall be minimized to the greatest extent possible until the installation process begins.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. All subgrade preparation shall be performed in accordance with the current version of ASTM D6884, Standard Practice for Installation of Articulating Concrete Block (ACB) Revetment Systems.

B. The slope shall be graded to a smooth plane surface to ensure that intimate contact is achieved between the slope face and the geotextile (filter fabric), and between the geotextile and the entire bottom surface of the individual ACBs. All slope deformities, roots, grade stakes, and stones which project normal to the local slope face must be regraded or removed. No holes, "pockmarks", slope board teeth marks, footprints, or other voids greater than 0.5 inch in depth normal to the local slope face shall be permitted. No grooves or depressions greater than 0.5 inch in depth normal to the local slope face with a dimension exceeding 1.0 foot in any direction shall be permitted. Where such areas are evident, they shall be brought to grade by placing compacted homogeneous material. The slope and slope face shall be uniformly compacted, and the depth of layers, homogeneity of soil, and amount of compaction shall be as required by the EOR.
C. Excavation and preparation for all termination trenches or aprons shall be done in accordance to the lines, grades and dimensions shown on Drawings. The termination trench hinge-point at the top of the slope shall be uniformly graded so that no dips or bumps greater than 0.5 inch over or under the local grade occur. The width of the termination trench hinge-point shall also be graded uniformly to assure intimate contact between all ACBs and the underlying grade at the hinge-point.

D. Immediately prior to placing the filter fabric and ACB mats, the prepared subgrade shall be inspected by the EOR as well as the Owner's representative. No fabric or blocks shall be placed thereon until that area has been approved by each of these parties.

3.02 PLACEMENT OF GEOTEXTILE FILTER FABRIC

A. All placement and preparation should be performed in accordance with the current version of ASTM D6884, Standard Practice for Installation of Articulating Concrete Block (ACB) Revetment Systems. Filter Fabric, or filtration geotextile, as specified elsewhere, will be placed within the limits of ACBs shown on Drawings.

B. The filtration geotextile will be placed directly on the prepared area, in intimate contact with the subgrade, and free of folds or wrinkles. The geotextile will not be walked on or disturbed when the result is a loss of intimate contact between the ACB and the geotextile or between the geotextile and the subgrade. The geotextile filter fabric will be placed so that the upstream strip of fabric overlaps the downstream strip. The longitudinal and transverse joints will be overlapped at least 1.5 feet for dry installations and at least 3 feet for below-water installations. The geotextile will extend at least 1 foot beyond the top and bottom revetment termination points, or as required by the EOR. If ACBs are assembled and placed as large mattresses, the top lap edge of the geotextile should not occur in the same location as a space between ACB mats unless the space is concrete filled.

3.03 PLACEMENT OF THE ACBS/MATS

A. ACB placement and preparation should be performed in accordance with the current version of ASTM D6884, Standard Practice for Installation of Articulating Concrete Block (ACB) Revetment Systems. ACB block/mats, as specified in Part 2 of these Specifications, will be constructed within the specified lines and grades shown on Drawings.

B. Field installation shall be consistent with the way the system was installed in preparation for hydraulic testing pursuant to the current version of ASTM D7277, Standard Test Method for Performance Testing of Articulating Concrete Block (ACB) Revetment Systems for Hydraulic Stability in Open...
Channel Flow. Any external restraints, anchors, or other ancillary components (such as synthetic drainage mediums) shall be employed as they were during testing; e.g., if the hydraulic testing installation utilized a drainage layer, then the field installation must also utilize a drainage layer. This does not preclude the use of other section components for other purposes, e.g., a geogrid for strengthening the subgrade for vehicular loading, or an intermediate filter layer of sand to protect very fine-grained native soils.

C. The subgrade shall be prepared in such a manner as to produce a smooth plane surface prior to placement of the ACBs or mats. No individual block within the plane of placed ACBs will protrude more than 0.5 inch or as otherwise specified by the EOR. ACBs should be flush and develop intimate contact with the subgrade section, as approved by the EOR. Proposed hand placing is only to be used in limited areas, specifically identified by the EOR or manufacturers’ mat layout drawings, as approved by the EOR.

D. If assembled and placed as large mattresses, the ACB mats will be attached to a spreader bar or other approved device to aid in the lifting and placing of the mats in their proper position by the use of a crane or other approved equipment. The equipment used should have adequate capacity to place the mats without bumping, dragging, tearing or otherwise damaging the underlying fabric. The mats will be placed side-by-side, so that the mats abut each other, and/or end-to-end. Mat seams or openings between mats greater than 2 inches will be backfilled with 4,000 psi nonshrink grout, concrete or other material approved by the EOR. Whether placed by hand or in large mattresses, distinct changes in grade that results in a discontinuous revetment surface in the direction of flow will require backfill at the grade change location so as to produce a continuous surface.

E. Termination trenches will be backfilled and compacted flush with the top of the blocks. The integrity of the trench backfill must be maintained so as to ensure a surface that is flush with the top surface of the ACBs for its entire service life. Termination trenches will be backfilled as shown on Drawings. Backfilling and compaction of trenches will be completed in a timely fashion. No more than 500 linear feet of placed ACBs with non-completed termination trenches will be permitted at any time.

F. The cells or openings in the ACBs will be backfilled and compacted with suitable material, as specified by the EOR. Backfilling and compaction will be completed in a timely manner so that no more than 500 feet of exposed mats exist at any time. Finishing requirements are explicitly at the discretion of the EOR.
G. The manufacturer of the ACBs/mats shall provide design and construction advice during the design and initial installation phases of the Project when required or as necessary, at the discretion of the EOR. The ACB supplier shall provide, at a minimum, 1 full day or two half-days of on-site project support upon request.

END OF SECTION
PART 1  GENERAL

1.01  REFERENCES

A. The following is a list of standards which may be referenced in this section:

   1. ASTM International (ASTM):
      e. C882, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.
      g. C940, Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.

1.02  SUBMITTALS

A. Action Submittals:

   1. Product data of grouts.
   2. Proposed method for keeping existing concrete surfaces wet prior to placing nonshrink grout.
B. Informational Submittals:

1. Manufacturer’s Written Instructions:
   a. Adding fiber reinforcing to batching.
   b. Mixing of grout.

2. Manufacturer’s proposed training schedule for grout work.

3. Manufacturer’s Certificate of Compliance in accordance with Section 01 61 00, Common Product Requirements.
   a. Grout free from chlorides and other corrosion-causing chemicals.
   b. Nonshrink grout properties of Category II and Category III, verifying expansion at 3 days or 14 days will not exceed the 28-day expansion and nonshrink properties are not based on gas or gypsum expansion.

4. Manufacturer’s Certificate of Proper Installation.

5. Statements of Qualification: Grout manufacturer’s representative.

6. Test Reports:
   a. Test report for 24-hour evaluation of nonshrink grout.
   b. Test results and service report from demonstration and training session.
   c. Field test reports and laboratory test results for field-drawn Samples.

7. List of Contractor’s equipment installation staff trained by grout manufacturer’s representative in:
   a. Nonshrink grout installation and curing.
   b. Epoxy grout installation and curing.

1.03 QUALIFICATIONS

A. Grout Manufacturer’s Representative: Authorized and trained representative of grout manufacturer. Minimum of 1-year experience that has resulted in successful installation of grouts similar to those for this Project.

B. For grout suppliers not listed herein, provide completed 24-hour Evaluation of Nonshrink Grout Test Form, attached at the end of this section. Provide independent testing laboratory test results for testing conducted within last 18 months.
PART 2  PRODUCTS

2.01 NONSHRINK GROUT AND EPOXY GROUT SCHEDULE

A. Furnish nonshrink grout (Category I, II, and III) and epoxy grout for applications as indicated in the following schedule:

<table>
<thead>
<tr>
<th>Application</th>
<th>Temperature Range</th>
<th>Max. Placing Time</th>
<th>Greater Than 20 Min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blockouts for gate guides</td>
<td>I or II</td>
<td>20 Min.</td>
<td>II</td>
</tr>
<tr>
<td>Machine bases 25 hp or less</td>
<td>II</td>
<td>II</td>
<td>II</td>
</tr>
<tr>
<td>Form Tie-Through bolt openings</td>
<td>II</td>
<td>II</td>
<td>II</td>
</tr>
<tr>
<td>Machine bases 26 hp and up</td>
<td>III or Epoxy Grout</td>
<td>III or Epoxy Grout</td>
<td>II</td>
</tr>
<tr>
<td>Baseplates and/or soleplates with vibration, thermal movement, etc.</td>
<td>III or Epoxy Grout</td>
<td>III or Epoxy Grout</td>
<td>II</td>
</tr>
</tbody>
</table>

2.02 NONSHRINK GROUT

A. Category I:

1. Nonmetallic and nongas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Test in accordance with ASTM C1107/C1107M:
   a. Grout shall have flowable consistency.
   b. Flowable for 15 minutes.
4. Grout shall not bleed at maximum allowed water.
5. Minimum strength of flowable grout, 3,000 psi at 3 days, 5,000 psi at 7 days, and 7,000 psi at 28 days.
6. Manufacturers and Products:
   a. BASF Building System, Inc., Shakopee, MN; MasterFlow 100.
   b. Euclid Chemical Co., Cleveland, OH; NS Grout.
   c. Dayton Superior Corp., Miamisburg, OH; 1107 Advantage Grout.
   e. Five Star Products, Inc., Fairfield, CT; Five Star Grout.
B. Category II:

1. Nonmetallic, nongas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with ASTM C1107/C1107M:
   a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
   b. Temperatures of 40 degrees F, 80 degrees F, and 90 degrees F.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout, 3,500 psi at 1 day, 4,500 psi at 3 days, and 7,500 psi at 28 days.
7. Maintain fluid consistency when mixed in 1-yard to 9-yard loads in ready-mix truck.
8. Manufacturers and Products:
   b. Five Star Products, Inc., Fairfield, CT; Five Star Fluid Grout 100.
   c. Euclid Chemical Co., Cleveland, OH; Hi Flow Grout.
   d. Dayton Superior Corp., Miamisburg, OH; Sure Grip High Performance Grout.
   e. US MIX Co., Denver, CO; US SPEC MP Grout.

C. Category III:

1. Metallic and nongas-liberating.
2. Prepackaged aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with ASTM C1107/C1107M:
   a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
   b. Temperatures of 40 degrees F and 100 degrees F.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout, 4,000 psi at 1 day, 5,000 psi at 3 days, and 9,000 psi at 28 days.
7. Maintain fluid consistency when mixed in 1-yard to 9-yard loads in ready-mix truck.
8. Manufacturer and Product:
   b. Euclid Chemical Co., Cleveland, OH; Hi-Flow Metallic Grout.
2.03  EPOXY GROUT

A. High-strength, nonshrink, high-temperature epoxy grouting material developed for the support of heavy equipment with vibratory loads.

B. Three-component mixture of a two-component epoxy resin system (100 percent solids) with a graded, precision aggregate blend.

C. Premeasured, prepackaged system.

D. Flowable.

E. Minimum compressive strength in accordance with ASTM C579 Method B, 9,500 psi at 75 degrees F at 7 days, 11,000 psi at post cure.

F. Maximum creep resistance in accordance with ASTM C1181 at 600 psi, 140 degrees F; 6.0 by 10^-3 in/in.

G. Minimum bond strength in accordance with ASTM C882, 2,000 psi.

H. Minimum tensile strength in accordance with ASTM C307, 2,000 psi.

I. Maximum coefficient of thermal expansion in accordance with ASTM C531 at 73 degrees F to 210 degrees F, 23.0 by 10^-6 in/in/degrees F.

J. Working Time: Minimum 2 hours at 50 degrees F; 1.5 hours at 70 degrees F; 50 minutes at 90 degrees F.

K. Good chemical resistance.

L. Good effective bearing area.

M. Noncorrosive.

N. Moisture insensitive.

O. Modify resin and aggregate content where recommended by epoxy grout manufacturer to provide desired epoxy grout flow properties.

P. Manufacturers and Products:

2. Euclid Chemical Co., Cleveland, OH; E3-G.
3. Dayton Superior Corp., Miamisburg, OH; Pro-Poxy 2000 Normal Set.
PART 3 EXECUTION

3.01 GROUT

A. General: Mix, place, and cure grout in accordance with grout manufacturer’s representative’s training instructions.

B. Epoxy Grout: Concrete slab shall be fully cured for 28 days to ensure excess water has evaporated. Test concrete surface for moisture in accordance with ASTM D4263 before epoxy grout is placed.

C. Form Tie-Through Bolt Holes: Provide nonshrink grout, Category II, fill space with dry pack dense grout hammered in with steel tool and hammer. Through-bolt holes; coordinate dry pack dense grout application with vinyl plug in Section 03 10 00, Concrete Forming and Accessories, and bonding agent in Section 03 30 00, Cast-in-Place Concrete.

D. Form Snap-Tie Hole: Fill tie hole in accordance with requirements of Section 03 30 00, Cast-in-Place Concrete.

3.02 GROUTING MACHINERY FOUNDATIONS

A. Block out original concrete or finish off at distance shown below bottom of machinery base with grout. Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material. Surface roughness in accordance with manufacturer’s written instructions.

B. Clean metal surfaces of all paint, oil, grease, loose rust, and other foreign material that will be in contact with grout.

C. Sandblast to bright metal all metal surfaces in contact with epoxy grout in accordance with manufacturer’s written instructions.

D. Set machinery in position and wedge to elevation with steel wedges, or use cast-in leveling bolts. Remove wedges after grout is set and pack void with grout.

E. Form with watertight forms at least 2 inches higher than bottom of plate.

F. Fill space between bottom of machinery base and original concrete in accordance with manufacturer’s representative’s training instructions.

G. If grout cannot be placed from one edge and flowed to the opposite edge, air vents shall be provided through the plate to prevent air entrapment.

H. Radius all corners of grout pad.
I. Install expansion joints for epoxy grout placement in accordance with manufacturer’s written instructions.

3.03 TANK FOUNDATIONS

A. Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material. Surface roughness in accordance with manufacturer’s written instructions.

B. Clean metal surfaces of all paint, oil, grease, loose rust and other foreign material that will be in contact with grout.

C. Set tank in position and wedge to elevation with steel wedges, or use cast-in leveling bolts. Remove wedges after grout is set and pack void with grout.

D. Form with watertight forms at least 2 inches higher than bottom of plate.

E. Fill space between bottom of tank base and original concrete in accordance with manufacturer’s representative’s training instructions.

3.04 FIELD QUALITY CONTROL

A. General:

1. Performed by Project representative’s inspection staff.
2. Perform the following quality control inspections. The grout manufacturer’s representative shall accompany the Project representative’s inspection staff on the first installation of each size and type of equipment.

B. Evaluation and Acceptance of Nonshrink Grout:

1. Inspect the surface preparation of concrete substrates onto which nonshrink grout materials are to be applied, for conformance to the specified application criteria including, but not limited to, substrate profile, degree of cleanliness, and moisture.
2. Inspect preparation and application of nonshrink grout form work for conformance to the manufacturer’s recommendations.
3. Conduct a final review of completed nonshrink grout installation for conformance to these Specifications.
4. Provide a flow cone and cube molds with restraining plates onsite. Continue tests during Project as demonstrated by grout manufacturer’s representative.
5. Perform flow cone and bleed tests, and make three 2-inch by 2-inch cubes for each 25 cubic feet of each type of nonshrink grout used. Use restraining caps for cube molds in accordance with ASTM C1107/C1107M.
6. For large grout applications, make three additional cubes and one more flow cone test. Include bleed test for each additional 25 cubic feet of nonshrink grout placed.
7. Consistency: As specified in Article Nonshrink Grout. Flow cone test in accordance with ASTM C939. Grout with consistencies outside range requirements shall be rejected.
8. Segregation: As specified in Article Nonshrink Grout. Grout when aggregate separates shall be rejected.
9. Nonshrink grout cubes shall test equal to or greater than minimum strength specified.
10. Strength Test Failures: Nonshrink grout work failing strength tests shall be removed and replaced.
11. Perform bleeding test in accordance with ASTM C940 to demonstrate grout will not bleed.
12. Store cubes at 70 degrees F.
13. Independent testing laboratory shall prepare, store, cure, and test cubes in accordance with ASTM C1107/C1107M.
14. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

C. Evaluation and Acceptance of Epoxy Grout:

1. Inspect ambient conditions during various phases of epoxy grouting installation for conformance with the epoxy grout manufacturer’s requirements.
2. Inspect the surface preparation of concrete substrates onto which epoxy grout materials are to be applied, for conformance to the specified application criteria including, but not limited to, substrate profile, degree of cleanliness, and moisture.
3. Inspect the surface preparation of the metallic substrates onto which the epoxy primer is to be applied.
4. Inspect the epoxy-primed metallic substrate for coverage and adhesion.
5. Inspect preparation and application of epoxy grout form work for conformance to the manufacturer’s recommendation.
6. Verify consistency obtained is sufficient for the proper field placement at the installed temperatures.
7. Inspect and record that the “pot life” of epoxy grout materials is not exceeded during the installation.
8. Inspect epoxy grout for cure.
9. Inspect and record that localized repairs made to grout voids are in conformance with the specification requirements.

10. Conduct a final review of completed epoxy grout installation for conformance to these Specifications.

11. Compression tests and fabrication of specimens for epoxy grout shall be made in accordance to ASTM C579, Method B, at intervals during construction as selected by the Project representative. A set of three specimens shall be made for testing at 7 days, and each earlier time period as appropriate.

12. Independent testing laboratory shall prepare, store, cure, and test cubes in accordance with ASTM C579.

13. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

3.05 MANUFACTURER’S SERVICES

A. General:

1. Coordinate demonstrations, training sessions, and applicable Site visits with grout manufacturer’s representative. Allow 2-week notice to grout manufacturer’s representative for scheduling purposes.

2. Provide and conduct onsite, demonstration and training sessions for bleed tests, mixing, flow cone measurement, cube testing, application, and curing for each category and type of grout.

3. Necessary equipment and materials shall be available for demonstration.

4. Conduct training prior to equipment mount installation work on equipment pads.

5. Training for each type of grout shall be not less than 4 hours’ duration.

B. Nonshrink Grout Training:

1. Training is required for all Type III grout installations.

2. Provide nonshrink grout installation training by the qualified grout manufacturer’s representative for Contractor’s workers that will be installing nonshrink grout for baseplates and equipment mounts. Schedule training to allow Engineer’s attendance.

3. Mix nonshrink grouts to required consistency, test, place, and cure on actual Project, such as, baseplates and form tie-through bolt holes to provide actual on-the-job training.

4. Use minimum of two bags for each grout Category III. Mix grout to fluid consistency and conduct flow cone and two bleed tests, make a minimum of six cubes for testing of two cubes at 1 day, 3 days, and 28 days. Use remaining grout for final Work.

5. Include recommended grout curing methods in the training.
6. Transport test cubes to independent test laboratory and obtain test reports.
7. Training by manufacturer’s representative does not relieve Contractor of overall responsibility for this portion of the work.
8. Submit a list of attendees that have been satisfactorily trained to perform epoxy grout installation for equipment mounting.

C. Epoxy Grout Training:

1. Provide epoxy grout installation training by the qualified epoxy grout manufacturer’s representative for Contractor’s workers that will be installing epoxy grout for equipment mounts. Schedule training to allow Engineer’s attendance.
2. Include training in:
   a. Performance testing such as compressive strength testing of the epoxy grout.
   b. All aspects of using the products, from mixing to application.
3. Transport test cubes to independent test laboratory and obtain test reports.
4. Training by manufacturer’s representative does not relieve Contractor of overall responsibility for this portion of the work.
5. Submit a list of attendees that have been satisfactorily trained to perform epoxy grout installation for equipment mounting.

3.06 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is part of this Specification.

1. 24-hour Evaluation of Nonshrink Grout Test Form and Grout Testing Procedures.

END OF SECTION
24-HOUR EVALUATION OF NONSHRINK GROUT TEST FORM

OBJECTIVE: Define standard set of test procedures for an independent testing laboratory to perform and complete within a 24-hour period.

SCOPE: Utilize test procedures providing 24-hour results to duplicate field grouting demands. Intent of evaluation is to establish grout manufacturer’s qualifications.

PRIOR TO TEST: Obtain three bags of each type of grout.

1. From intended grout supplier for Project.
2. Three bags of grout shall be of same lot number.

ANSWER THE FOLLOWING QUESTIONS FOR GROUT BEING TESTED FROM LITERATURE, DATA, AND PRINTING ON BAG:

A. Product data and warranty information contained in company literature and data? Yes_____ No_____

B. Literature and bag information meet specified requirements? Yes_____ No_____

C. Manufacturer guarantees grout as specified in Article Guarantee? Yes_____ No_____

D. Guarantee extends beyond grout replacement value and allows participation with Contractor in replacing and repairing defective areas? Yes_____ No_____

E. Water demands and limits printed on bag? Yes_____ No_____

F. Mixing information printed on the bag? Yes_____ No_____

G. Temperature restrictions printed on bag? Yes_____ No_____

*Rejection of a grout will occur if one or more answers are noted NO.
GROUT TESTING PROCEDURES

A. Bagged Material:
   1. List lot numbers. ___________
   2. List expiration date. ___________
   3. Weigh bags and record weight. ___________

Owner’s Representative will disqualify grout if bag weights have misstated measure plus or minus 2 pounds by more than one out of three bags. (Accuracy of weights is required to regulate amount of water used in mixing since this will affect properties).

B. Mixing and Consistency Determination:
   1. Mix full bag of grout in 10-gallon pail.
   2. Use electric drill with a paddle device to mix grout (jiffy or jiffler type paddle).
   3. Use maximum water allowed per water requirements listed in bag instructions.
   4. Mix grout to maximum time listed on bag instructions.
   5. In accordance with ASTM C939 (flow cone) determine time of mixed grout through the flow cone. __________ seconds
   6. Add water to attain 20- to 30-second flow in accordance with ASTM C939.
   7. Record time of grout through cone at new water demand. _______ seconds
   8. Record total water needed to attain 20- to 30-second flow. _______ pounds
   9. Record percent of water. __________ percent

C. When fluid grout is specified and additional water is required beyond grout manufacturer’s listed maximum water, ASTM C1107/C1107M will be run at new water per grout ratio to determine whether grout passes using actual water requirements to be fluid. Use new water per grout ratio on remaining tests.

D. Bleed Test:
   1. Fill two gallon cans half full of freshly mixed grout at ambient temperatures for each category and at required consistency for each.
   2. Place one can of grout in tub of ice water and leave one can at ambient temperature.
   3. Cover top of both cans with glass or plastic plate preventing evaporation.
   4. Maintain 38 degrees F to 42 degrees F temperature with grout placed in ice and maintain ambient temperature for second container for 1 hour.
   5. Visually check for bleeding of water at 15-minute intervals for 2 hours.
6. Perform final observation at 24 hours.

If grout bleeds a small amount at temperatures specified, grout will be rejected.

E. Extended Flow Time and Segregation Test (for Category II and Category III):

1. Divide the remaining grout into two 3-gallon cans. Place the cans into the
   40-degree F and 90-degree F containers and leave for 20, 40, and 60 minutes.
   Every 20 minutes remove and check for segregation or settlement of aggregate.
   Use a gloved hand to reach to the bottom of the can, if more than 1/4 inch of
   aggregate has settled to the bottom or aggregate has segregated into clumps
   reject the grout.

2. Right after the settlement test mix the grout with the drill mixer for 10 seconds.
   Take a ASTM C939 flow cone test of grout and record flow time. Maintain this
   process for 1 hour at ambient temperatures of 40 degrees F and 90 degrees F.
   a. 20 min _____, sec. @ 40 degrees F.
   b. 40 min _____, sec. @ 40 degrees F.
   c. 60 min _____, sec. @ 40 degrees F.
   d. 20 min _____, sec. @ 90 degrees F.
   e. 40 min _____, sec. @ 90 degrees F.
   f. 60 min _____, sec. @ 90 degrees F.

   All Category II and Category III grout that will not go through the flow cone with
   continuous flow after 60 minutes will be disqualified.

   Qualified   Disqualified

F. 24-hour Strength Test:

1. Using grout left in mixing cans in accordance with ASTM C1107/C1107M for
   mixing and consistency determination test and for extended time flow test,
   make minimum of nine cube samples.

2. Store cubes at 70 degrees F for 24 hours.

3. Record average compressive strength of nine cubes at 24 hours.

Grout will be disqualified if 24-hour compressive strengths are less than 2,500 psi for
grouts claiming fluid placement capabilities.

Grouts that have not been disqualified after these tests are qualified for use on the
Project for the application indicated in Nonshrink Grout Schedule.

_________________________  ____________________________
Signature of Independent Testing Laboratory   Date Test Conducted
SECTION 03 63 00
CONCRETE DOWELING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

2. ASTM International (ASTM):
3. International Code Council (ICC):
   b. Evaluation Services Reports.

1.02 DEFINITIONS

A. ICC Evaluation Services Report: Published by ICC for products provided by concrete adhesive anchor manufacturers.

B. Special Inspection: As defined in the ICC IBC and indicated on the Statement of Special Inspection (Plan) in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing.

1.03 SUBMITTALS

A. Action Submittals:

   1. Product Data: Manufacturer’s catalog information.

B. Informational Submittals:

   1. Manufacturer’s instructions for preparation, placement, drilling of holes, installation of anchors and adhesive, and handling of cartridges, nozzles, and equipment.
   2. ICC Evaluation Services Report: Specific to proposed doweling system manufacturer.
1.04 QUALITY ASSURANCE

A. Qualifications:
   1. Installer: Trained and certified by manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Container Markings: Include manufacturer’s name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

B. Store adhesive components in accordance with manufacturer’s written instructions.

C. Dispose of when:
   1. Shelf life has expired.
   2. Stored other than per manufacturer’s instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Adhesive:

   2. Suitable for long-term loads as well as for wind and seismic loads.
   3. Meet requirements of ASTM C881/C881M.
   4. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
   5. Disposable, Self-Contained Cartridge System:
      a. Capable of dispensing both components in proper mixing ratio.
      b. Fit into manually or pneumatically operated caulking gun.
   6. Mixed Adhesive: Nonsag, light paste consistency with ability to remain in a 1-inch diameter overhead drilled hole without runout.
   7. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
   8. Manufacturers and Products:
      a. Hilti, Inc., Tulsa, OK; HIT-RE 500-SD (ESR-2322) or HIT-HY 200 (ESR-3187) Adhesive Anchors.

B. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.

C. Reinforcing Dowels: As specified in Section 03 21 00, Steel Reinforcement.

PART 3 EXECUTION

3.01 INSTALLATION

A. Drilling Equipment:

1. Drilling Hammers for Dowel Holes:
   a. Electric or pneumatic rotary type with medium or light impact.
   b. Hollow drills with flushing air systems are preferred.
2. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.

B. Hole Diameter: Use drill bit diameter meeting ICC Evaluation Services Report requirements and as recommended by manufacturer.

C. Obstructions in Drill Path: When existing steel reinforcement is encountered during drilling, obtain Engineer approval for proposed fix.

D. Doweling:

1. Install per details shown on Drawings and in accordance with adhesive manufacturer’s instructions.
2. When using epoxy anchors, dowels may be prebent prior to installation to 15 degrees to align with other bars. Do not heat dowels to bend.
3. Bent Bar Dowels: Where edge distances are critical, and intersection with steel reinforcement is likely, drill hole at 10-degree angle or less and use prebent reinforcing bars.

E. Adhesive:

1. Install in accordance with written manufacturer’s instructions.
2. Dispense components through specially designed static mixing nozzle that thoroughly mixes components and places mixed adhesive at base of predrilled hole.
3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Proof Loading:

1. To be performed where continuous inspection of concrete dowels is required.
2. Testing will be performed by Owner’s Independent Testing Agency.
3. Proof loading to be performed only after adhesive has achieved proper cure per manufacturer’s requirements.
4. Testing will be conducted on minimum of 5 percent of installed dowels, with a minimum of two tension tests. A minimum of two cartridges per box or packaging unit will be tested.
5. Testing will be conducted in accordance with ASTM E488 and as follows:
   a. Performance of a static tension test of each test dowel.
   b. Test apparatus reaction base will not interfere with bond failure of dowel, but will preclude a concrete pullout cone failure.
   c. Each test dowel will be tested at a proof load equal to the lesser of 80 percent of the yield strength of the dowel bar or 50 percent of calculated ultimate load based on adhesive bond strength.
   d. Test load to be maintained for a minimum of 30 seconds without visible signs of movement of dowel or drop in gauge reading.
6. Failure of dowel bar or failure within base concrete will cause dowel to be rejected. For each rejected dowel, two additional dowels will be tested. Replace rejected dowels as approved by Engineer.

B. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspection (Plan) in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information on special inspection and testing are included in Section 01 45 33, Special Inspection, Observation, and Testing.

1. Special inspection will be performed by the Special Inspector in accordance with ICC ESR requirements and as specified in Section 01 45 33, Special Inspection, Observation, and Testing.
2. Continuous inspection required where noted in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing, and where concrete dowels are installed in overhead applications.
3. Periodic inspection required where continuous inspection is not specified.
4. Special Inspector will observe installation in accordance with requirements of the ICC Evaluation Services Report and will submit report including the following:
   a. Product Description: Product name, rod diameter, and length.
   b. Drill bit compliance.
   c. Hole diameter, diameter, and depth and cleanliness.
   d. Adhesive expiration date.

5. Verification of dowel installation in accordance with manufacturer’s published instructions.

C. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):

2. National Sanitation Foundation (NSF):

1.02 DEFINITIONS

A. Crack: Complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.

B. Defective Area: As defined in Section 03 30 00, Cast-in-Place Concrete.

C. Hydraulic Structure: Liquid containment structure and/or structure designed to mitigate liquid infiltration.

D. Injection: Method of bonding together, addressing or eliminating leakage through cracks or joints by installing resin under pressure to fill the void in crack or joint.

E. Joint: A planned and formed discontinuity in concrete structure at junction of adjacent and sequential concrete placements and may contain embedded waterstops.
F. Leak or Leakage: Crack or joint exhibiting presence of moisture, sign of efflorescence, intermittently wet to touch, or continuous flow of liquid.

G. Narrow Cracks: Width equal to or less than 0.015 inch.

H. Wide Cracks: Wider than 0.015 inch.

1.03 SUBMITTALS

A. Action Submittals:

1. Physical and chemical properties for epoxy resin.
2. Technical data for metering, mixing, and injection equipment.
3. Depth of penetration, length, material used, and procedures where epoxy is approved for use.
4. Marked up drawings of proposed epoxy injection repair crack locations, widths, and lengths and direction on structure.
5. Sample bottle.
6. Pot Life Test.
7. Slant Shear Test (Bond Strength).

B. Informational Submittals:

1. Manufacturer’s recommended surface preparation procedures and application instructions for epoxy resins.
2. Manufacturer’s Certificate of Compliance in accordance with Section 01 61 00, Common Product Requirements. Certified test results for each batch of epoxy resin.
3. Statements of Qualification for Epoxy Resin:
   a. Manufacturer’s Site representative.
   b. Injection applicator.
   c. Injection pump operating technician.
4. Sample of epoxy resin two component ratio and injection pressure test records for concrete crack repair work.
5. Installation instructions for repairing core holes with repair mortar.
6. Test results of epoxy resin bond tests.
7. Epoxy resin two component ratio and injection pressure test records for concrete crack repair work.

1.04 QUALITY ASSURANCE

A. Qualifications for Injection Staffs:

1. Manufacturer’s Site Representative:
b. Understands and is capable of explaining technical aspects of correct material selection and use.
c. Experienced in operation, maintenance, and troubleshooting of application equipment.

2. Injection Crew and Job Foreman:
   a. Provide written and verifiable evidence showing compliance with the following requirements:
      1) Licensed or certified by epoxy resin material manufacturer.
      2) Minimum 3 years’ experience in successful epoxy injection for at least 10,000 linear feet of successful crack injection, including 2,000 linear feet of wet crack injection to stop water leakage.

B. Injected Epoxy Resin: Fill cracks and joints with minimum resin depth penetration no less than 90 percent of depth between waterstop and outside face of structure for joints with an embedded waterstop.

C. Injected cracks and joints which leak shall be considered deficient work irrespective of depth of penetration. Reinjection of deficient work or, with approval of Engineer, provide other repairs to eliminate leakage.

D. Bond Strength Test for Epoxy Resin:
   1. Concrete failure before resin failure.
   2. 1,500 psi minimum bond strength per ASTM C882 test requirements with no failure of either concrete or epoxy resin.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping:
   1. Package resin material in new sealed containers and label with following information:
      a. Manufacturer’s name.
      b. Product name and lot number.

B. Storage and Protection: Store epoxy resin material containers in accordance with manufacturer’s printed instructions and at ambient temperatures below 110 degrees F and above 45 degrees F.
PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials and accessories specified in this section shall be products of:

1. BASF Construction Chemicals, LLC-Building Systems, Shakopee, MN; SCB Concreseive Series products that meet properties indicated in sub-section 2.2.B.
2. Sika Corp., Lyndhurst, NJ; Sikadur Series products that meet properties below.
3. Euclid Chemical Co., Cleveland, OH; Euco Series (#452) products that meet properties below.

2.02 EPOXY INJECTION RESIN

A. Two-component A and B structural epoxy resin for injection into cracks or joints in concrete structures for bonding or grouting.

B. Uncured Resin Properties:

1. When mixed in ratio specified on resin container label:

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Wide Cracks [A: or Joints]</th>
<th>Narrow Cracks [A: or Joints]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pot Life (60-gram mass) @ 77, plus or minus 4 deg F</td>
<td>As specified in Article Source Quality Control</td>
<td>13 to 25 minutes</td>
</tr>
<tr>
<td>Pot Life (60-gram mass) @ 100, plus or minus 4 deg F</td>
<td>As specified in Article Source Quality Control</td>
<td>3 to 10 minutes</td>
</tr>
<tr>
<td>Viscosity @ 40, plus or minus 3 deg F</td>
<td>Brookfield RVT Spindle No. 4 @ 20 rpm</td>
<td>4,400 cps</td>
</tr>
<tr>
<td>Viscosity @ 75 to 77 deg F</td>
<td>Brookfield RVT Spindle No. 2 @ 20 rpm</td>
<td>375 to 350 cps</td>
</tr>
</tbody>
</table>
C. Epoxy Resin Properties: When cured for 7 days at 77 degrees F, plus or minus 3 degrees F and conditioned at test temperature 12 hours prior to test, unless otherwise specified.

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Wide Cracks or Joints</th>
<th>Narrow Cracks or Joints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultimate Tensile Strength, psi</td>
<td>ASTM D368</td>
<td>[A: 8,000] min.</td>
</tr>
<tr>
<td>Tensile Elongation @ Break, percent</td>
<td>ASTM D638</td>
<td>4.2 max.</td>
</tr>
<tr>
<td>Flexural Strength, psi</td>
<td>ASTM D790</td>
<td>10,000 min.</td>
</tr>
<tr>
<td>Flexural Modulus, psi</td>
<td>ASTM D790</td>
<td>5.5 x 10^5 min.</td>
</tr>
<tr>
<td>Compressive Yield Strength, psi</td>
<td>ASTM D695*</td>
<td>15,000 min.</td>
</tr>
<tr>
<td>Compressive Modulus, psi</td>
<td>ASTM D695*</td>
<td>4.0x10^5 min.</td>
</tr>
<tr>
<td>Heat Deflection Temperature</td>
<td>ASTM D648*</td>
<td>130 deg F min.</td>
</tr>
<tr>
<td>Cured 3 days @ 40 deg F – Wet Concrete</td>
<td></td>
<td>3,500 psi min.</td>
</tr>
<tr>
<td>Cured 1 day @ 77 deg F – Dry Concrete</td>
<td></td>
<td>5,000 psi min.</td>
</tr>
<tr>
<td>Cured 3 days @ 77 deg plus or minus 3 deg F</td>
<td></td>
<td>5,000 psi min.</td>
</tr>
</tbody>
</table>

*Cure test specimens so that peak exothermic temperature of resin does not exceed 100 degrees F.

Note: See referenced specifications for preparation method of test specimens.

2.03 SURFACE SEAL
A. Sufficient strength and adhesion for holding injection fittings firmly in place and to resist pressures preventing leakage during injection.

2.04 WATER
A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards.

2.05 SAMPLE BOTTLE
A. Five-inch natural wide mouth HDPE bottle or 4-ounce clear PVC cylinder bottle; supplied with caps.
2.06 SOURCE QUALITY CONTROL

A. Test Requirements: Perform tests for each batch of epoxy resin.

B. Pot Life Test:
   1. Condition Component A and Component B to required temperature.
   2. Measure components in ratio of Component B as stated on manufacturer’s label into an 8-fluid ounce paper cup.
   3. Mix components for 60 seconds using non-metallic stirring instrument. Scraper sides and bottom of cup periodically.
   4. Probe mixture once with non-metallic stirring instrument every 30 seconds, starting 2 minutes prior to minimum specified pot life.
   5. Pot Life Definition: Time at which a soft stringy mass forms in center of cup.

C. Slant Shear Test: Prepare specimens and perform tests in accordance with ASTM C882.

PART 3 EXECUTION

3.01 GENERAL

A. Do not proceed with injection work until submittals have been reviewed and approved by Engineer.

B. Perform cracks or joints injection work after removing defective surface materials and after performing surface preparation, but prior to applying surface repair material unless otherwise noted. See Section 03 01 32, Repair of Vertical and Overhead Concrete Surfaces, and Section 03 01 33, Repair of Horizontal Concrete Surfaces, for concrete surface repair system.

C. Width of cracks may vary along length and through thickness of concrete section.

D. Remove all excess, unused epoxy resin materials on concrete surfaces exposed to view prior to end of Work.

3.02 EQUIPMENT

A. Portable, positive displacement type pumps with in-line metering to meter and mix two epoxy resin components and inject mixture into cracks or joints.

B. Pumps:
   1. Electric or air powered with interlocks providing positive ratio control of proportions for the two components at nozzle.
2. Primary injection pumps for each material of different mix ratio, including a standby backup pump of similar ratio.
3. Capable of immediate compensation for changes in resins.
4. Do not use batch mix pumps.

C. Discharge Pressure: Automatic pressure controls capable of discharging mixed epoxy resin at pressures in accordance with epoxy resin manufacturer’s printed instruction and able to maintain pressure.

D. Automatic Shutoff Control: Provide sensors on both Component A and Component B reservoirs for stopping machine automatically when only one component is being pumped to mixing head.

E. Proportioning Ratio Tolerance: Maintain epoxy resin manufacturer’s prescribed mix ratio within a tolerance of plus or minus 5 percent by volume at discharge pressure up to 160 psi.

F. Ratio/Pressure Check Device:
   1. Two independent valve nozzles capable of controlling flow rate and pressure by opening or closing valve to restrict material flow.
   2. Pressure gauge capable of sensing pressure behind each valve.

3.03 PREPARATION

A. Free cracks or joints from loose matter, dirt, laitance, oil, grease, efflorescence, salt, and other contaminants.

B. Clean cracks or joints in accordance with epoxy resin manufacturer’s instructions.

C. Clean surfaces adjacent to cracks or joints from dirt, dust, grease, oil, efflorescence, and other foreign matter detrimental to bond of surface seal system and to expose the full extent of cracks and joints in accordance with manufacturer’s printed instruction.

D. Do not use acids and corrosives for cleaning, other than those specified herein unless neutralized prior to injecting epoxy resin.

E. During installation and curing of materials, if ambient temperature is expected to drop below manufacturer’s recommended minimum temperature, provide enclosures and heat as required.

F. Provide work platforms as required.

G. Dry out cracks or joints if required by manufacturer’s instructions.
3.04 APPLICATION

A. All liquid is to be removed from hydraulic structure prior to commencing with epoxy injection, unless approved otherwise.

B. Entry Ports:

1. Establish openings for epoxy resin entry in surface seal along crack.
2. Determine space between entry ports equal to thickness of concrete member to allow epoxy resin to penetrate to the full thickness of the member.
3. Drill injection holes at an angle between 45 degrees and 60 degrees from surface of concrete and perpendicular to alignment of cracks or joints, to intersect crack or joint at midpoint of concrete section, and intersect joints at midpoint between waterstop and exterior concrete surface, except as noted otherwise.
4. Locate drill holes on alternate sides of crack or joint where possible, unless orientation of crack or joint is known or has been verified by non-destructive testing techniques or core drilling.
5. Drill Hole Spacing: Do not exceed concrete thicknesses or 12 inches maximum, except as noted otherwise.
6. Adjust location and angle of drill holes to suit orientation of crack or joint and at commencement of drilling holes for injection and at beginning of each subsequent shift.
7. Take measures to prevent drilling holes for injection too shallow or too deep, or damaging existing waterstop in joints.
8. Remove dust and debris in drill holes and on surface of structure resulting from drilling operation, by flushing with water prior to installing the injection packers or ports.
9. Space entry ports closer together to allow adjustment of injection pressure to obtain minimum loss of epoxy to soil at locations where:
   a. Cracks or joints extend entirely through concrete element.
   b. Backfill of walls on one side.
   c. Slab-on-grade.
   d. Difficult to excavate behind wall to seal both surfaces of crack.
10. Install injection packers or ports in drill holes in accordance with manufacturer’s printed instructions with zerk coupling or other one-way ball or check valve, to permit testing for watertightness and acid flushing of cracks and joints.

C. Acid Flushing of Cracks Joints:

1. Flush cracks and joints with acid flushing solution in accordance with manufacturer’s printed instructions, at high pressure or resin injection pressure. Apply acid flushing solution for a sufficient duration to permit
solution to penetrate full depth and length of cracks and joints or to waterstop in joints.

2. Following acid flushing, flush cracks and joints with copious quantities of potable water in accordance with manufacturer’s printed instructions until no evidence of acid flushing solution is visible in flush water.

3. Submit in-field health and safety plan for acid flushing operation. As a minimum, identify worker conducting acid flushing by wearing a reflective safety vest and signs indicating “Acid Flushing.” Also, clearly identify Work area where acid flushing is underway by signs and isolate by placing orange pylons or other temporary barrier, and signs indicating “Acid Flushing.” As work progresses, move pylons or barriers and signs to maintain a safe zone.

D. Application of Surface Seal along Cracks and Joints:

1. Apply surface seal in accordance with manufacturer’s instructions to designated cracks and joints face prior to injection. Seal surface of cracks or joints to contain and prevent escape of injection epoxy.

2. Cure surface seal in accordance with manufacturer’s printed instructions before commencing inject work.

E. Epoxy Injection:

1. Ensure zerk coupling is not installed in ports or packers next to the one being injected.

2. Start injection into each crack or joint at lowest elevation entry port or packer along vertical or diagonal crack or joint, and at one end of horizontal crack or joint.

3. Where injection entry ports or packers are used, continue injection at first port or packer until resin begins to flow out of port or packer at next highest elevation. Plug first port or packer and start injection at second port or packer until resin flows from next port or packer.

4. Inject entire crack joint with same sequence.

5. At no time inject more than 6 feet length of first vertical crack or joint before verifying resin in sample bottle has start to set and cure.

6. Prior to commencing injection work along a horizontal crack or joint in structure when processed using ports or packers with zerk couplings are used, remove zerk couplings from injection ports or packers except for two ports or packers located where injection work will commence. Commence injection work in first two ports or packers. Once clean resin is vented from third injection port or packer, cease injection at first port or packer, and install zerk coupling and commence injection at third port or packer. Repeat process for fourth and subsequent ports or packers until full length of crack or joint has been injected.
F. Finishing:

1. Allow epoxy resin to cure in accordance with manufacturer’s instruction after cracks or joints have been completely injected to allow surface seal removal without draining or runback of uncured epoxy resin material from cracks or joints.
2. Remove surface seal and injection packers or ports from cured injection resin along crack.
3. Finish crack or joint faces flush with adjacent concrete.
4. Indentations or protrusions caused by placement of entry ports, packers, drill holes, or damage from removal of surface seal is not acceptable.
5. Grind off protrusions and patch indentations and holes from injection packers and entry ports with a suitable patch material to satisfaction of Engineer.
6. Remove surplus surface seal material splatters and injection resin material runs and spills from concrete surfaces.

3.05 FIELD QUALITY CONTROL

A. Epoxy Resin Two Component Ratio Tests:

1. Disconnect mixing head and pump two resin components simultaneously through ratio check device.
2. Adjust discharge pressure to 160 psi for both resin components.
3. Simultaneously discharge both resin components into separate calibrated containers.
4. Compare amounts simultaneously discharged into calibrated containers during same time period to determine mix ratio.
5. Complete test at 160 psi discharge pressure and repeat procedure for 0 psi discharge pressure.
6. Run ratio test for each injection unit at beginning and end of each injection work day, and when injection work has stopped for more than 1 hour.
7. Document and maintain complete accurate records of ratios and pressure checks.

B. Injection Pressure Test:

1. Disconnect mixing head of injection equipment and connect two resin component delivery lines to pressure check device.
2. Pressure Check Device:
   a. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing of valve.
   b. Pressure gauge capable of sensing pressure buildup behind each valve.
3. Close valves on pressure check device and operate equipment until gauge pressure on each line reads 160 psi.
4. Stop pumps and observe pressure; do not allow pressure gauge to drop below 150 psi within 3 minutes.
5. Run pressure test for each injection equipment unit:
   a. Beginning and end of each injection work day.
   b. When injection work stops for more than 45 minutes.
6. Check tolerance to verify equipment capable of meeting specified ratio tolerance.

C. Bottled Sample Tests:

1. During injection operation, provide at least one sample of mixed epoxy resin for each injection pump per shift per injection work day in a sample bottle.
2. Provide sufficient sample to demonstrate sample material epoxy resin will set and cure correctly.
3. Label each bottled sample with Contractor’s name, date, and time sample was taken, and location in structure where sample was taken. Record details of bottle sample tests.
4. Place filled sample bottle upright in a container and allow sample to cure.
5. After sample has been allowed to cure, cut bottled sample open and visually inspect contents to verify that epoxy resin material has completely reacted and cured.
6. Evaluation and Assessment of Test:
   a. Should bottled sample(s) indicate a problem; such as epoxy resin not cured or foreign liquid in sample bottle, take verifying core sample immediately from cracks or joints, where material was used.
   b. Should above-referenced bottle sample(s) and core sample(s) indicate a problem with epoxy resin, arrange to have a Technical Representative of the epoxy resin manufacturer come to Site to review bottled sample(s) and core drilled sample(s) with Engineer and provide technical advice on corrective measures.
   c. Carry out further investigation work or corrective measures recommended by Technical Representative of epoxy resin manufacturer.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   c. C90, Standard Specification for Loadbearing Concrete Masonry Units.
   g. C216, Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale).

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer’s product information for each different item specified.
   b. Mix designs for mortar.

B. Informational Submittals:

1. Experience record of mortar color pigment proposed for use.
2. Manufacturer’s certificate of compliance for masonry units specified herein.
1.03 QUALITY ASSURANCE

A. Regulatory Requirements: For masonry construction meet requirements of the 2015 International Building Code as modified by the Oklahoma Uniform Building Code Commission Rules and as supplemented by these Specifications.

B. Mockups: Lay up a Sample panel for each type of masonry at the Site including reinforcing, air and water barrier, insulation, and veneer ties. Show bond pattern and method of finishing joints. Make Sample panels 8 feet high and 8 feet long, including base of wall flashing and one masonry control joint. Remove mockup after acceptance of permanent masonry Work. Acceptable Sample panel serves as a basis of color, texture, pattern, and workmanship for acceptance of the permanent construction.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection:

1. Store all masonry materials off ground and protected from precipitation.
2. Protect veneer materials from mud splatters and staining.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Do not lay masonry when ambient temperature is below 32 degrees F on a rising temperature or below 40 degrees F on a falling temperature, or when there is a probability of such conditions occurring within 48 hours, unless express approval of Engineer is obtained. In such case, make special provisions for heating materials and protecting finished Work. Protect masonry against freezing for a minimum of 48 hours after being laid. Protect tops of walls from precipitation at all times. Cover with waterproof paper when rain or snow is imminent and the Work is discontinued.

B. Humidity: Protect masonry construction from direct exposure to wind and sun when erected in an ambient air temperature of 99 degrees F (37 degrees C) in the shade with relative humidity less than 50 percent.

PART 2 PRODUCTS

2.01 MASONRY UNITS

A. Concrete Masonry Veneer:

1. General:
   a. Furnish special shapes for corners, jambs, lintels, and other areas shown or required.
b. Special units shall match texture of standard units.

2. Fluted Split-Face Textured Concrete Masonry Unit (CMU):
   a. ASTM C90: Medium weight.
   b. Nominal Size: 16 inches long by 8 inches high by 4 inches thick. Furnish special shapes in sizes shown on Drawings.
   c. Compressive Strength: 1,900 psi minimum, in accordance with ASTM C90, Table 2.
   d. Textured Exposed Faces: Six split-face ribs on a 16-inch face; outside corner units with ribs on face and end; ribs spaced, sized, and located so they align vertically when laid in running bond.
   e. Color of Units: Natural.

2.02 MORTAR MATERIALS

A. Portland Cement: ASTM C150, Type I, low alkali content (0.60 percent maximum).

B. Lime: ASTM C207, Type S.

C. Mortar: ASTM C270, Type S. Consisting of one part portland cement, from 1/4 part to 1/2 part lime putty or hydrated lime, and clean well-graded sand in the proportion of three times the sum of the cementitious material; or 1/2 part portland cement, one part masonry cement, and clean well-graded sand in the proportion of three times the sum of the cementitious material.

1. If color is added, add in a consistent manner to provide final uniformity.
2. No antifreeze liquid, salts, or other substances are allowed to lower freezing point. No calcium chloride is allowed in mortar.

D. Tuck-Pointing Mortar: Prehydrated Type N, one part portland cement, one part Type S hydrated lime, and six parts sand, by volume.

E. Mortar Color: Match block color.

F. Sand: ASTM C144, in addition not less than 5 percent passes the No. 100 sieve.

G. Water: Fresh, clean, and free of deleterious acids, alkalies, chlorides, and organic materials.
2.03 MORTAR PREPARATION

A. Place one-half the water and aggregate in operating mixer; add cement; add remaining aggregate and water and mix for at least 2 minutes. Add lime and continue mixing as long as needed to secure a uniform mass, but no less than 3 minutes after the addition of lime. Time the addition of admixture in strict accordance with manufacturer’s instructions and the procedure used for adding it to the mix shall provide good dispersion.

B. Mix mortar in machine with mixing drums clean and free of debris and dried mortar. Use mortar before the initial setting of the cement has taken place. Do not retemper mortar in which the cement has started to set.

C. Retemper mortar boards by adding water within a basin formed with the mortar and the mortar reworked into the water. Dashing or pouring water over mortar and retempering of harsh, nonplastic mortar is not permitted.

2.04 MASONRY CONTROL JOINTS

A. ASTM D1056, closed cell neoprene sponge, 3 inches wide by 3/8 inch thick.

2.05 FLUID APPLIED VAPOR RETARDER

A. Air and water barrier, fluid applied, one component, vapor permeable membrane, cures on masonry or concrete surfaces to form a resilient, monolithic, fully-bonded elastomeric sheet, 40 mils minimum dry thickness, meeting requirements of ASTM E2178 for air permeance.

B. Manufacturers and Products:

1. Grace; Perma-A-Barrier Liquid VP.
2. Hohmann and Barnard, Inc.; Textroflash Liquid VP.

2.06 THROUGH-WALL FLASHING

A. Stainless Steel: ASTM A666, Type 304 or Type 316, soft temper; No. 2D, dull finish, 0.018 inch minimum thick, unless otherwise shown.

B. Solder: ASTM B32, alloy composition Sn 60 for stainless steel.

C. Soldering Flux: ASTM B32, Type RA.
2.07 HORIZONTAL JOINT REINFORCEMENT

A. Stainless Steel Horizontal Joint Reinforcement and Continuous Wire:
   1. Two parallel No. 9 wires weld connected to No. 9 perpendicular cross wire and double wire eyes at 16 inches on center.
   2. Double Wire Seismic Hooks: 9-gauge steel wire Pintel swaged for insertion of continuous wire.
   4. Clean and free from loose rust, scale, and any coatings that reduce bond.
   5. Furnish special manufactured corner and wall intersection pieces.
   6. Manufacturers and Products:
      a. Hohmann and Barnard, Inc.; 270 ML Ladder and SH Hook and Wire.
      b. Wire-Bond; Series 800 Ladder Level - Eye, Seismic Hook and Wire.

2.08 WEEP HOLES

A. Weep Holes and Vents:
   1. Honeycomb, polypropylene; 3/8 inch by size of head joint; match color of mortar.
   2. Manufacturers and Products:
      a. Hohmann and Barnard; QV Quadro Vent.
      b. Wire-Bond; 3601 Cell Vent.

2.09 MORTAR BLOCK

A. HDPE mesh specifically designed to trap or block mortar droppings in masonry cavity walls allowing free passage of trapped water to weep holes below; 10 inches high by thickness of wall cavity.

B. Manufacturers and Products:
   1. Hohmann and Barnard; Mortar Trap.
   2. Heckmann Building Products; Weep-Thru Mortar Deflector.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other specific conditions, and other conditions affecting performance of masonry veneer.
B. Examine rough-in and built-in construction to verify actual locations of piping connections prior to installation.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.02 FLUID APPLIED VAPOR RETARDER

A. Cleaning of Substrate:
   1. Thoroughly clean surfaces to receive membrane following membrane manufacturer’s recommendations.
   2. Treat as necessary to remove laitance, loose material on surface, grease, oil, and other contaminants that will affect bond of the membrane.
   3. Vacuum clean or clear water wash surfaces and allow to dry completely.

B. Fill voids and control joints with sealant and overcoat with nonflow membrane material. Fill or coat visible shrinkage cracks to minimum 2 inches either side of crack.

C. Follow manufacturer’s directions for application, including limitations because of weather, temperature, and concrete cure time. Apply by brush or spray following manufacturer’s recommended coverage and coating rates.

3.03 GENERAL INSTALLATION

A. Provide or cut special shapes for corners, jambs, lintels, and other areas as shown or as required. Match color and texture of standard units.

B. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining construction. Use full-size units without cutting where possible.

C. Anchoring:
   1. Anchor all veneer types to structural backing wall as shown on Drawings and in conformance to the International Building Code.
   2. Maintain a space not less than 1 inch wide between masonry wall and concrete members.
   3. Keep space free of mortar or other rigid material to permit differential movement between backing wall and masonry.
   4. Attach veneer to backing with horizontal joint reinforcement every other course.
   5. Embed ties at least 2 inches in horizontal joint of veneer. Engage or swag a continuous horizontal wire into each anchor tie.
3.04 MASONRY VENEER WALL CONSTRUCTION—GENERAL

A. Mortar Beds: Lay masonry with full mortar coverage on horizontal and vertical joints. Rock closures into place with head joints thrown against two adjacent units in-place. Do not pound corners or jambs to fit stretcher units after setting in-place. Where adjustment to corners or jambs must be made after mortar has started to set, remove mortar and replace with fresh mortar.

B. Horizontal and Vertical Face Joints:
   1. Nominal Thickness: 3/8 inch.
   2. Construct uniform joints.
   4. Tool joints concave in exposed surfaces when thumbprint hard using jointing tool.
   5. Concave tool exterior joints belowgrade.
   6. Flush cut all joints not tooled.
   7. Fill horizontal joints between top of masonry partition and underside of concrete beams with mortar.

C. Movement Joints: Keep clean of all mortar and debris.

D. Masonry Control Joints:
   1. Provide continuous vertical control joints in masonry as shown on Drawings.
   2. Omit mortar from vertical joints. Place control joint material as wall is built.

E. Through-Wall Flashing:
   1. Place flashing on bed of mortar.
   2. Lap cross joints of through-wall flashing at least 2 inches.
   3. Extend flashing beyond exterior face of wall and provide drip edge.
   4. Cover flashing with mortar.

F. Mortar Block: Install continuously in cavity space on flashing against inside face of brick veneer, zig-zag side up. No adhesive or fasteners required. Follow manufacturer’s recommendations.

G. Flashing: Clean surface of masonry smooth and free from projections that might puncture, gouge, or otherwise damage flashing material.
H. Weep Vents: Provide weep vents in head joints in first course immediately above all flashing leaving head joint free and clean of mortar.
   1. Maximum Spacing: 24 inches OC.
   2. Keep weep holes and area above flashing free of mortar droppings.

I. Sealant Joints:
   1. Retain sealant joints around outside perimeters of exterior doors, window frames, and other wall openings:
      b. Uniform Width: 1/4 inch.

J. Pointing: Cut out defective joints and holes in exposed masonry and repoint with mortar. Dry brush masonry surface after mortar has set at end of each day’s Work and after final pointing.

3.05 CONCRETE MASONRY UNIT VENEER INSTALLATION

A. General: Do not install cracked, broken, or chipped masonry units exceeding ASTM C216 allowances. Thoroughly wet masonry just before laying except in freezing weather where units are laid dry. Prewetting may also be omitted if the units at the time of laying has a rate of absorption not exceeding 0.025 ounce of water per square inch of surface after being placed in 1/8 inch of water for 1 minute.

   1. Coordinate installation with backup walls, through wall flashing, and other construction. Use masonry saws to cut and fit exposed units. Lay units plumb, true to line, with level courses accurately spaced, and do not furrow bed joints.
   2. Finish horizontal run by racking back in each course; toothing not permitted. Adjust all units to final position while mortar is soft and plastic. If units are displaced after mortar has stiffened, remove, clean joints and units of mortar, and relay with fresh mortar.
   3. Bond unexposed units in wythe by lapping a minimum of 2 inches. Adjust ledger support members to keep Work level at proper elevation. Provide pressure relieving joints by placing a continuous compressible pad under ledger support members.
   4. When joining fresh masonry to set or partially set masonry:
      a. Remove loose concrete masonry unit and mortar.
      b. Clean and lightly wet exposed surface of set masonry prior to laying fresh masonry.

B. Pattern: Lay masonry in running bond.
3.06 CLEANING

A. Follow masonry and mortar color manufacturer’s recommendations for use of cleaning agents.

B. Application:

1. Thoroughly wet surface of masonry on which no efflorescence appears before using cleaning agent.
2. Scrub with acceptable cleaning agent.
3. Immediately rinse with clean water.
4. Work small sections at a time.
5. Work from top to bottom.
6. Protect sash, metal lintels, and other materials, which may corrode when masonry is cleaned with acid solution.
7. Remove efflorescence in accordance with masonry manufacturer’s recommendations.

C. Leave Work area and surrounding surfaces clean and free of mortar spots, droppings, and broken masonry.

3.07 FIELD QUALITY CONTROL AND QUALITY CONTROL

A. At least once a week while installation of masonry veneer is in progress, take mortar Samples for testing. Continue on that basis for duration of installation of masonry veneer at discretion of Engineer.

B. Take Samples in accordance with ASTM C270.

C. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in Statement of Special Inspections Plan in Structural General Notes on Drawings. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

D. Contractor-Furnished Quality Control: Inspect and test as required in Section 01 45 16.13, Contractor Quality Control.

3.08 PROTECTION

A. Wall Covering:

1. During erection, cover top of wall with strong waterproof membrane at end of each day or shutdown and as follows:
   a. Cover partially completed walls when Work is not in progress.
   b. Extend cover minimum of 24 inches down both sides.
c. Hold cover securely in-place.

B. Protect sills, ledges, and offsets from mortar drippings or other damage during construction. Remove misplaced mortar immediately. Protect face materials against staining. Protect the door jambs and corners from damage during construction.

END OF SECTION
SECTION 04 22 00
CONCRETE UNIT MASONRY

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   d. C90, Standard Specification for Loadbearing Concrete Masonry Units.
   e. C140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   l. C618 12, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   m. C744, Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units.
   n. C979, Pigments for Integrally Colored Concrete.

2. International Code Council (ICC):
   b. ICC Evaluation Service (ICC-ES) Reports.
3. The Masonry Society (TMS):
   a. TMS 402/ACI 530/ASCE 5; Building Code Requirements for Masonry Structures and Companion Commentaries (MSJC Code and Commentary).
   b. TMS 602/ACI530.1/ASCE6; Specification for Masonry Structures.
   c. 602/American Concrete Institute ACI 530.1/ASCE 6, Specification for Masonry Structures and Companion Commentaries (Masonry Standards Joint Committee Specifications and Commentary).

1.02 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings.
   2. Data Sheets:
      a. Horizontal joint reinforcement.
      b. Preformed control joint materials.
      c. Water repellent masonry sealer.
      d. Grout mix design.
      e. Mortar mix design. Prebagged mortar properties and data sheets.
      f. Grout sand gradation in accordance with ASTM C404.

B. Informational Submittals:
   1. Method and Location of Placing Grout: High lift or low lift.
   2. Mix design test results.
   3. Certifications:
      a. Units comply with ASTM C55 and ASTM C90.
      b. Grout test results conform to ASTM C1019.
      c. Grout aggregates conform to requirements of ASTM C33, including nonreactivity.
      d. Mortar sand conform to requirements of ASTM C144.
   4. Test results of Project samples from masonry unit manufacturer stating that units comply with ASTM C90. Documentation of material testing shall be one less than 1 year old.
   5. Test results of proposed grout mix deign stating that units comply with ASTM C1019. Documentation of material testing shall be 1 year old or less.
   6. Test reports stating aggregates for mortar meet requirements of ASTM C144.
   7. Test reports or letter of certification stating aggregates for grout meet requirements of ASTM C404.
8. Letter from water repellent admixture manufacturer verifying masonry unit manufacturer’s proper use of product.
10. Field test results to qualify materials.
   a. Grout tests in accordance with ASTM C1019.

1.03 QUALITY ASSURANCE

A. Preinstallation Conference:
   1. Required Meeting Attendees:
      a. Masonry subcontractor, including masonry foreman.
      b. Ready-mix producer.
      c. Admixture representative.
      d. Testing and sampling personnel.
      e. Design Structural Engineer.
   2. Schedule and conduct prior to start of masonry construction.
   3. Notify Engineer of location and time.
   4. Agenda shall include:
      a. High lift and low lift procedures.
      b. Mortar, grout, unit, and reinforcing submittals.
      c. Types and locations of rebar splices.
      d. Joint tooling.
      e. Admixture types, dosage, performance, and redosing at Site.
      f. Mix designs and test of mix.
      g. Placement methods, techniques, equipment, consolidation, and reconsolidation.
      h. Protection procedures for environmental conditions.
      i. Other specified requirements requiring coordination.
   5. Submit conference minutes as specified in Section 01 31 19, Project Meetings.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Keep units and mortar/grout cementitious ingredients, including lime, dry.

PART 2 PRODUCTS

2.01 COMPRESSIVE STRENGTH OF MASONRY ASSEMBLAGE

A. Minimum 28-Day Specified Compressive Strength (f’m) of Masonry: 1,500 psi.
2.02 CONCRETE MASONRY UNITS (CMU)

A. ASTM C90: Medium weight.
   1. Net Area Compressive Strength: 1,900 psi minimum, in accordance with TMS 602, Table 2.
   2. Nominal Size: 16 inches long by 8 inches high by thickness shown on Drawings.
   3. Color of Units: Natural.
   5. Surface Texture: Smooth on interior, concealed exterior, and surface 1 foot below finished grade.

B. General Concrete Masonry Unit (CMU) Requirements:
   1. Furnish or cut special shapes for corners, jambs, lintels, and other areas shown or required.
   2. Special units shall match color and texture of standard units.
   3. Where units are placed so end of unit is exposed, such as at a corner or intersection, exposed end of that block shall have surface to match color and texture of sides of other units.
   4. Furnish sound, dry, clean units free of cracks, prior to placing in structure.
   5. Vertical Cells to be Grouted: Capable of alignment sufficient to maintain clear, unobstructed continuous vertical cell dimensions in accordance with TMS 602, Table 7.
   6. Masonry unit size and shape shall allow for all placement patterns. Use vertical grout dams to prevent materials, such as grout from escaping from cell being filled to adjacent cells where material is not intended to be placed.

2.03 MORTAR MATERIALS

A. Portland Cement-Lime Mortar:
   1. ASTM C270.
   2. Cement: ASTM C150, Type I and Type II portland cement.
   3. Lime: ASTM C207, Type S hydrated.
   4. Aggregates:
      a. Non-reactive in accordance with ASTM C33, Appendix X1.

B. Water: Fresh, clean, and potable.
C. Manufacturers and Products:
   1. W.R. Grace; DRY-BLOCK.
   2. Harris Specialty Chemicals.
   3. Axim Italcementi Group; Intrapel.
   4. BASF Chemical Co.; Rheopel Admixture.

D. Mortar Color Admixture:
   1. Meet the requirements of ASTM C979.
   2. Manufacturer and Product: Davis Colors, Los Angeles, CA; True Tone Mortar Color.
   3. Color shall be as shown on Finish Schedule.

2.04 GROUT MATERIALS

A. Cement: ASTM C150, Type I and Type II portland cement.

B. Fly Ash:
   1. Fly Ash (Pozzolan): Class F fly ash in accordance with ASTM C618.

C. Slag Cement: In accordance with ASTM C989, Grade 100 or Grade 120.

D. Lime: ASTM C207, Type S hydrated.

E. Aggregates:
   1. ASTM C404, fine and coarse.
   2. Nonreactive in accordance with ASTM C33, Appendix X1.

F. Water: Fresh, clean, and potable.

2.05 REINFORCEMENT

A. Reinforcement: Clean and free from loose rust, scale, and coatings that reduce bond.

B. Deformed Bars: As specified in Section 03 21 00, Steel Reinforcement.

C. Horizontal Joint Reinforcement:
   1. Two parallel, ASTM A82/A82M, No. 9 wires, galvanized in accordance with ASTM A153/A153M, weld connected to No. 9 diagonal cross wire at 16 inches, maximum, center.
   2. Furnish special manufactured corner and wall intersection pieces.
   3. Manufacturer: Dayton Superior/Dur-O-Wal, Dayton, OH.
2.06 PREFORMED CONTROL JOINTS

A. Solid rubber cross-shape extrusions as manufactured by:

2.07 MORTAR MIXES

A. In accordance with ASTM C270, Type S and MSJC Specifications.

B. Mix Method:
   1. Property Method: Minimum average mortar 28-day compressive strength 1,800 psi.

C. Mixing: Machine mix in approved mixers in accordance with ASTM C270.

2.08 GROUT MIXES

A. Compressive Strength Property: Minimum 2,000 psi at 28 days. Grout strength shall not exceed two times the minimum specified strength.

B. Mix Design:
   1. Proportions: Design mix to meet property/strength requirements.
   2. Slump: 8-inch minimum, 11-inch maximum.

C. Mixing:
   1. Do not use water reducers, air entrainment, plasticizing, high-range water reducers, or other non-specified admixtures in grout mixes.
   3. For high lift grouting, add approved grout expansion admixture in accordance with manufacturer’s recommendations.
   4. Fluid consistency suitable for placing without segregation with a slump of 8 inches to 11 inches.

2.09 WATER REPELLENT MASONRY SEALER

A. Characteristics:
   1. Water-based blend of silanes and siloxanes.
   2. VOC compliant.
B. Performance Requirements:

1. Water Absorption: 95 percent reduction in weight gain when tested in accordance with ASTM C140.
2. Water Repellency: 99 percent reduction in weight gain when tested in accordance with ASTM E514.

C. Manufacturers and Products:

2. BASF Construction Chemicals; Enviroseal PBT.

PART 3    EXECUTION

3.01    GENERAL

A. Meet requirements of 2015 IBC, Chapter 21, and 2013 The Masonry Society (TMS) 602/American Concrete Institute (ACI) 530.1/ASCE 6, Specification for Masonry Structures and Companion Commentaries (MSJC), Part 3, Execution, except as modified in this section.

B. Moisture Protection:

1. Keep units dry while stored on Site.
2. Do not wet units prior to laying.

C. Provide measures to prevent moisture from entering incomplete walls and open cells.

D. Cold Weather: Meet requirements of MSJC Specification Section “Cold Weather Construction.”

E. Hot Weather: Meet requirements of MSJC Specification Section “Hot Weather Construction.”

F. After construction during cold weather, maintain newly constructed masonry temperature above 32 degrees F for a minimum of 24 hours using MSJC or other approved cold weather methods.

G. After construction and during hot weather, fog spray newly constructed masonry in accordance with MSJC hot weather construction requirements.

3.02    PREPARATION

A. Concrete Foundations: Meet tolerance requirements of ACI 117 prior to starting any masonry work.
B. Prepare surface contact area of foundation concrete for initial mortar placement by removing laitance, loose aggregate, and other materials, and anything that would prevent mortar from bonding to foundation.

C. Patch or grind out-of-tolerance foundation surfaces to receive mortar prior to starting masonry work.

D. Clean reinforcement dowels and projecting embeds by removing laitance, spillage, or items that will adversely affect grout bond.

E. Prevent surface damage to foundation concrete that will be exposed to view outside of contact area.

3.03 LAYING MASONRY UNITS

A. General:

1. Finish Tolerances (Measured on Interior Surfaces): Meet requirements of “Site Tolerance” requirements of Part 3, Execution, of the MSJC Specifications.
2. Place units with chipped edges or corners such that chipped area is not exposed to view.

B. Wall Units:

1. General:
   a. If necessary to move a unit after once set in-place, remove from wall, clean, and set in fresh mortar.
   b. Tooothing of masonry units is not permitted.
2. Running Bond:
   a. Unless otherwise shown, lay up walls in straight, level, and uniform courses using a running bond pattern.
   b. Place units for continuous vertical cells and mortar joints to prevent materials, such as grout, from escaping from cell being filled to adjacent cells where material is not intended to be placed.
   c. Corners: Lay standard masonry bond for overlapping units and grout solid.
   d. Intersecting Walls: Half unit appearance shall not extend and be visible on exterior side of intersecting wall. Provide hooked corner bars in bond beam units and joint reinforcement as shown on Drawings.
3. Special Shapes:
   a. Provide and place such special units as corner block, doorjamb block, lintel block fillers, and similar blocks as may be required.
   b. Use required shapes and sizes to work to corners and openings, maintaining proper bond throughout wall.
3.04 BUILT-IN ITEMS

A. Position door frames, windows, vents, louvers, and other items to be built in wall, and construct wall around them.

B. Install masonry anchors to secure items to wall.

C. Fill spaces around items with grout except use mortar at mortar joints.

D. Do not place electrical, instrumentation, or water conduits in a cell containing parallel reinforcement, unless approved in writing by Engineer. Additionally, pipes, sleeves, and conduits shall meet requirements of TMS 402/ACI 530/ASCE 5, Building Code Requirements for Masonry Structures (MSJC Code) and MSJC specification construction requirements.

3.05 MORTAR JOINTS

A. General:
   1. Meet masonry erection requirements of MSJC, Part 3, Execution, 3.3B.
   2. As units are laid, remove excess mortar from grout space of cells to be filled. Final grout space, including any remaining mortar projections, shall be as required by MSJC Table “Grout Space Requirements.”
   3. Place mortar before initial setting of cement takes place. Retemper only as required for it to remain plastic. Retempering of colored mortar is not allowed.

B. Exposed Joints:
   1. Tool joints exposed to view after final construction, unless otherwise noted or shown.
   2. Cut joints flush and as mortar takes its initial set; tool to provide a concave joint.
   3. Perform tooling with tool that compacts mortar, pressing excess mortar out.
   4. Perform tooling when mortar is partially set, but still sufficiently plastic to bond rather than dragging it out.
   5. Rake out joints that are not tight at time of tooling, point, and then tool.
   6. Rake and tool joints at split-face surfaces, interior and exterior.

C. Concealed Joints: Strike flush with no further treatment required.
3.06 CONTROL JOINTS

A. Preformed Control Joints:
   1. Omit mortar from vertical joints.
   2. Place in units fabricated to receive rubber control joint material as wall is built.
   3. After wall is grouted, cured, and cleaned, install backing rod and sealant as specified in Section 07 92 00, Joint Sealants.
   4. Place and tool sealant to match depth of typical joint.

3.07 REINFORCING

A. Foundation Dowels:
   1. Locate first foundation dowel at end of wall in center of first cell; typically 4 inches from end of wall.
   2. Locate at each side of control joints and openings and below beam and joist seats, and then locate at maximum required spacing between these bars.
   3. Size, number, and location of foundation dowels shall match all typical and additional vertical wall reinforcing, unless otherwise noted.
   4. When foundation dowel does not line up with vertical core, do not slope more than 1 horizontal to 6 vertical to bring it into alignment.

B. Vertical Reinforcing:
   1. Use deformed bars.
   2. Hold in position near ends of bars by wire ties to dowels or by reinforcing positioners.
   3. For high lift grouting, hold in position at maximum intervals of 160 bar diameters by reinforcing positioners.
   4. Lap reinforcing bars as shown or approved.
   5. Wire tie splices together.
   6. Minimum Bar Clearance: 1/2-inch from masonry for coarse grout, from formed surfaces, and from parallel bars in same grout space.

C. Horizontal Reinforcing:
   1. Use deformed bars.
   2. Lay on webs of bond beam units and place as wall is built. Increase web depth to ensure 1/2-inch cover over top of rebar.
   3. Lap reinforcing bars where spliced and wire tie together.
   4. Minimum Bar Clearance: 1/2 inch from masonry for coarse grout, from formed surfaces, and from parallel bars in same grout space.
5. Terminate reinforcing bars 2 inches clear from control joints except horizontal bars at roof and floor courses shall be continuous through joints.

D. Horizontal Joint Reinforcement:
   1. Use where indicated on Drawings.
   2. Space maximum 16 inches apart, vertically.
   3. Lap ends 16 inches minimum.
   4. Terminate reinforcing 2 inches clear from control joints except reinforcement at roof and floor courses shall be continuous through joints.
   5. Use manufactured corner and other wall intersection pieces.

3.08 MORTAR PRODUCTION
   A. Mix bulk materials in accordance with MSJC Specification.
   B. Mix prebagged materials with water to produce a workable consistency.
   C. Remix or retemper to maintain workability. Discard mortar that has begun to stiffen or is not used within 2-1/2 hours after initial mixing.

3.09 GROUT PLACEMENT
   A. Do not mix, convey, or place with equipment constructed of aluminum.
   B. Secure vertical and horizontal reinforcement, ties, bolts, anchors, and other required embedments in place; inspect and verify before placing grout.
   C. Grout beams over openings in one continuous operation.
   D. Maintain vertical alignment in accordance with ACI 530.1, Table 7:
      1. Place grout within 1-1/2 hours of addition of water to mix.
      2. Use reinforcing positioners to secure vertical reinforcement.
   E. Grouting Requirements:
      1. Partial grout all walls as shown.
         a. Slump: 8 inches to 11 inches.
         b. Do not start grouting until wall mortar has cured for 24 hours, minimum.
      2. Fully embed horizontal steel with grout in an uninterrupted pour.
      3. Do not construct wall more than one course above top of grout pour prior to placing grout.
4. Partial Grouting Requirements:
   a. Fill cells containing reinforcing steel, anchor bolts, and other embedded items as shown with grout.
   b. Construct cells to be filled to confine grout within cell.
   c. Cover tops of unfilled vertical cells under a bond beam with metal lath to confine grout fill to bond beam section.
   d. Form horizontal construction joints between pours by stopping grout pour 1-1/2 inches below a mortar joint, except at a bond beam; stop pour 1/2 inch below top of masonry unit.

F. Vibration:
   1. Use internal “pencil” type, low energy vibrator to thoroughly consolidate grout and reduce amount of air voids. Do not use concrete vibrators.
   2. After initial water loss and settlement has occurred, but before it has taken any set, reconsolidate grout.
   3. Waiting period for reconsolidation will vary depending upon weather conditions and block absorption rates, but under “normal” weather conditions with average masonry units the waiting period should be between 30 minutes and 60 minutes.

G. Cleanouts:
   1. Construct in accordance with MSJC specification.
   2. Provide for grout pours heights over 5 feet 4 inches in accordance with the 2015 IBC.
   3. Provide of sufficient size to permit cleaning of cell, positioning of reinforcing, and inspection at bottom of every vertical cell containing reinforcing and maximum of 32 inches on center.
   4. Location: Concealed from view after final construction, unless otherwise approved by Engineer.
   5. After wall has been inspected and approved and prior to grouting, cap cleanouts in a manner that will seal them from grout leakage and provide a flush finish.

3.10 WATER REPELLENT MASONRY SEALER

A. Remove efflorescence prior to applying water repellents. Dispose of waste generated.

B. Apply to exposed exterior concrete masonry walls.
C. Repoint loose, cracked, or disintegrating mortar at least 7 days prior to application. Ensure joint sealants and caulking are fully cured and wall surfaces are clean, dry, and free of chemical cleaners, efflorescence, dirt, oils, mortar smears, and other surface contaminants.

D. Follow manufacturer’s recommendations for weather conditions during application.

E. Test a 5-foot by 5-foot wall area to ensure proper coverage, desired water repellency properties, and desired surface appearance when sealer is fully dried.

F. Apply with spray, brush, or roller following manufacturer’s recommendations, at a coverage rate of 50 square feet to 150 square feet per gallon, as determined by testing. Use two-coat application where recommended by manufacturer.

3.11 FIELD QUALITY CONTROL

A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

B. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

C. Masonry shall be tested by testing agency retained by Owner.

D. Provide adequate facilities for safe storage and proper curing of masonry prisms, mortar samples, and grout samples, as applicable, onsite for first 24 hours, and for additional time as may be required before transporting to test lab.

E. Masonry Testing:

1. Masonry strength shall be determined using unit strength method as shown.

2. Masonry test prisms, when required or desired, shall be constructed onsite with same materials and workmanship to be used for Project and in accordance with ASTM C1314. Method and frequency of prism testing shall be as shown on the Special Inspection and Testing Plan.
3. Unit Strength Method:
   a. Method and frequency for mortar, grout, and masonry unit sampling and testing shall be as shown.
   b. Provide masonry units for test samples required.

F. Corrective Action:
   1. If compressive strength tests made prior to construction of permanent structure fail to meet Specifications, adjustments shall be made to mix designs for mortar, or grout, or both, as needed to produce specified strength.
   2. If strength tests performed on materials representative of in-place construction fail to meet Specifications, prisms or cores shall be cut from constructed walls in sufficient locations to adequately determine strength in accordance with MSJC.

3.12 CLEANING

A. Immediately after completion of grouting, clean masonry surfaces of excess mortar, grout spillage, scum, stains, dirt, and other foreign substances using clean water and fiber brushes.

B. Clean walls not requiring painting or sealing so there are no visible stains.

3.13 PROTECTION OF INSTALLED WORK

A. Do not allow grout and mortar stains to dry on face of exposed masonry.

B. Protect tops of walls at all times. Cover tops of walls with waterproof paper when rain or snow is imminent and when the Work is discontinued.

C. Adequately brace walls until walls and roof are completed.

D. Provide sufficient bracing to protect walls against damage from elements, including wind and snow.

E. Protect masonry against freezing for minimum 72 hours after being laid.

F. Protect masonry from damage until final acceptance of the Work. Damaged units will not be accepted.

END OF SECTION
SECTION 05 05 19
POST-INSTALLED ANCHORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 318, Building Code Requirements for Structural Concrete.
   b. 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
   c. 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.


4. ASTM International (ASTM):
   e. A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
   g. A385, Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
   h. A563, Specification for Carbon and Alloy Steel Nuts.
   i. A780, Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   l. F436, Specification for Hardened Steel Washers.
   m. F468, Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
q. F1554, Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
a. Evaluation Reports for Concrete and Masonry Anchors.
b. AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
c. AC70, Acceptance Criteria for Fasteners Power-driven into Concrete, Steel and Masonry Elements.
d. AC106, Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.
e. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
f. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements. Evaluation Reports for Concrete and Masonry Anchors.
7. Specialty Steel Industry of North America (SSINA):
a. Specifications for Stainless Steel.
b. Design Guidelines for the Selection and Use of Stainless Steel.
c. Stainless Steel Fabrication.
d. Stainless Steel Fasteners.

1.02 DEFINITIONS

A. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

B. Exterior Area: Location not protected from weather by a building or other enclosed structure to include buried roof structures.

C. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or wash down, and where wall or roof slab is not common to a water-holding or earth-retaining structure.

D. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or wash down, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.
E. Submerged: Location at or below top of wall of open water-holding structure, such as a basin or channel, or wall, ceiling, or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Specific instructions for concrete anchor installation, including drilled hole size and depth, preparation, placement, procedures, and instructions for safe handling of anchoring systems.

B. Informational Submittals:

1. Concrete and Masonry Anchors:
   a. Manufacturer’s product description and installation instructions.
   b. Current ICC-ES or IAPMO-UES Report for each type of post-installed anchor to be used.

2. Passivation method for stainless steel members.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Installers of adhesive anchors horizontally or upwardly inclined to support sustained tension loads shall be certified by an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Installer Certification Program or equivalent.


1.05 DELIVERY, STORAGE, AND HANDLING

A. Package stainless steel items in a manner to provide protection from carbon impregnation.

B. Protect hot-dip galvanized finishes from damage as a result of metal banding and rough handling.
PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise indicated, meet the following requirements:

<table>
<thead>
<tr>
<th>Item</th>
<th>ASTM Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stainless Steel:</td>
<td></td>
</tr>
<tr>
<td>Threaded Rods</td>
<td>F593, AISI Type 316, Condition CW</td>
</tr>
<tr>
<td>Nuts*</td>
<td>F594, AISI Type 316, Condition CW</td>
</tr>
<tr>
<td>Carbon Steel:</td>
<td></td>
</tr>
<tr>
<td>Threaded Rods</td>
<td>F1554, Grade 36 or F568M Class 5.8</td>
</tr>
<tr>
<td>Flat and Beveled Washers</td>
<td>F436</td>
</tr>
<tr>
<td>(Hardened)</td>
<td></td>
</tr>
<tr>
<td>Nuts*</td>
<td>A194/A194M, Grade 2H</td>
</tr>
<tr>
<td>Galvanized Steel:</td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>A153/A153M</td>
</tr>
</tbody>
</table>

*Nuts of other grades and styles having specified proof load stresses greater than specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than minimum tensile strength of specified threaded rod.

B. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, and zinc-plated steel material types as indicated in Fastener Schedule at end of this section.

2.02 POST-INSTALLED CONCRETE ANCHORS

A. General:

1. AISI Type 316 stainless, hot-dip galvanized or zinc-plated steel, as shown in Fastener Schedule at end of this section.
2. Post-installed anchor systems used in concrete shall be approved by ICC Evaluation Services Report or equivalent for use in cracked concrete and for short-term and long-term loads including wind and earthquake.
3. Mechanical Anchors: Comply with the requirements of ICC-ES AC193 or ICC-ES ACI 355.2.
4. Adhesive Anchors: Comply with the requirements of ICC-ES AC308 or ICC-ES ACI 355.4.
B. Torque-Controlled Expansion Anchors (Wedge Anchors):

1. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; Kwik-Bolt –TZ (KB-TZ) Anchors (ESR-1917).
   b. DeWalt/Powers Fasteners, Brewster, NY; Power-Stud +SD1, +SD2, +SD4, or +SD6 Anchors (ESR-2502 and ESR-2818).

C. Self-Tapping Concrete Screw Anchors:

1. Manufacturers and Products:
   a. DeWalt/Powers Fasteners, Brewster, NY; Wedge-Bolt+ (ESR-2526).
   b. DeWalt/Powers Fasteners, Brewster, NY; Vertigo+ Rod Hanger Screw Anchor (ESR-2989).
   c. DeWalt/Powers Fasteners, Brewster, NY; Snake+ Flush Mount Screw Anchor (ESR-2272).
   d. Hilti, Inc., Tulsa, OK; HUS-EZ Screw Anchor (ESR-3027).
   e. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Titen HD Screw Anchor (ESR-2713).

D. Adhesive Anchors:

1. Threaded Rod:
   a. Diameter as shown on Drawings.
   b. Length as required to provide minimum depth of embedment indicated and thread projection required.
   c. Clean and free of grease, oil, or other deleterious material.

2. Adhesive:
   a. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
   b. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.

3. Packaging and Storage:
   a. Disposable, self-contained system capable of dispensing both components in proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.
   b. Store adhesive on pallets or shelving in a covered storage area.
   c. Package Markings: Include manufacturer’s name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
d. Dispose of when:
    1) Shelf life has expired.
    2) Stored other than in accordance with manufacturer’s instructions.

4. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System, HIT RE 500 V3 (ESR-3814), or HIT-HY 200 (ESR-3187).
   c. DeWalt/Powers Fasteners, Brewster NY; Pure 110+ Epoxy adhesive anchor system (ESR-3298).

E. Adhesive Threaded Inserts:
   1. Type 316 stainless steel, internally threaded inserts.

2.03 POST-INSTALLED MASONRY ANCHORS

A. General: AISI Type 316 stainless, hot-dip galvanized, or zinc-plated steel, as shown in Fastener Schedule at end of section.

B. Current ICC Evaluation Report indicating acceptance for anchors at structural applications in masonry.

C. Manufacturers and Products:
   1. Hilti, Inc., Tulsa, OK; Kwik-Bolt-3 (KB-3) (ESR-1385), for grout-filled masonry, HIT-HY 70 (ESR-2682) for grout filled CMU, hollow CMU, or unreinforced masonry.
   2. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt 2 (IAPMO ER 240) for grout filled CMU, Titen-HD (ESR-1056) for grout filled or hollow CMU, AT-XP (IAPMO ER-281) for grout filled CMU.
   3. DeWalt/Powers Fasteners, Brewster NY; Power-Stud+ SD1 (ESR-2966) for grout-filled masonry, Wedgebolt+ (ESR-1678) for grout-filled masonry.

PART 3 EXECUTION

3.01 CONCRETE AND MASONRY ANCHORS

A. Begin installation only after concrete or masonry to receive anchors has attained design strength.
B. Locate existing reinforcing with Ground Penetrating Radar or other method approved by Engineer prior to drilling. Coordinate with Engineer to adjust anchor locations where installation would result in hitting reinforcing.

C. Install in accordance with written manufacturer’s instructions.

D. Provide minimum embedment, edge distance, and spacing as indicated on Drawings.

E. Use only drill type and bit type and diameter recommended by anchor manufacturer.

F. Clean hole of debris and dust per manufacturer’s requirements.

G. When unidentified embedded steel, rebar, or other obstruction is encountered in drill path, slant drill to clear obstruction. If drill must be slanted more than indicated in manufacturer’s installation instructions to clear obstruction, notify Engineer for direction on how to proceed.

H. Adhesive Anchors:
   
   1. Unless otherwise approved by Engineer and adhesive manufacturer:
      a. Do not install adhesive anchors when temperature of concrete or masonry is below 40 degrees F or above 100 degrees F.
      b. Do not install prior to concrete attaining an age of 21 days.
      c. Remove any standing water from hole with oil-free compressed air. Inside surface of hole shall be dry.
      d. Do not disturb anchor during recommended curing time.
      e. Do not exceed maximum torque as specified in manufacturer’s instructions.

I. Prestressed Concrete: Do not use drilled-in anchors in prestressed or post-tensioned concrete members without Engineer’s prior approval unless specifically shown on Drawings.

3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

B. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.
### FASTENER SCHEDULE

A. Unless indicated otherwise on Drawings, provide fasteners as follows:

<table>
<thead>
<tr>
<th>Service Use and Location</th>
<th>Product</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Post-Installed Anchors for Metal Components to Cast-in-Place Concrete (such as, Ladders, Handrail Posts, Electrical Panels, Platforms, and Equipment)</td>
<td>Anchor material type to match material being anchored (for example, stainless steel anchors to anchor stainless steel equipment, zinc-plated anchors to anchor painted equipment, galvanized anchors to anchor galvanized equipment)</td>
<td>Verify product acceptability and manufacturer’s requirements if anchor installation will occur in an overhead application</td>
</tr>
<tr>
<td>Interior Dry Areas</td>
<td>Anchor material type to match material being anchored (for example, stainless steel anchors to anchor stainless steel equipment, zinc-plated anchors to anchor painted equipment, galvanized anchors to anchor galvanized equipment)</td>
<td>Verify product acceptability and manufacturer’s requirements if anchor installation will occur in an overhead application</td>
</tr>
<tr>
<td>Submerged, Exterior, Interior Wet, and Corrosive Areas</td>
<td>Stainless steel adhesive anchors</td>
<td>Verify product acceptability and manufacturer’s requirements if anchor installation will occur in an overhead application</td>
</tr>
<tr>
<td>2. Anchors in Grout-Filled Concrete Masonry Units</td>
<td>Anchor material type to match material being anchored (for example, stainless steel anchors to anchor stainless steel equipment, zinc-plated anchors to anchor painted equipment, galvanized anchors to anchor galvanized equipment)</td>
<td></td>
</tr>
<tr>
<td>Service Use and Location</td>
<td>Product</td>
<td>Remarks</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Submerged, Exterior, Interior Wet, and Corrosive Areas</td>
<td>Stainless steel adhesive anchors</td>
<td></td>
</tr>
<tr>
<td>3. Anchors in Hollow Concrete Masonry Units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior Dry Areas</td>
<td>Anchor material type to match material being anchored (for example, stainless steel anchors to anchor stainless steel equipment, zinc-plated anchors to anchor painted equipment, galvanized anchors to anchor galvanized equipment)</td>
<td>Adhesive anchors shall be installed with screen tubes.</td>
</tr>
<tr>
<td>Exterior, Interior Wet, and Corrosive Areas</td>
<td>Stainless steel adhesive anchors</td>
<td>Adhesive anchors shall be installed with screen tubes.</td>
</tr>
<tr>
<td>4. All Others</td>
<td>Stainless steel fasteners</td>
<td></td>
</tr>
</tbody>
</table>

B. Antiseizing Lubricant: Use on all stainless steel threads.

C. Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 120 degrees F.

END OF SECTION
PART 1  GENERAL

1.01  REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Society of Mechanical Engineers (ASME):
   a. BPVC SEC V, Nondestructive Examination.
   b. BPVC SEC IX, Welding and Brazing Qualifications.


3. American Welding Society (AWS):
   a. A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.
   b. A3.0, Standard Welding Terms and Definitions.
   g. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
   h. D1.8/D1.8M, Structural Welding Code - Seismic Supplement.
   i. QC1, Standard for AWS Certification of Welding Inspectors.


1.02  DEFINITIONS

A. CJP: Complete Joint Penetration.

B. CWI: Certified Welding Inspector.

1. Contractor’s Welding Inspector: Contractor’s CWI acts for, and on behalf of, the Contractor for all inspection and quality matters within the scope of the Contract Documents. Contractor is required to provide a welding inspector to oversee welding operations and be responsible for visual inspection and necessary correction of all deficiencies in materials and workmanship required to meet referenced welding codes. This type of Quality Control Inspection is not classified as Special Inspection.
2. Verification Inspector: CWI who acts on behalf of the Owner. This type of independent inspection and testing is the prerogative of the Owner, who may perform this function, or waive independent verification inspection if it is not required by the building official and building code.

C. MT: Magnetic Particle Testing.

D. NDE: Nondestructive Examination.

E. NDT: Nondestructive Testing.

F. PJP: Partial Joint Penetration.

G. PQR: Procedure Qualification Record.

H. PT: Liquid Penetrant Testing.

I. Special Inspection: Nondestructive examination exclusive of VT. Special inspection includes NDE, such as MT, PT, UT, RT and Verification Inspection. Special Inspection personnel report to, and are retained by the Owner. See additional requirements in Section 01 45 33, Special Inspection, Observation, and Testing.

J. RT: Radiographic Testing.


M. WPQ: Welder/Welding Operator Performance Qualification Record.


1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Shop and field WPSs and PQRs.
   b. NDT procedure specifications prepared in accordance with ASME BPVC SEC V.
   c. Welding Data (Shop and Field): Submit welding data together with Shop Drawings as a complete package.
      1) Show on Shop Drawings, or on a weld map, complete information regarding base metal specification designation, location, type, size, and extent of welds with reference
called out for WPS and NDE numbers in tails of combined welding and NDE symbols as indicated in AWS A2.4.

2) Clearly distinguish between shop and field welds.

3) Indicate, by welding symbols or sketches, details of welded joints and preparation of base metal. Provide complete joint welding details showing bevels, groove angles, and root openings for welds.

4) Welding and NDE Symbols: In accordance with AWS A2.4.

5) Welding Terms and Definitions: In accordance with AWS A3.0.

B. Informational Submittals:

1. WPQs.
2. CWI credentials.
3. Testing agency personnel credentials.
4. CWI visual inspection (VT) reports.
5. Welding Documentation: Submit on forms in referenced welding codes.

1.04 QUALIFICATIONS

A. WPSs: In accordance with AWS D1.1/D1.1M (Annex M Forms) for shop or field welding; or ASME BPVC SEC IX (Forms QW-482 and QW-483) for shop welding only.

B. WPQs: In accordance with AWS D1.1/D1.1M (Annex M Forms); or ASME BPVC SEC IX (Form QW-484).

C. CWI: Certified in accordance with AWS QC1, and having prior experience with specified welding codes. Alternate welding inspector qualifications require prior approval by Engineer.

D. Testing Agency: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.

1.05 SEQUENCING AND SCHEDULING

A. Unless otherwise specified, Submittals required in this section shall be submitted and approved prior to commencement of welding operations.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Contractor’s CWI shall be present whenever shop welding is performed. CWI shall perform inspection at suitable intervals, prior to assembly, during
assembly, during welding, and after welding. CWI shall perform inspections as required in AWS D1.1/D1.1M or referenced welding code and as follows:

1. Verifying conformance of specified job material and proper storage.
2. Monitoring conformance with approved WPS.
3. Monitoring conformance of WPQ.
4. Inspecting weld joint fit-up and performing in-process inspection.
5. Providing 100 percent visual inspection of welds.
6. Coordinating with nondestructive testing personnel and reviewing NDE test results.
7. Maintaining records and preparing reports documenting that results of CWI VT and subsequent NDE testing comply with the Work and referenced welding codes.

PART 3 EXECUTION

3.01 GENERAL

A. Welding and Fabrication by Welding: Conform to governing welding codes referenced in attached Welding and Nondestructive Testing Table.

3.02 NONDESTRUCTIVE WELD TESTING REQUIREMENTS

A. Quality Control Inspection:

1. All Welds: 100 percent VT by Contractor’s CWI.
2. Acceptance Criteria:
   b. All Other Structural Steel: AWS D1.1/D1.1M, Paragraph 6.9, Visual Inspection, Statically Loaded Nontubular Connections.

B. Nondestructive Testing Requirements:

1. NDT frequency shall be as specified below, as required by referenced welding codes, or as specified in the attached table. In case there is a conflict, the higher frequency level of NDT shall apply.
   a. Nontubular Connections:
      1) CJP Butt Joint Groove Welds: 10 percent random UT. Use UT for CJP butt joint groove welds that cannot be readily radiographed.
      2) All Other CJP Groove Welds: 10 percent random UT.
      3) Fillet Welds and PJP Groove Welds: 10 percent random PT or MT.
b. Tubular Connections:
   1) CJP Butt Joint Groove Welds made from One Side without Backing: 100 percent RT or UT in accordance with AWS D1.1/D1.1M, Paragraph 9.26.2 requirements.
   2) CJP Butt Joint Groove Welds made without Backing or Back-gouging: 10 percent random UT. Use UT for CJP butt joint groove welds that cannot be readily radiographed.
   3) All Other CJP Groove Welds: 10 percent random UT.
   4) Fillet Welds and PJP Groove Welds: 10 percent random PT or MT.

2. NDT Procedures and Acceptance Criteria:
   a. Nontubular Connections:
      3) PT and MT:
         b) Acceptance criteria per AWS D1.1/D1.1M, Paragraph 6.9, Visual Inspection, Statically Loaded Nontubular Connections.
   b. Tubular Connections:
      1) RT: Comply with requirements for Nontubular Connections and additional requirements of AWS D1.1/D1.1M, Clause 9, Paragraph 9.28 and Paragraph 9.29.
      2) UT: Comply with requirements for Nontubular Connections and additional requirements of AWS D1.1/D1.1M, Clause 9, Paragraph 9.27.
      3) PT and MT:
         b) Acceptance criteria per AWS D1.1/D1.1M, Paragraph 9.25.

3.03 FIELD QUALITY CONTROL

A. Contractor’s CWI shall be present whenever field welding is performed. CWI shall perform inspection, at suitable intervals, prior to assembly, during
assembly, during welding, and after welding. CWI shall perform inspections as required in AWS D1.1/D1.1M or referenced welding code and as follows:

1. Verify conformance of specified job material and proper storage.
2. Monitor conformance with approved WPS.
3. Monitor conformance of WPQ.
4. Inspect weld joint fit-up and perform in-process inspection.
5. Provide 100 percent visual inspection of all welds in accordance with Paragraph Quality Control Inspection.
6. Supervise nondestructive testing personnel and evaluating test results.
7. Maintain records and prepare report confirming results of inspection and testing comply with the Work.

3.04 WELD DEFECT REPAIR

A. Repair and retest rejectable weld defects until sound weld metal has been deposited in accordance with appropriate welding codes.

3.05 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this Specification.

1. Welding and Nondestructive Testing Table.

END OF SECTION
### WELDING AND NONDESTRUCTIVE TESTING

<table>
<thead>
<tr>
<th>Specification Section</th>
<th>Governing Welding Codes or Standards</th>
<th>Submit WPS</th>
<th>Submit WPQ</th>
<th>Onsite CWI Req’d</th>
<th>Submit Written NDT Procedure Specifications</th>
<th>NDT Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>03 21 00 Steel Reinforcement</td>
<td>AWS D1.4/D1.4M, Structural Welding Code - Reinforcing Steel</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>100% VT and 100% MT of all rebar splices; also see Section 03 21 00</td>
</tr>
<tr>
<td>05 12 00 Structural Steel Framing</td>
<td>AWS D1.1/D1.1M, Structural Welding Code - Steel</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>100% VT and 10% UT or RT of all groove-and-butt joint welds; 10% MT of all fillet welds; also see Section 05 12 00</td>
</tr>
<tr>
<td>05 21 19 Open Web Steel Joists Framing</td>
<td>AWS D1.1/D1.1M, Structural Welding Code - Steel</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>100% VT; also see Section 05 21 19</td>
</tr>
<tr>
<td>05 31 00 Steel Decking</td>
<td>AWS D1.1/D1.1M, Structural Welding Code - Steel or AWS D1.3/D1.3M, Structural Welding Code - Sheet Steel</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>100% VT; also see Section 05 31 00</td>
</tr>
<tr>
<td>05 50 00 Metal Fabrications</td>
<td>AWS D1.1/D1.1M, Structural Welding Code - Steel or AWS D1.2/D1.2M, Structural Welding Code - Aluminum or AWS D1.6/D1.6M, Structural Welding Code - Stainless Steel</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>100% VT; also see Section 05 50 00</td>
</tr>
<tr>
<td>05 52 19 Steel Railings</td>
<td>AWS D1.1/D1.1M, Structural Welding Code - Steel or</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>100% VT; also see Section 05 52 19, Steel Railings</td>
</tr>
<tr>
<td>05 53 00 Metal Gratings</td>
<td>AWS D1.1/D1.1M, Structural Welding Code - Steel or AWS D1.2/D1.2M, Structural Welding Code - Aluminum</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>100% VT; also see Section 05 53 00</td>
</tr>
<tr>
<td>33 05 01.01 Welded Steel Pipe and Fittings</td>
<td>ASME BPV Code, Section IX; and AWS D1.1/D1.1M, Structural Welding Code - Steel</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>100% VT; also see Section 33 05 01.01</td>
</tr>
</tbody>
</table>
SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1  GENERAL

1.01  REFERENCES

A.  The following is a list of standards which may be referenced in this section:

2.  American Institute of Steel Construction (AISC):
   a.  201, Certification Program for Structural Steel Fabricators.
   b.  206, Certification Program for Structural Steel Erectors—
       Standard for Structural Steel Erectors.
   d.  325, Steel Construction Manual.
   e.  326, Detailing for Steel Construction.
   g.  360, Specification for Structural Steel Buildings.
   h.  420, Certification Standard for Shop Application of Complex
       Protective Coating Systems.
3.  American Welding Society (AWS):
4.  ASTM International (ASTM):
       Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
   c.  A53/A53M, Standard Specification for Pipe, Steel, Black and
       Hot-Dipped, Zinc-Coated Welded and Seamless.
   d.  A123/123M, Standard Specification for Zinc (Hot-Dip
       Galvanized) Coatings on Iron and Steel Products.
   e.  A143/A143M, Standard Practice for Safeguarding Against
       Embrittlement of Hot-Dip Galvanized Structural Steel Products
       and Procedure for Detecting Embrittlement.
       on Iron and Steel Hardware.
   g.  A325, Standard Specification for Structural Bolts, Steel, Heat
       Treated, 120/105 ksi Minimum Tensile Strength.
   h.  A384/A384M, Standard Practice for Safeguarding Against
       Warpage and Distortion During Hot-Dip Galvanizing of Steel
       Assemblies.
   i.  A385/A385M, Standard Practice for Providing High-Quality Zinc
       Coatings (Hot-Dip).
k. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
m. A572/A572M, Standard Specification for High-Strength Low Alloy Columbium-Vanadium Structural Steel.
q. A1085/A1085M, Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS).
s. F959, Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
w. F3125, 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.

5. Occupational Safety and Health Administration (OSHA).

1.02 SUBMITTALS

A. Action Submittals:

1. Provide Shop Drawing details showing:
   a. Erection plans.
   b. Members, including piece numbers, sizes, grades, dimensions, cambers, and connection details.
   c. Anchor bolt layouts.
   d. Hardened washer details.
   e. Connection material specifications.
f. Indicate type, size, and length of bolts.
g. Joint details for complete penetration welds.
h. Indicate welds by standard AWS symbols, distinguishing between shop and field welds and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.

2. Product specifications, including primer and other coatings.
3. Identify pretensioned and slip-critical high strength bolted connections.
4. Locations of Class A, or higher, faying surfaces.
5. Weld access hole dimensions, surface profile, and finish requirements.
6. Location of demand critical shop welds.
7. Locations and dimensions of protected zones.
8. Gusset plates drawn to scale when they are detailed to accommodate inelastic rotation.
9. Nondestructive testing (NDT) where performed by the fabricator.
10. Welding requirements as specified in AISC 341, Appendix W, Section W2.2.

B. Informational Submittals:

1. Name and address of manufacturer(s).
2. Mill Certificates of tests made in accordance with ASTM A6/A6M.
3. Manufacturers’ testing procedures and standards.
4. Preparation and installation or application instructions, as appropriate.
5. Proposed method to resolve misalignment between anchor bolts and bolt holes in steel members.
6. High-Strength Bolts:
   a. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that products meet specified chemical and mechanical requirements.
   b. Manufacturer’s inspection test report results for production lot(s) furnished to include:
      1) Tensile strength.
      2) Yield strength.
      3) Reduction of area.
      4) Elongation and hardness.
   c. Certified Mill Test Reports for Bolts and Nuts:
      1) Name and address of manufacturer.
      2) Bolts correctly marked.
      3) Marked bolts and nuts used in required mill tests and manufacturer’s inspection tests.
7. Direct Tension Indicators (DTIs): Manufacturer’s test report meeting requirements of ASTM F959.
8. Twist-Off-Type Tension-Control (TC) Bolts: Manufacturer’s test report meeting requirements of ASTM F1852 or ASTM F2280.
9. Welding Procedures, Qualifications, and Inspection Reports: As specified in Section 05 05 23, Welding.
10. Hot-Dip Galvanizing: Certificate of compliance signed by galvanizer with description of material processed and ASTM standard used for coating.
11. Charpy V-notch test results.

1.03 QUALITY ASSURANCE

A. Qualifications:
   1. Welding qualifications as specified in Section 05 05 23, Welding.

B. Certifications: Mill identification marks, heat number, size of section, and length in accordance with ASTM A6/A6M.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Load structural members in such a manner that they will be transported and unloaded without damage to coatings and without being excessively stressed, deformed, or otherwise damaged.

B. Storage:
   1. Store materials to permit easy access for inspection and identification. Store in a dry area and keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
      a. Do not store materials in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials as directed.
   2. Store fasteners in a protected place in sealed containers with manufacturer’s labels intact.
      a. Fasteners may be repackaged provided testing and inspecting agency observes repackaging and sealing of containers.
      b. Clean and lubricate bolts and nuts that become dry or rusty before use.
      c. Comply with manufacturer’s written recommendations for cleaning and lubricating fasteners and for retesting fasteners after lubrication.
C. Handle materials to avoid distortion or damage to members or supporting structures.

PART 2 PRODUCTS

2.01 MATERIALS

A. Recycled Content of Steel Products:
   1. Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:
      a. W-Shapes: 60 percent.
      b. Channels, Angles, S-Shapes: 60 percent.
      c. Plate and Bar: 25 percent.
      d. Cold-Formed Hollow Structural Sections: 25 percent.
      e. Steel Pipe: 25 percent.
      f. All Other Steel Materials: 25 percent.

B. Rolled Plates, Shapes except W-Shapes and Bars: ASTM A36/A36M, unless indicated otherwise.

C. W-Shapes: ASTM A992/A992M, unless indicated otherwise on Drawings.

D. Steel Pipe: ASTM A53/A53M, Grade B.

E. Round Hollow Structural Sections (HSS): ASTM A500/A500M, Grade C (Fy equals 46 ksi).

F. Square and Rectangular Hollow Structural Sections (HSS): ASTM A500/A500M, Grade C (Fy equals 50 ksi).

G. For hot-dip galvanized steel that is exposed to view and does not receive paint, limit combined phosphorus and silicon content to 0.04 percent. For steels that require a minimum of 0.15 percent silicon, such as plates over 1.5 inches thick for ASTM A36/A36M and ASTM A572/A572M steels, limit maximum silicon content to 0.21 percent and phosphorous content to 0.03 percent.

2.02 FASTENERS

A. Anchor Bolts: As specified in Section 05 50 00, Metal Fabrications.

B. Post-Installed Anchors: As specified in Section 05 05 19, Post-Installed Anchors.
C. High-Strength Bolts:
   1. ASTM A325, Type 1, hot-dip galvanized.
   2. Bolt Length and Thread Length: As required for connection type shown, with hardened washers as required.

D. Direct Tension Indicators (DTIs) or Load Indicator Washers:
   1. ASTM F959, coating type to match bolt finish.
   2. Type A325 or A490, to match bolt type.
   3. Manufacturers and Products:
      a. TurnaSure LLC, Langhorne, PA; DTIs.
      b. Applied Bolting Technology Products, Ludlow, VT; DTIs, regular or Squirter type.

E. Twist-Off-Type Tension-Control (TC) Bolts:
   1. High-strength, ASTM F1852, bolt Type 1, mechanically galvanized.
   2. Manufacturers:
      a. LeJeune Bolt Company, Burnsville, MN.
      b. Nucor Fastener, Saint Joe, IN.
      c. Haydon Bolts, Philadelphia, PA.
      d. Vermont Fasteners Manufacturing, Swanton, VT.

F. Nuts: ASTM A563, type to match bolt type and finish.

G. Hardened Steel Flat and Beveled Washers: ASTM F436, type to match bolt finish.

H. Stud Shear Connectors: As specified in Section 05 50 00, Metal Fabrications.

2.03 ANCILLARY MATERIALS

A. Surface Preparation and Primer: As specified in Section 09 90 00, Painting and Coating.

B. Grout: As specified in Section 03 62 00, Grouting.

2.04 FABRICATION

A. General:
   1. Fabricate as shown and in accordance with AISC 360 and AISC 303.
   2. Columns: Full-length members without splices, unless shown otherwise or approved by Engineer.
   3. Mark and match mark materials for field assembly.
4. Complete assembly, including bolting and welding of units, before start of finishing operations.
5. Fabricate to agree with field measurements.
6. Fabricate beams with rolling camber up.
7. Provide camber as indicated on Drawings.

B. Connections:

1. Shop Connections: Weld or bolt as shown on Drawings.
2. Meet requirements of AISC 325 for bolted double-angle shear connections, unless indicated otherwise.
3. Meet OSHA requirements for one independent bolt at beams framing in to column web connections.

C. Welded Construction:

1. As specified in Section 05 05 23, Welding.
2. Groove and Butt Joint Welds: Complete penetration, unless otherwise indicated.

D. Interface with Other Work:

1. Holes:
   a. As necessary or as indicated for securing other Work to structural steel framing, and for passage of other Work through steel framing members shall be approved by Engineer.
   b. No flame-cut holes are permitted without prior approval of Engineer.
2. Weld threaded nuts to framing members, and other specialty items to receive other Work.

2.05 FINISHES

A. Shop Paint Primer:

1. Surface Preparation and painting as specified in Section 09 90 00, Painting and Coating.
2. Do not shop prime the following surfaces, unless indicated otherwise:
   a. Within 2 inches of field-welded connections.
   b. Steel members to be completely encased in reinforced concrete or coated with cementitious fireproofing.
3. Apply shop primer to top flange surfaces of composite steel beams, unless indicated otherwise.
B. Galvanizing:

1. Fabricate steel to be galvanized in accordance with ASTM A143/A143M, ASTM A384/A384M, and ASTM A385/A385M. Avoid fabrication techniques that could cause distortion or embrittlement of steel.
2. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.
3. Remove, by blast cleaning or other methods, surface contaminants and coatings not removable by normal chemical cleaning process in galvanizing operation.
4. Hot-dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM A123/A123M.
5. Hot-dip galvanize ASTM A325 bolts, nuts, washers, and hardware components in accordance with ASTM A153/A153M. Oversize holes to allow for zinc alloy growth. Shop-assemble bolts, nuts, and washers with special lubricant and test in accordance with ASTM A325 and ASTM A563.
6. Mechanically zinc coat ASTM F1852 twist-of-type tension-control (TC) bolts, nuts, and washers in accordance with ASTM F1852 and ASTM B695, Class 50.
7. Coat ASTM F2280 twist-off-type tension-control (TC) bolts, nuts, and washers in accordance with ASTM F1136.
8. Galvanize components of bolted assemblies separately before assembly.

C. Slip Critical Bolted Connections:

1. Coated Faying Surfaces: Coat faying surfaces of slip critical bolted connections specified or shown with a paint primer with a Class A or Class B coating in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts and as specified in Section 09 90 00, Painting and Coating. Protect against overspray by use of masking. Remove inadvertent overspray from the faying surfaces.
2. Galvanized Faying Surfaces: Roughen galvanized surfaces of slip critical bolted connections by hand wire brushing in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts as a Class C faying surface.

D. Welding:

1. Contractor’s Certified Welding Inspector (CWI): Inspect and test fabrication welds as specified in Section 05 05 23, Welding.
2. Visually inspect fabrication welds in accordance with AWS D1.1/D1.1M, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
3. An independent testing agency will be retained by Owner to perform the inspection and testing of fabrication welds as specified in Section 05 05 23, Welding.

4. Repair and retest defective welds as specified in Section 05 05 23, Welding.

E. Special inspection of fabrication process and shop welding will be provided by Owner as indicated on Drawings.

F. Hot-Dip Galvanizing:

   1. An independent testing agency will be retained by Owner to inspect and test hot-dip galvanized fabricated items in accordance with ASTM A123/A123M and ASTM A153/A153M.

   2. Visually inspect and test for thickness and adhesion of zinc coating for minimum of three test samples from each lot in accordance with ASTM A123/A123M and ASTM A153/A153M.

   3. Reject and retest nonconforming articles in accordance with ASTM A123/A123M and ASTM A153/A153M.

PART 3 EXECUTION

3.01 ERECTION

A. General:

   1. Meet requirements of AISC 360 and AISC 303, with exceptions as specified.

   2. Install Contractor-designed temporary construction bracing to provide necessary support until components are in place and construction is complete.

   3. Provide additional field connection material as required by AISC 303.

   4. Splice members only where indicated and accepted on Shop Drawings.

B. Field Assembly:

   1. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly.

   2. Set structural frames accurately to lines and elevations shown.

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

   4. Level and plumb individual members of structure within tolerances shown in AISC 303.
5. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be completed and in service.

6. Perform necessary adjustments to compensate for minor discrepancies in elevations and alignment.

C. Setting Baseplates and Bearing Plates:

1. Clean concrete and masonry bearing surfaces of bond reducing materials and roughen to improve bond to surfaces.
2. Clean bottom surface of baseplates and bearing plates.
3. Set loose and attached baseplates and bearing plates for structural members on wedges, shims, leveling nuts, or other adjustable devices. Use leveling plates where indicated.
4. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to placing grout. Weld plate washer to baseplate where indicated.
5. Grout Under Baseplate: As specified in Section 03 62 00, Grouting, prior to placing loads on structure.

D. Anchor Bolts:

1. Coordinate installation of anchor bolts and other connectors required for securing structural steel to in-place work.
2. Provide templates and other devices for presetting bolts and other anchors to accurate locations.
3. Projection of anchor bolts beyond face of concrete and threaded length shall be adequate to allow for full engagement of threads of hold-down nuts, adjustment of leveling nuts, washer thicknesses, and construction tolerances, unless indicated otherwise.
4. Placement Tolerances:
   a. As required by AISC 303, unless indicated otherwise.
   b. Embedded anchor bolts shall not vary from dimensions shown on Drawings by more than the following:
      1) Center-to-Center of Any Two Bolts Within an Anchor Group: 1/8 inch.
      2) Center-to-Center of Adjacent Anchor Bolt Groups: 1/4 inch.
      3) Variation from Perpendicular to Theoretical Bearing Surface: 1:50.
E. Connections:

1. High-Strength Bolted:
   a. Tighten in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts.
   b. Pretension all bolts unless noted otherwise on Drawings.
   c. Hardened Washers:
      1) Provide at locations required by Washer Requirements section of RCSC Specification for Structural Joints Using High Strength Bolts, to include pretensioned and slip critical connections using slotted or oversized holes or ASTM A490 bolts.
      2) Use beveled style and extra thickness where required by RCSC Specification.
      3) Use square or rectangular beveled washers at inner flange surfaces of American Standard beams and channels.
      4) Do not substitute DTIs for hardened flat washers required at slotted and oversize holes.
   d. For snug-tightened connections (N, X), tighten to snug tight condition. Use hardened washer over slotted or oversize holes in outer plies.

2. Pretensioned Bolted:
   a. Use DTIs or twist-off-type tension-control (TC) bolts at slip critical (SC) and pretensioned bearing-type connections.
   b. DTIs:
      1) Position within bolted assembly in accordance with ASTM F959.
      2) Install bolts, with DTIs plus hardened washers as required, in holes of assembly and tighten until plies are in firm contact and fasteners are uniformly snug tight.
   c. Final tightening bolts begin at most rigid part of bolted connection and progress toward free edges until final twist-off-type tension-control (TC) bolts or until DTIs have been compressed to an average gap equal to or less than shown in ASTM F959, Table 2.

3. Welded:
   a. As specified in Section 05 05 23, Welding.
   b. Groove and Butt Joint Welds: Complete penetration, unless otherwise indicated.
3.02 MISFITS

A. At Bolted Connections:
   1. Immediately notify Engineer for approval of one of the following methods of correction:
      a. Ream holes that must be enlarged to admit bolts and use oversized bolts.
      b. Plug weld misaligned holes and redrill holes to admit standard size bolts.
      c. Drill additional holes in connection, conforming to AISC for bolt spacing and end and edge distances, and add additional bolts.
      d. Reject member containing misfit, incorrect sized, or misaligned holes and fabricate new member to ensure proper fit.
   2. Do not enlarge incorrectly sized or misaligned holes in members by burning or by use of drift pins.

B. At Anchor Bolts:
   1. Resolve misalignments between anchor bolts and bolt holes in steel members in accordance with approved Shop Drawing.
   2. Do not flame cut to enlarge holes without prior approval of Engineer.

C. Gas Cutting:
   1. Do not use gas cutting torches in field for correcting fabrication errors in structural framing.
   2. Secondary members not under stress and concealed in finished structure may be corrected by gas cutting torches, if approved by Engineer.
   3. Finish flame-cut sections equivalent to sheared and punched appearance.

3.03 REPAIR AND CLEANING

A. Clean shop primer from field welds, bolted connections, and abraded areas immediately after erection.

B. Remove and grind smooth tack welds, fit-up-lugs, and weld runoff tabs.

C. Remove weld back-up bars and grind smooth where indicated on Drawings.

D. Apply touchup paint primer by brush or spray of same thickness and material as that used in shop application and as specified in Section 09 90 00, Painting and Coating.
E. Hot-Dip Galvanized Coating Repair:
   1. Conform to ASTM A780/A780M.
   2. For minor repairs at abraded areas, use sprayed zinc conforming to
      ASTM A780/A780M.
   3. For flame cut or welded areas, use zinc-based solder, or zinc sticks,
      conforming to ASTM A780/A780M.
   4. Use magnetic gauge to determine thickness is equal to or greater than
      base galvanized coating.

3.04 FIELD FINISH
A. Field finish in accordance with Section 09 90 00, Painting and Coating.

3.05 FIELD QUALITY ASSURANCE AND QUALITY CONTROL
A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17
   requirements, is provided in Statement of Special Inspections Plan in
   Supplement located at end of Section 01 45 33, Special Inspection,
   Observation, and Testing. Contractor responsibilities and related information
   are included in Section 01 45 33, Special Inspection, Observation, and
   Testing.

B. Contractor-Furnished Quality Control: Inspect and test as required in
   Section 01 45 16.13, Contractor Quality Control.

C. High-Strength Bolted Connections:
   1. An independent testing agency will be retained by Owner to perform the
      following inspection and testing in accordance with the RCSC
      Specification for Structural Joints Using High-Strength Bolts:
      a. Marking identification and conformance to ASTM standards.
      b. Alignment of bolt holes.
      c. Placement, type, and thickness of hardened washers.
      d. Tightening of bolts.
   2. Snug-Tightened Connections (N, X): Snug tight condition with plies of
      joint in firm contact.
   3. Pretensioned Bearing and Slip Critical (SC) Connections:
      a. Conduct preinstallation test.
      b. Monitor installation and tightening of DTIs or TC bolts.
      c. Monitor condition of faying surfaces for slip critical connections.
4. Preinstallation Test:
   a. Conduct test in accordance with Specification for Structural Joints Using ASTM A325 or ASTM A490 bolts prior to using bolt tension measuring device.
   b. Select representative sample of not less than three bolts of each diameter, length, and grade.
   c. Include DTIs and flat hardened washers as required to match actual connection assembly.


6. Defective Connections: Correct and reinspect defective and improperly tightened high-strength bolted connections. Retest pretensioned bolts as necessary to demonstrate compliance of completed work.

D. Welding:

1. Contractor’s Certified Welding Inspector (CWI): Inspect and test field welds as specified in Section 05 05 23, Welding.
2. Visually inspect field welds in accordance with AWS D1.1/D1.1M, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
3. An independent testing agency will be retained by Owner to perform inspection and testing of field welds as specified in Section 05 05 23, Welding.
4. Repair and retest defective welds as specified in Section 05 05 23, Welding.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Institute of Steel Construction (AISC):
3. Steel Joist Institute (SJI):
   a. Standard Specifications and Load Tables:
      1) Open-Web Steel Joists, K-Series.
      3) Super Longspan Steel Joists, SLH-Series.
      4) Joist Girders.

1.02 SUBMITTALS

A. Action Submittals:

1. Plan view layout of joists and bridging.
2. Elevation view of each type of joist showing configuration, chord and web member sizes, panel point dimensions, and chord extensions.
3. Connection and bearing details.
4. Special joist reinforcing and connections for supported items, such as monorails and mechanical equipment.
5. Bridging member sizes and connection details.
6. Complete design, including stress and deflection calculations, for joists, joist members, and connections for design load and equipment weight as indicated, plus any construction loads applied by Contractor’s operations.
7. Calculations shall include check of joist chord bending stresses for concentrated loads applied between panel points.
ZINK DAM IMPROVEMENTS

8. Registered Professional Engineer’s stamp, valid in same state as Project, on structural calculations.
9. Procedure for handling, erection, and bracing of steel joists.

B. Informational Submittals:

1. Joist manufacturer’s installation requirements.
2. Welding Procedures, Qualifications, and Inspection Report: As specified in Section 05 05 23, Welding.

1.03 QUALITY ASSURANCE

A. General: Design and fabricate steel joists and bridging to meet requirements of SJI Standard Specifications and Load Tables.

B. Certification: SJI Membership, with certification for joist types as indicated on Drawings.

C. Qualifications for Field Welding: As specified in Section 05 05 23, Welding.

1.04 DELIVERY, STORAGE, AND HANDLING

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

B. Protect joist paint system from abrasion at steel bands and other joists.

C. Store joists and bridging off ground on wood sleepers.

D. Support joists so there is no danger of tipping, sliding, rolling, shifting or material damage.

PART 2 PRODUCTS

2.01 STEEL JOISTS AND BRIDGING

A. Provide type of joist, chord configuration, and depth as indicated on Drawings.

B. Design and Manufacture:

1. In accordance with the applicable SJI Standard Specifications.
2. Chord Members: Rolled double angle sections only.
3. Provide the following where indicated, in accordance with SJI Standard Specifications and Load Tables:
   a. Bottom chord bracing and end anchorage for uplift design criteria.
   b. Ceiling extension to within 1 inch of finished wall surface, unless otherwise indicated.
   c. Top chord extension, S type unless otherwise indicated.
   d. Bottom chord extension and stabilizer plates for joist girders.
   e. Full camber, unless otherwise indicated.

C. Joist Bridging:
   1. In accordance with applicable SJI Standard Specifications for type of joist.
   2. Furnish bridging of minimum size and type as indicated.
   3. Provide anchorage connection to walls and girders at bridging lines as indicated.

2.02 SHOP PRIMER

A. Surface Preparation and Primer: As specified in Section 09 90 00, Painting and Coating.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine supporting framing and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of steel joists.

3.02 INSTALLATION

A. Erection: SJI Standard Specifications and approved shop drawings.
   B. Welded Connections: As specified in Section 05 05 23, Welding.

3.03 TOUCHUP PAINTING

A. Immediately following erection, remove debris from completed installation.
   B. Clean field welds, bolted connections, rust spots, and abraded areas.
   C. Repair damaged painted and galvanized surfaces as specified in Section 09 90 00, Painting and Coating.
3.04 FIELD QUALITY CONTROL

A. Welding:

1. Visually inspect field welds in accordance with AWS D1.1, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
2. Repair defective welds as specified in Section 05 05 23, Welding.

B. Special inspection will be provided by Owner as noted in Section 01 45 33, Special Inspection, Observation, and Testing.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

3. ASTM International (ASTM):
   a. A611, Standard Specification for Structural Steel (SS), Sheet, Carbon, Cold-Rolled.
   b. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
4. Factory Mutual (FM):
   a. Factory Mutual Approval Guide.
   b. FM Research Corporation (FMRC): Approval Requirements for Steel Roof Deck Construction.
6. Steel Deck Institute (SDI):
   a. Design Manual for Composite Decks, Form Decks and Roof Decks.

1.02 SUBMITTALS

A. Action Submittals:

1. Plan view layout of decking showing type and section properties of deck panels, reinforcing channels, pans, special jointing, and accessories.
2. Location of openings, deck laps, and deck attachment details.
B. Informational Submittals:

1. Decking manufacturer’s installation requirements.
2. Welding Procedures, Qualifications, and Inspection Report: As specified in Section 05 05 23, Welding.
3. Operation manuals for mechanical fastener installation tools.
4. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.

1.03 QUALITY ASSURANCE

A. General: For metal decking section properties, meet requirements of AISI Specifications for Design of Cold-Formed Steel Structural Members.

B. FM Requirements:

1. Steel Roof Deck: Listed in Factory Mutual “Approval Guide” for Class 1 fire rating and Class 1-90 wind uplift rating.
2. Mechanical Fasteners: Packing containers shall show name of manufacturer and product and FMRC approval mark.

C. Qualifications for Field Welding: As specified in Section 05 05 23, Welding.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store deck bundles on platforms or pallets, with one end elevated to provide drainage.

C. Protect bundles against condensation with a ventilated waterproof covering.

D. Stack bundles so there is no danger of tipping, sliding, rolling, shifting or material damage.
PART 2 PRODUCTS

2.01 METAL DECKING

A. Provide metal deck as shown in the following schedule:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof Deck</td>
<td>1-1/2</td>
<td>36</td>
<td>0.0358</td>
<td>33</td>
<td>0.23</td>
<td>0.21</td>
<td>400</td>
<td>Galv, G-60</td>
</tr>
</tbody>
</table>

B. Materials and Finishes:

1. Galvanized Deck:
   a. Sheet steel for galvanized deck and accessories shall conform to ASTM A653 Structural Quality Grade 33 or higher, as shown in Steel Deck Schedule.
   b. Galvanizing shall conform to ASTM A924 with coating class of G60 or G90 as defined in ASTM A653 and as shown in Steel Deck Schedule.

C. Manufacturers:

   1. Vulcraft Division of Nucor Co., Brigham City, UT.
   2. BHP Steel Building Products, USA, Inc., West Sacramento, CA.
   3. Verco Manufacturing, Inc., Phoenix, AZ.
   4. United Steel Deck, Inc., Summit, NJ.

2.02 ACCESSORIES

A. Provide pour stops, column closures, end closures, cover plates, girder fillers, ridge and valley plates, finish strips, reinforcing channels, and other accessories as required for complete installation.

B. Accessories shall be minimum 22-gauge, except edge forms shall be sized as required by the deck manufacturer, unless shown otherwise on Drawings.

2.03 MECHANICAL FASTENERS

A. Self-Drilling Screws:

   1. Self-drilling, self-tapping screws with hexagonal washer head and corrosion-resistant finish.
2. Manufacturers and Products:
   a. ITW Buildex, Itasca, IL; ICH Traxx Self-Drilling Fasteners with Climaseal Coating and Autotraxx Standup Installation Tool.

B. Powder Driven Fasteners:
   1. Knurled shank, minimum 1/2-inch diameter steel washer, corrosion-resistant coating.
   2. Pin diameter and length to suit deck type and flange thickness of steel support member.
   3. Manufacturers and Products:
      a. ITW Buildex, Itasca, IL; Buildex BX14 pins with yellow dichromate galvanizing and BX900 Installation Tool.
      b. Hilti, Inc., Tulsa, OK; ENP-series fasteners with electroplated zinc coating and DX-750 Installation Tool.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Examine supporting framing and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of steel deck.

3.02 INSTALLATION
   A. Locate deck bundles to prevent overloading of support framing members.
   B. Install at right angles to supporting members in a three span minimum lay-up, unless shown otherwise, and in accordance with Specification and manufacturer’s installation recommendation.
   C. Bearing: 1-1/2 inches, minimum.
   D. Endlaps: Minimum of 2 inches and located over supports.
   E. Do not stretch sidelaps.
   F. Closure Plates:
      1. Install closure and cover plate accessories as recommended by the metal deck manufacturer, unless shown otherwise on Drawings.
2. Floor Deck and Form Deck Closures:
   a. Fasten column closures, cell closures, and zee closures to deck to provide tight fitting closures at open ends of ribs and sides of decking.
   b. Fasten cell closures at changes of direction of deck units unless otherwise indicated.

G. Holes and Openings:
   1. Cut and fit around roof openings and other work projecting through or adjacent to decking.
   2. Locate holes and openings as shown to clear structural framing and bracing members.
   3. Reinforcement around Openings:
      a. Roof Deck: For hole sizes of at least 6 inches across, but not more than 12 inches across in roof deck, reinforce with 0.0474-inch design thickness steel plate, painted or galvanized to match deck coating. Extend plate at least 12 inches beyond opening in all directions and attach to top of roof deck with No. 10 self-drilling screws at 6-inch spacing and at all corners. For openings larger than 12 inches across, reinforce roof deck with framing as shown on Drawings.
      b. Composite Floor Deck and Form Deck: Reinforce openings as indicated on Drawings.

H. Protect deck areas from heavy concentrated loads or wheel traffic with planking or other approved means.

I. Install temporary shoring, if required, to meet strength and deflection limitations, before placing any concrete topping on deck panels.

J. Completed Deck: Free from buckles and irregularities, and in accordance with FM and UL requirements.

3.03 DECK ATTACHMENT

A. Fasten panels as shown on Drawings.

B. Welded Connections: Weld deck sidelaps, attachment to framing, and accessories in accordance with AWS D1.3 and as specified in Section 05 05 23, Welding.
C. Mechanical Fasteners:

1. Self-Drilling Screws:
   a. Install screws in accordance with manufacturer’s written instructions and with special installation tool. Do not over-torque.
   b. Remove and redrive screws at sidelaps where upper sheet is not drawn tightly against lower sheet.

2. Powder Driven Fasteners:
   a. Install fasteners in accordance with manufacturer’s written instructions and with special installation tool.
   b. Minimum Sidelap Edge Distance: 3/8 inch.
   c. Minimum End/End Lap Distance: 1 inch.
   d. Head Projection: As specified by manufacturer for correct penetration into flange of steel support member.

3.04 TOUCHUP PAINTING

A. Immediately following erection, remove unused deck edge trimmings, screws, fasteners, welding washers, butt ends of welding rods, and debris from completed installation.

B. Clean field welds, bolted connections, rust spots, and abraded areas.

C. Repair damaged painted surfaces as specified in Section 09 90 00, Painting and Coating.

D. Repair damaged galvanized surfaces with zinc-rich spray paint in accordance with ASTM A780; color to match galvanized deck.

E. Use magnetic gauge to determine that thickness of repair is equal to or greater than base painted or galvanized coating.

3.05 FIELD QUALITY CONTROL

A. An independent testing agency will be retained by Owner to perform following inspections.

1. Welded Connections: Visually inspect in accordance with AWS D1.3, Section 7, and as specified in Section 05 05 23, Welding.

2. Mechanical Fasteners: Visually inspect, in accordance with manufacturer’s instructions, for each type of fastener.

B. Repair or replace defective welds and fasteners.

END OF SECTION
SECTION 05 50 00
METAL FABRICATIONS

PART 1  GENERAL

1.01  REFERENCES

A.  The following is a list of standards which may be referenced in this section:

2.  American Galvanizers Association (AGA):
   a.  Inspection of Hot-Dip Galvanized Steel Products.
6.  American Society of Safety Engineers (ASSE): A10.11, Safety Requirements for Personnel and Debris Nets.
7.  American Welding Society (AWS):
   c.  D1.6/D1.6M, Structural Welding Code - Stainless Steel.
8.  ASTM International (ASTM):
   h.  A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   i.  A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.


m. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.


q. A385/A385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).


s. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

t. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.


y. A793, Standard Specification for Rolled Floor Plate, Stainless Steel.


mm. F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.


9. Occupational Safety and Health Administration (OSHA):
   b. 29 CFR 1926.105, Safety Nets.
   c. 29 CFR 1926.502, Fall Protection Systems Criteria and Practices.

10. Specialty Steel Industry of North America (SSINA):
    a. Specifications for Stainless Steel.
    b. Design Guidelines for the Selection and Use of Stainless Steel.
    c. Stainless Steel Fabrication.
    d. Stainless Steel Fasteners.

1.02 DEFINITIONS

A. Anchor Bolt: Cast-in-place anchor; concrete or masonry.

B. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

C. Exterior Area: Location not protected from weather by building or other enclosed structure.

D. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or washdown, nor where wall or roof slab is common to a water-holding or earth-retaining structure.

E. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or washdown, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.
F. Submerged: Location at or below top of wall of open water-holding structure, such as basin or channel, or wall, ceiling or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Metal fabrications, including welding and fastener information.
2. Samples: Color samples of abrasive stair nosings.

B. Informational Submittals:

1. U-Channel Concrete Inserts:
   a. Manufacturer’s product description.
   b. Allowable load tables.
4. Galvanized coating applicator qualifications.
5. Hot-Dip Galvanizing: Certificate of compliance signed by galvanizer, with description of material processed and ASTM standard used for coating.

1.04 QUALITY ASSURANCE

A. Qualifications:


1.05 DELIVERY, STORAGE, AND HANDLING

A. Insofar as practical, factory assemble specified items. Package assemblies, which have to be shipped unassembled to protect materials from damage and tag to facilitate identification and field assembly.

B. Package stainless steel items to provide protection from carbon impregnation.

C. Protect painted coatings and hot-dip galvanized finishes from damage as a result of metal banding and rough handling. Use padded slings and straps.

D. Store fabricated items in dry area, not in direct contact with ground.
1.06 SPECIAL GUARANTEE

A. Manufacturer’s extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at option of Owner, removal and replacement of sidewalk doors and floor hatches found defective during a period of 5 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in General Conditions.

PART 2 PRODUCTS

2.01 GENERAL

A. For hot-dip galvanized steel that is exposed to view and does not receive paint, limit the combined phosphorus and silicon content to 0.04 percent. For steels that require a minimum of 0.15 percent silicon (such as plates over 1.5 inches thick for ASTM A36/A36M steel), limit maximum silicon content to 0.21 percent and phosphorous content to 0.03 percent.

B. Unless otherwise indicated, meet the following requirements:

<table>
<thead>
<tr>
<th>Item</th>
<th>ASTM Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel Wide Flange Shapes</td>
<td>A992/992M</td>
</tr>
<tr>
<td>Other Steel Shapes and Plates</td>
<td>A36/A36M or A572/A572M, Grade 50 or A992/A992M for other steel shapes</td>
</tr>
<tr>
<td>Steel Pipe</td>
<td>A500, Grade B</td>
</tr>
<tr>
<td>Hollow Structural Sections (HSS)</td>
<td>A500/A500M, Grade C</td>
</tr>
<tr>
<td>Stainless Steel:</td>
<td></td>
</tr>
<tr>
<td>Bars and Angles</td>
<td>A276, AISI Type 316 (316L for welded connections)</td>
</tr>
<tr>
<td>Shapes</td>
<td>A276, AISI Type 304 (304L for welded connections)</td>
</tr>
<tr>
<td>Steel Plate, Sheet, and Strip</td>
<td>A240/A240M, AISI Type 316 (316L for welded connections)</td>
</tr>
<tr>
<td>Bolts, Threaded Rods, Anchor Bolts, and Anchor Studs</td>
<td>F593, AISI Type 316, Group 2, Condition SH</td>
</tr>
<tr>
<td>Nuts</td>
<td>F594, AISI Type 316, Condition CW</td>
</tr>
<tr>
<td>Item</td>
<td>ASTM Reference</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Steel Bolts and Nuts:</td>
<td></td>
</tr>
<tr>
<td>Carbon Steel</td>
<td>A307 bolts, with A563 nuts</td>
</tr>
<tr>
<td>High-Strength</td>
<td>A325, Type 1 bolts, with A563 nuts</td>
</tr>
<tr>
<td>Anchor Bolts and Rods</td>
<td>F1554, Grade [A: 36] [B: 55], with weldability supplement S1</td>
</tr>
<tr>
<td>Eyebolts</td>
<td>A489</td>
</tr>
<tr>
<td>Threaded Rods</td>
<td>A36/A36M</td>
</tr>
<tr>
<td>Flat Washers (Unhardened)</td>
<td>F844</td>
</tr>
<tr>
<td>Flat and Beveled Washers (Hardened)</td>
<td>F436</td>
</tr>
<tr>
<td>Thrust Ties for Steel Pipe:</td>
<td></td>
</tr>
<tr>
<td>Threaded Rods</td>
<td>A193/A193M, Grade B7</td>
</tr>
<tr>
<td>Nuts</td>
<td>A194/A194M, Grade 2H</td>
</tr>
<tr>
<td>Plate</td>
<td>A283/A283M, Grade D</td>
</tr>
<tr>
<td>Welded Anchor Studs</td>
<td>A108, Grades C-1010 through C-1020</td>
</tr>
<tr>
<td>Aluminum Bolts and Nuts</td>
<td>F468, Alloy 2024-T4</td>
</tr>
<tr>
<td>Cast Iron</td>
<td>A48/A48M, Class 35</td>
</tr>
</tbody>
</table>

C. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, zinc-plated steel, and aluminum material types as indicated in Fastener Schedule at end of this section.

2.02 ANCHOR BOLTS AND ANCHOR BOLT SLEEVES

A. Cast-In-Place Anchor Bolts:

1. Headed type, unless otherwise shown on Drawings.
2. Material type and protective coating as shown in Fastener Schedule at end of this section.

B. Anchor Bolt Sleeves:

1. Plastic:
   a. Single unit construction with corrugated sleeve.
   b. Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.
c. Material: High-density polyethylene.
2. Fabricated Steel: ASTM A36/A36M.

2.03 POST-INSTALLED CONCRETE AND MASONRY ANCHORS
A. See Section 05 05 19, Post-Installed Anchors.

2.04 STUD SHEAR CONNECTORS
A. Headed anchor studs (HAS), or threaded anchor studs (TAS), or stud shear connectors, as indicated on Drawings.
   1. Carbon Steel: ASTM A108, Standard Quality Grade 1010 through Grade 1020, inclusive either semikilled or killed aluminum or silicon dioxide, unless indicated otherwise.
   2. Stainless Steel: ASTM F593, AISI Type 316, Condition CW, where indicated.
B. Manufacturers:
   1. Nelson Stud Welding, FabriSteel Co., Elyria, OH.

2.05 PIPE SLEEVES
A. As specified in Section 40 27 01, Process Piping Specialties.

2.06 STEEL LINTELS AND SHELF ANGLES
A. ASTM A36/A36M, hot-dip galvanize after fabrication in accordance with ASTM A123/A123M.

2.07 EMBEDDED STEEL SUPPORT FRAMES FOR FLOOR PLATE AND GRATING
A. Steel angle support frames to be embedded in concrete shall be stainless steel, ASTM A276, AISI Type 316, unless indicated otherwise.
B. Welded anchors for stainless steel support frames shall also be stainless steel.

2.08 U-CHANNEL CONCRETE INSERTS
A. Rolled ASTM A240/A240M, AISI Type 316 stainless steel, 0.105-inch-thick, 1-5/8 inches wide by 1-3/8 inches deep, with stainless steel anchors at 10-inch maximum spacing, styrofoam fillers, and end caps.
B. Nut and Bolt Hardware: Type 316 stainless steel, 5/8-inch minimum diameter, unless indicated otherwise. Manufacturer’s standard to match insert.

C. Manufacturers and Products:

1. Power-Strut, Wayne, MI; PS 349 Series.
2. B-Line Systems, Inc., Highland, IL; B32 Series.
3. Halfen Anchoring Systems, Converse, TX; Channel Type 4141HTA.

2.09 ABRASIVE NOSING FOR STAIRS

A. Unless otherwise shown on Drawings, furnish flush type abrasive nosings on stairs.

B. Nosing Components:

1. Homogeneous epoxy abrasive, with minimum 50 percent aluminum oxide content, formed and cured upon an extruded aluminum base.
2. Epoxy abrasive shall extend over and form curved front edge of nosing.

C. Anchoring System: Double-set anchors consisting of two rows of integrally extruded anchors.

D. Size: 3 inches wide by 1/4 inch to 3/8 inch thick by length as shown.

E. Color: Selected by Engineer from manufacturer’s standard color range.

F. Manufacturers and Products:

1. Wooster Products, Inc., Wooster, OH; Spectra Type WP3J.
2. American Safety Tread Co., Inc., Helena, AL; Type BF-311D.

2.10 FLOOR PLATE

A. Material:

1. Galvanized Steel: Carbon steel, ASTM A786/A786M, commercial grade, hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
2. Stainless Steel: ASTM A793, AISI Type 304.

B. Minimum Thickness:

1. Steel: 1/4 inch, unless shown otherwise on Drawings.
2. Aluminum: 3/8 inch, unless shown otherwise on Drawings.
C. Surface: Raised-lug pattern or diamond tread, unless shown otherwise on Drawings.

D. Slip-Resistant Surface:
   1. Provide where indicated on Drawings.
   2. Manufacturers and Products:
      a. IKG/Borden, Clark, NJ; MEBAC 2.
      b. W.S. Molnar Co., Detroit, MI; SLIPNOT Grade 2–Medium.

2.11 SIDEWALK DOORS

A. Load Capacity: 300 psf with maximum deflection of 1/150th of span.

B. Component Fabrication:
   1. Access Door Leaf(s): 1/4-inch aluminum diamond pattern plate. Provide stainless steel safety chain and attachments for end of double-leaf door assembly when open.
   2. Channel Frame: 1/4-inch-thick extruded aluminum trough frame with continuous anchor flange around perimeter. Weld 1-1/2-inch diameter drain coupling, and drain pipe, to frame trough at front right corner, unless indicated otherwise on Drawings.

C. Door Hardware:
   1. Hinges: Heavy-duty brass or stainless steel with stainless steel pins through-bolted to cover plate with tamper-proof stainless steel bolts flush with top of cover and to outside leg of channel frame with stainless steel bolts and locknuts.
   2. Lifting Mechanism: Stainless steel compression lift springs enclosed in telescoping vertical housing or stainless steel torsion lift springs.
   3. Hold-Open Arm:
      a. Locks automatically in OPEN position.
      b. Disengages with slight pull on vinyl grip with one hand.
      c. Door can be easily closed with one hand by pulling forward and down on vinyl grip.
   4. Snap Lock:
      a. Stainless steel snap lock mounted on bottom of door leaf with removable topside key wrench and inside fixed lever handle.
      b. Threaded plug for flush outside surface with key wrench removed.

D. Aluminum: Mill finished with protective coating applied to surfaces to be in contact with concrete, as specified in Section 09 90 00, Painting and Coating.
E. Manufacturers and Products:

4. ITT Flygt Corporation, Trumbull, CT; FDRN Series.
5. Thompson Fabricating Co., Birmingham, AL; TE Series.
6. Halliday Products, Orlando, FL; WS Series.

2.12 FLOOR HATCHES

A. Load Capacity: 150 psf with maximum deflection of 1/150th of span.

B. Component Fabrication:

1. Access Door Leaf(s): 1/4-inch-thick aluminum diamond pattern plate. Provide stainless steel safety chain and attachments for end of double-leaf door assembly when open.

C. Door Hardware:

1. Hinges: Heavy-duty brass or stainless steel with stainless steel pins, through-bolted to cover plate with tamper-proof stainless steel bolts flush with top of cover and to outside leg of channel frame with stainless steel bolts and locknuts.
2. Lifting Mechanism: Stainless steel compression lift springs enclosed in telescoping vertical housing or stainless steel torsion lift springs.
3. Hold-Open Arm:
   a. Locks automatically in OPEN position.
   b. Disengages with slight pull on vinyl grip with one hand.
   c. Door can be easily closed with one hand by pulling forward and down on vinyl grip.
4. Snap Lock:
   a. Stainless steel snap lock mounted on bottom of door leaf with removable topside key wrench and inside fixed lever handle.
   b. Threaded plug for flush outside surface with key wrench removed.

D. Aluminum: Mill finished with protective coating applied to surfaces to be in contact with concrete, as specified in Section 09 90 00, Painting and Coating.

E. Manufacturers and Products:

2. Nystrom Products Co., Minneapolis, MN; FH Series.
4. ITT Flygt Corporation, Trumbull, CT; FLE Series.
5. Thompson Fabricating Co., Birmingham, AL; TI Series.
6. Halliday Products, Orlando, FL; SS Series.

2.13 LADDERS

A. Fabricate ladders with rails, rungs, landings, and cages to meet applicable requirements of OSHA, CFR Part 1910.27, and ALI A14.3.

1. Design ladder for concentrated load of 200 pounds imposed by user concentrated at points that will cause maximum stress in structural member being considered.
2. Include weight of ladder and attached appurtenances together with live load in design of rails and fastenings.

B. Flat Bar Ladder:

1. Punch rails, pass rungs through rails, and weld on outside.
2. Weld brackets to ladder for fastening ladder to wall.
3. Hot-dip galvanize steel after fabrication in accordance with ASTM A123/A123M and ASTM A385/A385M.

C. Ladder Safety Post:

1. Telescoping tubular, spring balanced and automatically locking in raised position, with release lever for unlocking.
2. Post: Hot-dip galvanized steel in accordance with ASTM A123/A123M.
3. Hardware: Stainless steel, AISI Type 316.
4. Furnish dissimilar metal protective coatings at connections.

2.14 SAFETY CLIMB DEVICE

A. General:

2. Belt and harness shall withstand minimum drop test of 250 pounds in 6-foot free fall.
3. Fall Prevention System Material: Hot-dip galvanized steel in accordance with ASTM A123/A123M.
B. Components and Accessories:

1. Main Components: Sleeve or trolley, safety harness, and carrier or climbing rail.
2. Ladder rung clamps hot-dip galvanized steel mounting brackets and hardware.
3. Removable extension kit with tiedown rod or trolley gate, mandrel, and carrier rail for ladders under manholes and hatches.

C. Manufacturers and Products:

1. Miller by Honeywell, Franklin, PA; Miller Saf-T-Climb.
2. TS Products, Cambridge, Ontario, Canada; TS Safety Rail System.

2.15 LADDER CLIMB PREVENTION SHIELD

A. Eight feet long with angled sides to within 2 inches of wall when closed.

B. Furnish dissimilar metals protective coatings at bolted connections.

C. Manufacturer and Product: North Safety Products, Specialty Products Division, Toronto, Ontario, Canada; Ladder Gate 770-000-001.

2.16 ACCESSORIES

A. Antiseizing Lubricant for Stainless Steel Threaded Connections:

1. Suitable for potable water supply.
2. Resists washout.
3. Manufacturers and Products:
   a. Bostik, Middleton, MA; Neverseez.
   b. Saf-T-Eze Div., STL Corp., Lombard, IL; Anti-Seize.

B. Neoprene Gasket:

1. ASTM D1056, 2C1, soft, closed-cell neoprene gasket material, suitable for exposure to sewage and sewage gases, unless otherwise shown on Drawings.
2. Thickness: Minimum 1/4 inch.
3. Furnish without skin coat.
4. Manufacturer and Product: Monmouth Rubber and Plastics Corporation, Long Branch, NJ; Durafoam DK1111LD.
2.17 FABRICATION

A. General:

1. Finish exposed surfaces smooth, sharp, and to well-defined lines.
2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.
3. Conceal fastenings where practical; where exposed, flush countersink.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Grind cut edges smooth and straight. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.
6. Fit and assemble in largest practical sections for delivery to Site.

B. Materials:

1. Use steel shapes, unless otherwise noted.
2. Steel to be Hot-dip Galvanized: Limit silicon content to less than 0.04 percent or to between 0.15 percent and 0.25 percent.
3. Fabricate aluminum in accordance with AA Specifications for Aluminum Structures–Allowable Stress Design.

C. Welding:

1. Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.
2. Welded fabrications shall be free from twisting or distortion caused by improper welding techniques.
3. Steel: Meet fabrication requirements of AWS D1.1/D1.1M, Section 5.
4. Aluminum: Meet requirements of AWS D1.2/D1.2M.
5. Stainless Steel: Meet requirements of AWS D1.6/D1.6M.
6. Welded Anchor Studs: Prepare surface to be welded and weld with stud welding gun in accordance with AWS D1.1/D1.1M, Section 7, and manufacturer’s instructions.
7. Complete welding before applying finish.

D. Painting:

1. Shop prime with rust-inhibitive primer as specified in Section 09 90 00, Painting and Coating, unless otherwise indicated.
2. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
3. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.
E. Galvanizing:

1. Fabricate steel to be galvanized in accordance with ASTM A143/A143M, ASTM A384/A384M, and ASTM A385/A385M. Avoid fabrication techniques that could cause distortion or embrittlement of the steel.
2. Provide venting and drain holes for tubular members and fabricated assemblies in accordance with ASTM A385/A385M.
3. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.
4. Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.
5. Hot-dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM A123/A123M.
6. Hot-dip galvanize bolts, nuts, washers, and hardware components in accordance with ASTM A153/A153M. Oversize holes to allow for zinc alloy growth. Shop assemble bolts and nuts.
7. Galvanized steel sheets in accordance with ASTM A653/A653M.
8. Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.

F. Electrolytic Protection: Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.

G. Watertight Seal: Where required or shown, furnish neoprene gasket of a type that is satisfactory for use in exposed weather conditions. Cover full bearing surfaces.

H. Fitting: Where movement of fabrications is required or shown, cut, fit, and align items for smooth operation. Make corners square and opposite sides parallel.

I. Accessories: Furnish as required for a complete installation. Fasten by welding or with stainless steel bolts or screws.

2.18 SOURCE QUALITY CONTROL

A. Visually inspect all fabrication welds and correct deficiencies.

2. Aluminum: AWS D1.2/D1.2M.
3. Stainless Steel: AWS D1.6/D1.6M.
B. Hot-Dip Galvanizing:

1. An independent testing agency, will be retained by Owner to inspect and test hot-dip galvanized fabricated items in accordance with ASTM A123/A123M and ASTM A153/A153M.
2. Visually inspect and test for thickness and adhesion of zinc coating for minimum of three test samples from each lot in accordance with ASTM A123/A123M and ASTM A153/A153M.
3. Reject and retest nonconforming articles in accordance with ASTM A123/A123M and ASTM A153/A153M.

PART 3 EXECUTION

3.01 INSTALLATION OF METAL FABRICATIONS

A. General:

1. Install metal fabrications plumb and level, accurately fitted, free from distortion or defects.
2. Install rigid, substantial, and neat in appearance.
3. Install manufactured products in accordance with manufacturer’s recommendations.
4. Obtain Engineer approval prior to field cutting steel members or making adjustments not scheduled.

B. Aluminum:

1. Do not remove mill markings from concealed surfaces.
2. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.
3. Fabrication, mechanical connections, and welded construction shall be in accordance with the AA Aluminum Design Manual.

C. Pipe Sleeves:

1. Provide where pipes pass through concrete or masonry.
2. Holes drilled with a rotary drill may be provided in lieu of sleeves in existing walls.
3. Provide center flange for water stoppage on sleeves in exterior or water-bearing walls.
4. Provide rubber caulking sealant or a modular mechanical unit to form watertight seal in annular space between pipes and sleeves.
ZINK DAM IMPROVEMENTS

D. Steel Lintels and Shelf Angles: Provide as required for support of masonry and other construction not attached to structural steel framing, unless otherwise shown on Drawings.

3.02 CAST-IN-PLACE ANCHOR BOLTS

A. Locate and hold anchor bolts in place with templates at time concrete is placed.

B. Use anchor bolt sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt.

C. Minimum Bolt Size: 1/2-inch diameter by 12 inches long, unless otherwise shown.

3.03 U-CHANNEL CONCRETE INSERTS

A. Provide as indicated for pipe supports and where otherwise shown on Drawings.

B. Except for interior dry areas, use plastic clips or similar dielectric material to isolate channel anchors from concrete reinforcing steel.

3.04 ABRASIVE NOSINGS

A. Provide abrasive nosings on concrete steps not being supplied or coated with another type of nosing or nonskid material.

3.05 ACCESS COVERS

A. Install access covers, including sidewalk doors, floor hatches, and hinged manhole covers in accordance with manufacturer’s instructions.

B. Accurately position prior to placing concrete, such that covers are flush with floor surface.

C. Protect from damage resulting from concrete placement. Thoroughly clean exposed surfaces of concrete spillage to obtain a clean, uniform appearance.

3.06 SAFETY CLIMB DEVICE SYSTEM

A. Provide for each ladder where unbroken height between levels exceeds 20 feet, or at lesser height where indicated on Drawings.

B. Install in accordance with manufacturer’s instructions.

C. Furnish additional accessories required to complete system for each ladder.
D. Furnish one harness for each ladder equipped with safety climb device.

E. Furnish pivot section at platforms, landings, and roofs.

F. When installed to required height, fall prevention system shall be rigid and an integral part of the structure.

3.07 ELECTROLYTIC PROTECTION

A. Aluminum and Galvanized Steel:
   1. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
   2. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.
   3. Allow coating to dry before installation of the material.
   4. Protect coated surfaces during installation.
   5. Should coating become marred, prepare and touch up in accordance with paint manufacturer’s written instructions.

B. Titanium: Where titanium equipment is in contact with concrete or dissimilar metal, provide full-face neoprene insulation gasket, 3/32-inch minimum thickness and 70-durometer hardness.

C. Stainless Steel:
   1. During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.
   2. After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.
   3. Remove contamination using cleaning and passivation methods in accordance with requirements of ASTM A380 and ASTM A967.
   4. Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.
   5. After treatment, visually inspect surfaces for compliance.

3.08 PAINTING

A. Painted Galvanized Surfaces: Prepare as specified in Section 09 90 00, Painting and Coating.

B. Repair of Damaged Hot-Dip Galvanized Coating:
   1. Conform to ASTM A780/A780M.
2. For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780/A780M.
3. For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780/A780M.
4. Use magnetic gauge to determine thickness is equal to or greater than base galvanized coating.

3.09 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance:

1. In accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing.
2. Contractor responsibilities and related information on special inspection, observation, and testing are included in Section 01 45 33, Special Inspection, Observation, and Testing.

B. Contractor-Furnished Quality Control:

1. Inspection and testing required in Section 01 45 16.13, Contractor Quality Control.
2. Manufacturer’s Certificate of Compliance per Section 01 61 00, Common Product Requirements, for test results, or calculations, or drawings that ensure material and equipment design and design criteria meet requirements of Section 01 61 00, Common Product Requirements.

C. Stud Shear Connectors:

1. At start of each production period, conduct the following test to determine proper generator, control unit, and stud welding gun settings, in accordance with AWS D1.1/D1.1M, Chapter 7:
   a. Weld two test studs and visually inspect for full 360-degree flash.
   b. Bend test studs 30 degrees from vertical for headed anchor studs (HAS). Torque test threaded anchor studs (TAS) studs per AWS D1.1/D1.1M, Section 7.6.6.2.
   c. Test studs will be acceptable if there is no failure of welds.
   d. If weld fails, repeat test until two consecutive test studs test to be satisfactory.
2. During production, if visual inspection reveals weld does not exhibit full 360-degree flash or that stud has been repaired by welding, conduct the following test in accordance with AWS D1.1/D1.1M, Chapter 7:
   a. Bend HAS studs or stud shear connectors approximately 15 degrees from vertical, away from missing portion of flash. For TAS studs, torque test per AWS D1.1/D1.1M, Section 7.6.6.2.
b. Studs meeting this test without exhibiting cracks in weld will be considered acceptable and left in bent position.
c. Replace studs failing test.

3. Special inspection shall be provided by Owner where indicated in Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing.

3.10 FASTENER SCHEDULE

A. Unless indicated otherwise on Drawings, provide fasteners as follows:

<table>
<thead>
<tr>
<th>Service Use and Location</th>
<th>Product</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Anchor Bolts Cast Into Concrete for Structural Steel, Metal Fabrications and Castings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior Dry Areas</td>
<td>Zinc-plated steel headed anchor bolts, unless indicated otherwise</td>
<td></td>
</tr>
<tr>
<td>Exterior and Interior Wet Areas</td>
<td>Hot-dip galvanized steel headed anchor bolts</td>
<td></td>
</tr>
<tr>
<td>Submerged and Corrosive Areas</td>
<td>Stainless steel headed anchor bolts with fusion bonded coating</td>
<td>See Section 09 90 00, Painting and Coating</td>
</tr>
<tr>
<td>2. Anchor Bolts Cast Into Concrete for Equipment Bases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior Dry Areas</td>
<td>Hot-dip galvanized steel headed anchor bolts, unless otherwise specified with equipment</td>
<td></td>
</tr>
<tr>
<td>Submerged, Exterior, Interior Wet, and Corrosive Areas</td>
<td>Stainless steel headed anchor bolts with fusion bonded coating, unless otherwise specified with equipment</td>
<td>See Section 09 90 00, Painting and Coating</td>
</tr>
<tr>
<td>3. Post-Installed Anchors: See Section 05 05 19, Post-Installed Anchors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service Use and Location</td>
<td>Product</td>
<td>Remarks</td>
</tr>
<tr>
<td>-------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>4. Anchors Cast in Grout-Filled Concrete Masonry Units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry Areas</td>
<td>Hot-dip galvanized steel headed anchor bolts or zinc-plated steel sleeve anchors</td>
<td></td>
</tr>
<tr>
<td>Exterior and Interior Wet Areas</td>
<td>Hot-dip galvanized steel headed anchor bolts, zinc-plated or stainless steel sleeve anchors</td>
<td></td>
</tr>
<tr>
<td>5. Connections for Structural Steel Framing</td>
<td></td>
<td>Use hot-dipped galvanized high-strength bolted connections for galvanized steel framing members.</td>
</tr>
<tr>
<td>Exterior and Interior Wet and Dry Areas</td>
<td>High-strength steel bolted connections</td>
<td></td>
</tr>
<tr>
<td>6. Connections for Steel Fabrications and Wood Components</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior and Interior Wet and Dry Areas</td>
<td>Hot-dip galvanized carbon steel bolted connections</td>
<td></td>
</tr>
<tr>
<td>7. Connections of Aluminum Components</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Submerged, Exterior and Interior Wet and Dry Areas</td>
<td>Stainless steel bolted connections, unless otherwise specified with equipment</td>
<td></td>
</tr>
<tr>
<td>8. All Others</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior and Interior Wet and Dry Areas</td>
<td>Stainless steel fasteners</td>
<td></td>
</tr>
</tbody>
</table>

B. Antiseizing Lubricant: Use on stainless steel threads.

END OF SECTION
PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. All of the Contract Documents, including General and Supplementary Conditions, and Division 01, General Requirements, apply to the work of this Section, and are hereby made a part of this Section.

B. Examine all Drawings and other Sections of the Specifications for requirements therein affecting the work of this trade.

1.02 SUMMARY

A. General:

1. Provide all labor, materials, equipment and services, and perform all operations in connection with the furnishing and installing of metal fabrications complete, in accordance with Drawings and Specifications, and including, but not limited to, the following:
   a. Metal Handrails (Site Stairs).
   b. All anchors, fixings, attachments, and reinforcements required for a complete installation, except those specifically indicated as being provided by others.
   c. Clean up.

B. Related Sections include, but are not limited to, the following:

1. Section 03 30 00, Cast-in-Place Concrete.
2. Section 32 13 13, Concrete Paving.
3. Section 32 13 13.13, Exposed Aggregate Concrete Paving.

1.03 REFERENCES

A. General: Standards listed by reference, including revisions by issuing authority, form a part of this specification section to extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.
The following standards are cited in this Section. They govern the Work of this Section only to the extent specified in each citation. Use the latest edition of each standard.

1. AISC: American Institute of Steel Construction.
3. ASCE: American Society of Civil Engineers.
5. AWS: American Welding Society. Comply with all recommendations and practices for the materials and methods.
7. RCSC: Research Council on Structural Connections Specifications.

1.04 SUBMITTALS

A. Submittals shall conform to Division 01, General Requirements.

B. Product Data:

1. Provide manufacturer’s data showing installation and limitations in use. Supply Certificates of Compliance for all materials required for fabrication and installation, certifying that each material item complies with or exceeds specific requirements. Work includes but is not limited to:
   a. Mill Test Reports:
      1) Submit mill test reports signed by manufacturers certifying that their products comply with all requirements. Mill test reports shall be submitted for the following:
         a) Structural steel, including chemical and physical properties.
         b) Metal components for all work.
         c) Bolts, nuts and washers, including mechanical and chemical analysis.

C. Samples: After acceptance of Product Data and prior to ordering the below listed materials, submit representative samples of material to the Landscape Architect for selection and approval as follows. Do not order materials until Landscape Architect’s approval has been obtained. Delivered materials shall closely match the approved samples. Submit duplicate samples of each type listed below showing full range of color variation, finish and texture that can be expected in the permanent work.

1. Metal Components for all Work: Rail, plate and tube sections, 12-inch length minimum.
2. Attachment hardware and fittings, one each.
D. Shop Drawings: Provide Shop Drawings for metalwork that show all details, including sizes, materials, patterns, quantities and manner of assembling the various members, properly coordinated with the related work. Shop Drawings shall show true profiles, methods of anchoring hardware, member size, weight/wall thickness, shape, kinds and locations of shop and field connections, fittings and accessories, support and anchorage, relation to adjacent structures, and other data necessary to fabricate, erect, and coordinate work of affected trades. Take accurate field measurements before preparation of Shop Drawings and Specifications. Welding Symbols per AWS A2.4.

1. Metal Handrails (Site Stairs).

E. Sample Panels and Mockups: Upon approval of all materials and Shop Drawings, the Contractor shall construct sample panels and mockups on site in the minimum size indicated below. Each sample panel shall be large enough to display typical characteristics of each item and type of work. The Landscape Architect must approve the visual characteristics, quality of workmanship, and installation methods before final work is started. If the original sample is not approved, the Contractor shall provide additional samples, as required, at no cost to the Owner until an approved sample is obtained. The approved sample shall become the standard for the entire job. Sample panel shall not be constructed on a location becoming part of the final work, unless otherwise noted, and shall remain undisturbed until all work is completed. Contractor shall completely remove any panels not set in place as part of the final work, from site upon final acceptance of work.

1. Sample Panel and Mockup Requirements:
   a. Metal Handrail (Site Stairs): One full segment. May be used in the final Work if accepted and approved by the Landscape Architect.

1.05 QUALITY ASSURANCE

A. Materials and methods of construction shall comply with the following standards:

1. AISC: American Institute of Steel Construction.
5. SSPC: Steel Structures Protective Coatings.
B. Fabricator Qualifications:

1. Work shall be done by a fabricator who has successfully produced and installed Work of required kind and quality for at least 5 years. He shall have the equipment, skilled workers, and capacity to accomplish the Work and meet the constructions schedule.

2. Welders: AWS-qualified operators.

C. Welding:

1. Qualify procedures and personnel according to the following:
   a. AWS D1.6, “Structural Welding Code – Stainless Steel.”

D. Materials and work shall conform to the latest edition of reference specifications specified herein and to all applicable code and requirements, whichever is more stringent.

E. Installer Qualifications: An experienced installer who has completed installation of railings and guardrails similar in material, design, and extent to that indicated for this project and whose work has resulted in construction with a record of successful in-service performance.

1.06 PROJECT CONDITIONS

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

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.

2. Provide allowance for trimming and fitting at site.

1.07 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
1.08 PERFORMANCE CRITERIA

A. Individual and aggregate components of the Work of this Section shall be designed, fabricated, assembled, transported, installed and protected so that no evidence of the following shall be apparent, visually or measurable, when Work of this Sections is subject to the pressures, loads, temperatures and conditions specified.

1. Damage of any kind.
2. Offset from true alignment between consecutive components in line is in excess of 1/16 inch.

B. Design Loads: Individual and aggregate components of this Section shall withstand the loads acting normal to the surface described hereinafter.

1. Design load due to ice build-up of 3 psf.
2. Uniform and point live loading on guardrails and handrails as per provision of the ASCE 7 Minimum Design Loads for Buildings and Other Structures.
3. Load combinations shall be as per the requirements of the State of Oklahoma of the International Building Code.
4. Handrails: Withstand a 200-pound concentrated load, applied downward or horizontally at any point, and a nonconcurrent 50 pounds per linear foot uniform load, applied downward or horizontally, without rotating or over stressing assemblies or their anchorages.

C. Thermal Movement: Exterior work shall accommodate a minus 30 degrees F to a plus 180 degrees F metal temperature shift without distortion or overstress.

D. Structural Movement: Provision shall be made in the Work of this Section to accommodate differential structural movements, deflections, and thermal movement of the structure(s) due to gravity loads, wind loads, seismic loads and temperature.

E. Analysis: Requirements of this Section shall be analytically and mathematically proven, except for those requirements to be proven exclusively by physical testing methods. Calculations, related data and their application in engineering, fabrications, assembly and installation shall be the responsibility of the Contractor’s Professional Engineer registered in the State of Oklahoma.
1.09 WARRANTY

A. The Contractor shall provide his own warranty for products and workmanship as well as the manufacturer’s warranty for all products in this Section.

1. Minimum Warranty Period: 1 year after final acceptance.
2. The Contractor shall extend to the Owner any extended warranties provided by the manufacturer.

PART 2 PRODUCTS

2.01 GENERAL FABRICATION REQUIREMENTS

A. Materials for fabricated items of this Section shall be new and free from defects impairing strength, function, durability, or appearance, and of best commercial quality for purposes specified. Exposed-to-view surfaces exhibiting pitting, seam marks, roller mark, “oil canning” stains, discolorations or other imperfections on finished units are not acceptable. Stock materials, patterns, products or fabricated items of manufactures meeting the requirements of the approved Shop Drawings and as herein specified will be acceptable if approved by the Landscape Architect.

B. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

C. Make straight sections free of bow or camber. Make bends to constant radii without causing buckle, collapse or cracking. Abrupt or sharp bends or transitions shall not be accepted.

D. Forming shall be true to detail, clean, straight, with sharply defined profiles. Metals shall have smooth finished surfaces excepting where otherwise particularly specified.

E. Welding: Follow AWS recommendations. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. Grind exposed welds smooth so that no roughness shows after finishing.

F. Shear and punch Work cleanly accurately. Remove burrs, barbs, splinters and sharpness; all edges and ends rolled, rounded, or capped.

G. Make flush, tight, butt joints where not otherwise shown/specified. Locate joints where least conspicuous.
H. Fit and trial assemble Work in the shop. Permanently shop assemble Work into the largest Section that meet shipping and field conditions. Use connections that maintain structural value of joined pieces.

I. All joints shall be of such a character, and so assembled, that they will be as strong and rigid as adjoining sections. Joints required to be welded shall be continuously welded as specified and face of welds dressed flush and smooth. Spot welding is only allowed for temporary shop connections.

J. Exposed joints shall be close fitting and jointing made where least conspicuous. Joints exposed to weather shall be formed to exclude water.

K. Weights of connections and accessories shall be adequate to safely sustain and withstand stresses and strains to which they will be normally subjected.

L. All work shall be fabricated to allow for expansion and contraction of materials.

M. Work to be built-in with masonry or concrete work shall be of form required for anchorage or shall be provided with suitable inserts, anchors, expansion shields, etc., as indicated, specified, or necessary for proper anchorage.

N. Furnish and set all supporting members, fastenings, framing, hangers, bracing, brackets, strap bolts, angles, and the like required to set and connect the work rigidly and properly to other construction.

O. Finish metal fabrications after assembly and field verification that assembles fit.

1. All work shall be manufactured in ample time so as not to delay the progress of the work and shall be delivered at the building at such time as required for proper coordination. Fabrication shall be in a thorough and workmanlike manner.

2.02 METALWORK – STAINLESS STEEL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes. Surfaces exposed-to-view that exhibit pitting, seam marks, roller marks, “oil canning,” stains, discoloration or other imperfections are not acceptable.
2.03 METALWORK FINISHES

A. General:
   1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   2. Finish metal fabrications after assembly.

B. Stainless Steel Finishes:
   1. Remove tool and die marks and stretch lines or blend to finish.
   2. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
   3. Dull Satin Finish: No. 6, unless otherwise indicated on Drawings.
   4. Prior to finishing, the surface of all stainless steel components shall be free of all surface contaminants.
   5. After finishing, all stainless steel components shall be passivated prior to installation. Passivation shall be Nitric Acid Passivation, with a Nitric Acid content of 10 percent to 15 percent by volume in water. The Contractor shall submit a certificate demonstrating that the stainless steel edge was passivated, including method, date, and shop where work was performed.

2.04 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.

B. Aluminum Bolts and Nuts: Regular hexagon-head bolts, ASTM F4901; Base plate treated to receive bolt, and, where indicated, flat washers.
C. Cast-in-Place Anchors in Concrete: Anchors capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing according to ASTM E488, conducted by a qualified independent testing agency.

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A153/A153M.

2.05 GROUT

A. Non-Metallic Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining product containing selected silica sands, portland cement, shrinkage compensating agents, plasticizing and water reducing agents, complying with CRD-C621.

B. Products:

1. Subject to compliance with requirements, provide one of the following:
   a. Euco N.S.; Euclid Chemical Co.
   b. Crystex; L&M Construction Chemicals.
   c. Masterflow 713; Master Builders.
   d. Five Star Grout; U.S. Grout Corp.
   e. Upcon; Upco Chem. Div., USM Corp.
   f. Propak, Protex Industries, Inc.

C. Clear Sealant: Provide a clear water-based, nonyellowing, sealing compound resistant to discoloration from UV light exposure.

2.06 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Concrete Base Slab and Foundation: Refer to Section 03 30 00, Cast-in-Place Concrete.

PART 3 EXECUTION

3.01 EXAMINATION

A. Comply with Division 01, General Requirements.
B. The installer shall examine previous work, related work, and conditions under which this work is to be performed and notify the Contractor in writing of all deficiencies and conditions detrimental to the proper completion of this work.

C. Beginning work means installer accepts substrates, subgrades, previous work, and conditions.

3.02 FABRICATION GENERAL

A. Fabricate work of this Section to be straight, plumb, level and square, and to sizes, shapes and profiles indicated on approved Shop Drawings. Ease exposed edges. Cut, reinforce, drill, and tap metal work as required for proper assembly.

1. Structural load requirements shall conform to the State of Oklahoma Building Code. Design and support systems with a safety factor of at least six unless otherwise indicated.

2. Allow for thermal movement resulting from 100 degrees F change in ambient temperature.

3. Ease exposed edges to a radius of approximately 1/32 inch unless indicated otherwise. Form bent corner to smallest radius possible without causing grain separation or impairing work.

4. Remove sharp or rough areas on all exposed traffic surfaces.

5. Weld seams continuously. Spot welding is permitted for temporary welding only.

B. Work Exposed to View: Select materials with special care. Provide materials that are smooth and free of blemishes, such as pits, roller marks, trade names, scale and roughness. Fabricate work with uniform hairline joint. Form welded joints and seams continuously. Grind welds flush to be smooth.

C. Verify grading and measure conditions at all site locations before fabrication.

D. The design of all Site Metal Fabrications shall endeavor to keep site operations at a minimum. Manufacturing, finishing and assembly processes shall be, to the extent practicable, carried out offsite and under controlled environmental conditions.

E. Fit and trail assemble Work in the hop. Permanently shop assemble Work into the largest section that meets shipping and field conditions. Use connections that maintain structural value of joined pieces.
F. Manufacturer’s Standards: Materials, components and systems incorporated in the Work shall be mixed, applied, installed and otherwise used in strict accordance with the recommended standards and procedures of the respective manufacturers.

G. Storage and Handling: Storage of materials, components and systems shall be in a dry, well-ventilated location. Handling of materials shall be kept to a minimum, and all materials shall be carefully protected from soiling, condensation and other harmful moisture.

H. Thermal Cutting:
   1. Perform thermal cutting by machine. If a thermal cutting machine is impractical, thermal cutting may be done by hand provided that cut edges are not exposed to view.
   2. Plane thermally cut edges to be welded.

I. Holes:
   1. Provide holes required for securing the Work and for passage of other Work through components specified in the Section as indicated on the approved Shop Drawings.
   2. Cut, drill or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.

J. Joining and Reinforcing:
   1. Accurately fit and firmly secure all exposed metal joints with metal-to-metal hairline contacts.
   2. Accurately mill ends framing members transmitting loads in bearing.
   3. All work shall be properly reinforced for hardware, anchors and other attachments.
   4. All fasteners shall be installed at an approved spacing.
   5. No self-drilling fasteners or explosive fasteners shall be permitted.
   6. Shop install and tighten high-strength bolts according to RCSC’s Specification for Structural Joints Using ASTM A325 or A490 Bolts. Connection type shall be snug-tightened unless otherwise required by the engineering design.
   7. All jointing and splicing of members shall be concealed.
   8. Exposed Fasteners:
      a. Exposed fasteners shall occur only where expressly permitted on the approved Shop Drawings.
      b. Spacing and location of all fasteners shall be as indicated in the approved Shop Drawings.
c. Where exposed in finished surfaces, fasteners shall be socket-head countersunk type screws, spanner head bolts, or socket head cap screws, as indicated on the Contract Documents and as indicated in the approved Shop Drawings.

d. All exposed screws and bolts in Guardrail System specifically noted on Drawings shall be tamperproof with a design subject to review and as indicated in the approved Shop Drawings.

K. Welding:

1. All welding of steel shall be in accordance with the recommendations of the American Welding Society.

2. Steel welding shall be done by skilled mechanics qualified by test as prescribed in the American Welding Society code and as applicable to the material thickness and type of welded joint on which the welders will be employed.

3. All welding shall be done with electrodes and/or methods recommended by the suppliers of the metals being welded. The type, size, and spacing of welds shall be as shown on the approved Shop Drawings. Welding materials and methods shall be such as not to cause distortion, discoloration, or result in any adverse effect on the required profiles and finishes of visible surfaces of the Architectural Metals.

4. All welds shall be continuous or shall be intermittent structural welds infilled with seal welds to form a continuous, uniform, watertight connection.

5. Weld splatter and welding oxides on exposed surfaces shall be removed. All exposed welds shall be finished to match and blend with adjacent parent metal prior to final finish application.

6. Stud welding shall be done by mechanics trained by the manufacturer of the stud setting system. The manufacturer shall develop specific programs and instructions in cooperation with the fabricator to suit the need of the specific details. The fabricator shall exercise particular care that all recommendations of the manufacturer are closely followed.

7. The visible marks such as telegraphing on finished surfaces due to welding of studs shall not be acceptable.

3.03 PREPARATION AND GENERAL INSTALLATION REQUIREMENTS

A. Prior to start of installation, inspect the structure and verify all conditions and dimensions as being acceptable to receive the Work of this Section.
B. Should any conditions be found that may prohibit proper execution of the Work, the Contractor shall immediately notify the Landscape Architect in writing of these conditions. Installation shall not proceed until remedial action, acceptable to the Landscape Architect, has been executed.

C. Install work per approved Shop Drawings; square, level, plumb, and true; free from distortion; and in proper relation to adjoining work. Provide all anchoring devices necessary to secure work to structure.

1. Maximum offset from true horizontal, vertical and design location shall not exceed 1/8 inch per 12 feet nor 1/2 inch over any one length of the structure.
2. Maximum offset from true alignment between components separated by less than 3 inches, shall not exceed 1/16 inch.
3. Joint widths as noted in the Contract Documents are the design joint width at an ambient temperature of 70 degrees F. Installation procedures shall be adjusted to take into account the ambient temperature at the time of installation.
4. All tolerances are non-cumulative.

D. Carefully fit and true work before joining and anchoring it. Make field joints and connections to standard specified for fabrication. Supply anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, templates, instructions, and direction as required for installation.

E. Erect work square, plumb and true, accurately fitted, and with tight joints and intersections. All anchors, inserts and other members to be set in concrete shall be furnished loose by this trade to be built-into concrete by those trades. No field cutting or drilling is allowed.

F. Anchorage: Install work in Cast-in-place concrete footing per the approved Shop Drawings.

G. Where not otherwise indicated on Drawings or specified for a particular fabrication, anchor work as follows:

1. To Hardened Concrete: Use expansion and bolts except where cast-in-anchors are specified. Shim and grout base plates.
2. To Sleeves Cast in Hardened Concrete: Set and plumb work in grout-filled sleeves. Support work until grout is set.

H. Grouting: Mix, place, install, consolidate, and cure grout per manufacturer’s instructions. Clean up excess.
I. No Field Welding of stainless steel metal work will be allowed.

J. Separate dissimilar metals with bushings, grommets or washers to prevent electrolytic corrosion.

K. Care shall be exercised to properly brace and reinforce prefabricated assemblies against racking during hoisting and installation.

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

L. Base and Bearing Plates:

2. Set base and bearing plates for structural members on shims as required.
3. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but, if protruding, cut-off flush with edge of base or bearing plate prior to packing with grout.

M. Anchors and Connections:

1. Anchors and connections shall be provided to fully satisfy their required purpose of adjustability, movement and load transfer.
2. Anchors and connections that do not provide for movement shall be of such movement by appropriate means.
3. Anchors and connections that are designed for movement shall be of such construction that friction is low enough to allow for such movement without causing buckling and any other damage and without causing binding and noises.
4. Self-drilling fasteners shall not be permitted.
5. Powder actuated or explosive fasteners shall not be permitted.
6. Metal surfaces shall be separated in such a manner that metal does not move on metal. Materials used for this purpose shall be low-friction components.
7. Connections between different materials, or different alloys of the same metal, shall be designed to accommodate the differential thermal movement of the materials to be connected.
8. All anchors, connections and fixings exposed to view shall be UNS S31600 stainless steel or shall be hot-dip galvanized to match adjacent surfaces. All other anchors shall be hot-dip galvanized.
9. Avoid excess shimming that may induce additional stress on the fastener. The total thickness (t) of a shim pack shall not exceed a dimension equal to the diameter (d) of the fastener/anchor. Where \( t > d \), the fastener/anchor shall be recalculated to take into account the additional stress from bending on the fastener with the assumption that the shim does not contribute to resistance to fastener while bending. Additional stress due to bending shall be added to tension stress and the tension/shear interaction analyzed.

10. Shim packs that only resist compressive forces may be high-impact plastic, Korolath type, or equal. Shim pack subject to shear forces shall be doughnut-type stainless steel or hot-dip galvanized steel plates pinned together, or interlocking high-impact plastic shims acting as a monolithic shim.
   a. Terminate and tension cables in accordance with the manufacturer’s instructions. Provide tamper-resistant locktight materials on all fittings.

3.04 CLEANING

A. Remove temporary coverings and protection of adjacent work.

B. Clean installed products in accordance with manufacturer’s instructions before Owner’s acceptance. Do not use chlorine-based or abrasive cleaners.

C. Remove from Project site and legally dispose of construction debris associated with this Work.

3.05 PROTECTION

A. Correct nonconforming and damaged Work. Replace work damaged during manufacture, shipping, storage or erection. Replace Work that cannot be repaired as directed by the Landscape Architect.

B. Protect Work from damage and abuse by use of temporary protective coverings approved by metal fabricator. Remove protective covering at time of Final Acceptance.

1. Protection materials, such as plastic membrane tapes and adhesive sheeting, shall be suitable for the intended protection application and protection period.

2. Protection materials shall be installed in a manner that will not trap harmful moisture or otherwise contaminate the Work in any way.

C. Remove and replace any portion of the Work that has been damaged by other trades. All damaged material shall be promptly removed from the site.
D. Acceptance of the completed installation requires that the installation be sound, neat and free of all extraneous materials, and free from defects of materials and workmanship.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Iron and Steel Institute (AISI): As applicable.
2. ASTM International (ASTM):
   e. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   h. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
3. International Code Council (ICC):
   b. Evaluation Services Reports, as applicable.

1.02 DEFINITIONS


B. Railings: This term shall include guardrail systems, handrail systems, platform railing systems, ramp-rail systems, and stair-rail systems. Railings may be comprised of a framework of vertical, horizontal, or inclined members, grillwork or panels, accessories, or combination thereof.

C. Special Inspection: As defined by the ICC IBC.
D. Toeboards: Vertical barrier at floor level usually erected on railings along exposed edges of floor or wall openings, platforms, or ramps to prevent miscellaneous items from falling through.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Project-specific scaled plans and elevations of railings and detail drawings. Include railing profiles, sizes, connections, anchorage, size and type of fasteners, and accessories.
   b. Manufacturer’s literature and catalog data of railing and components.
   c. Design Data: Where proposed design of post base connections is different than details shown on Drawings, submit calculations or test data for alternate railing anchorages using ICC IBC design loads.

B. Informational Submittals:

1. Manufacturer’s assembly and installation instructions.
2. Special Inspection: Manufacturer’s instructions for Special Inspection of post-installed concrete anchors.
3. Test Reports: Test data for anchorages may supplement design data submitted for alternate anchorage details. Testing of anchorages shall be in accordance with ASTM E894 and ASTM E935 using applied loads in accordance with the ICC IBC.

1.04 QUALITY ASSURANCE

A. Qualifications: Calculations required for alternate anchorage designs (if proposed) shall be stamped by a registered civil or structural engineer licensed in the state where the Project will be constructed.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Railings adequately packaged and wrapped to prevent scratching and denting during shipment, storage, and installation. Maintain protective wrapping to the extent possible until railing is completely installed.
PART 2  PRODUCTS

2.01  STEEL RAILINGS

A.  Pipe Railings/Round HSS:

1.  Painted carbon steel, ASTM A500/A500M Grade B.
3.  Wall Thickness:
   a.  Rail: 0.145-inch, minimum.
   b.  Post: 0.200-inch, minimum.

B.  Accessories, including railing components, flanges, wall brackets, anchor plates, shall conform to the following:

2.  Wall Brackets:
   a.  Malleable iron, round top, and painted.
   b.  Manufacturers and Products:
      1)  The Wagner Companies; No. 1765.
      2)  Julius Blum & Co., Inc.; No. 1382.
3.  Rail Terminals (including Wall Returns):
   a.  Round, galvanized steel, welded to rail, with two 5/16-inch holes for 1/4-inch fasteners.
   b.  Manufacturer: The Wagner Companies.
4.  Railing System Gate:
   a.  As specified herein for painted steel pipe.
   b.  Gate Hardware: Painted steel or AISI Type 304 or Type 316 stainless steel.
5.  Railing Picket Panels and Clamps:
   a.  Painted steel, solid bar or pipe meeting minimum requirements specified for pipe rails.
   b.  Fasteners: Galvanized steel, painted steel, or stainless steel.
6.  Toeboards and Accessories:
   a.  ASTM A36/A36M steel painted.
   b.  Toeboards: Provide slotted holes for expansion and contraction where required.
   c.  Fasteners: Galvanized steel, painted steel, or stainless steel.

C.  Miscellaneous Fasteners: Galvanized steel, painted steel, or stainless steel.
2.02 ANCHOR BOLTS, FASTENERS, AND CONCRETE ANCHORS

A. Locknuts, Washers, and Screws:
   2. Flat Washers: Molded nylon.

B. Bolts and Nuts for Bolting Railing to Metal Beams: Hot-dipped galvanized ASTM A325 bolts.

C. Concrete Anchors:
   1. Galvanized steel anchor rods conforming to ASTM F1554, Grade 36.
   2. Post-installed anchors shall be in accordance with Section 05 05 19, Post-Installed Anchors, unless otherwise specified herein.

2.03 FABRICATION OF WELDED STEEL RAILINGS

A. Shop Assembly:
   1. Post spacing and railing details shall be as shown on Drawings.
   2. Post to Baseplate Connection: Field fit-up is required as shown on Drawings.
   3. Alternate Post to Baseplate Connection:
      a. Field measure elevation of concrete at each post location and determine exact post length so baseplate is on concrete surface.
      b. Rails shall be in straight alignment when rails to posts and posts to baseplates are welded.
      c. Field weld posts to baseplates.
   4. Remove burrs from cut edges.
   5. Form elbow bends and wall returns to uniform radius, free from buckles and twists, with finished surfaces smooth.
   6. Cover exposed ends of steel pipe by welding 1/8-inch minimum thickness steel plate in place or use prefabricated fittings.
   7. Welding:
      a. In accordance with Section 05 05 23, Welding.
      b. Thoroughly fuse without undercutting or overlap.
      c. Remove splatter, grind exposed welds to blend, and contour surfaces to match those adjacent.
      d. Grind welds prior to painting of railing sections.
   8. Furnish explosion prevention holes at closed ends of pipes.
   9. Form and assemble joints exposed to weather to prevent water and moisture from penetrating.
B. Shop/Factory Finishing: After fabrication paint steel components other than stainless steel components as specified in Section 09 90 00, Painting and Coating.

C. Tolerances:
   1. Cut pipe square within 2 degrees and lengths within 1/8 inch.
   2. Welding: Miter and cope intersections of posts and rails within 2 degrees, fit to within 0.020 inch, and perform continuous welds around joints.

D. Repair of Defective Work: Remove stains and replace defective Work.

PART 3 EXECUTION

3.01 GENERAL

A. Where required, provide railing posts longer than needed and field cut to exact dimensions required in order to satisfy vertical variations on actual structure.

B. Install railing with base that provides plus or minus 1/4-inch vertical adjustment inside base fitting. If adjustment is required in field and exceeds plus or minus 1/4-inch, reduce post length not to exceed beyond bottom of lowest set-screw or bolt in base fitting.

C. Modification to supporting structure is not permitted where railing is to be attached.

D. Protection from Entrapped Water:
   1. Make provisions in exterior and interior installations subject to high humidity to drain water from railing system.
   2. For posts mounted in concrete, bends, and elbows occurring at low points drill weep holes of 1/4-inch diameter at lowest possible elevations, one hole per post or rail. Drill hole in plane of rail.

3.02 RAILING INSTALLATION

A. Expansion Joints:
   1. Maximum intervals of 54 feet on center and at structural movement joints.
   2. Slip joint with internal sleeve extending 2 inches beyond each side of joint. Provide 1/2-inch slip joint gap to allow for expansion.
4. Locate joints within 12 inches of posts. Locate expansion joints in rails that span movement joints in structural walls and floors supporting the posts.

B. Posts and Rails:

1. Surface Mounted and Side Mounted Posts:
   a. Bolt post baseplate connectors firmly in place.
   b. Install to account for small variation in leveling grouts and shims between adjacent posts.

2. Set posts plumb and aligned to within 1/8 inch in 12 feet.
3. Set rails horizontal or parallel to slope of steps to within 1/8 inch in 12 feet.
4. Install posts and rails in same plane.
5. Remove projections or irregularities and provide a smooth surface for sliding hands continuously along top rail.
6. Use offset rail for use on stairs and platforms if post is attached to web of stringers or structural platform supports.
7. Support 1-1/2-inch rails directly above stairway stringers with offset fittings.

C. Wall Brackets: Support wall rails on brackets as shown on Drawings.

D. Toeboard:

1. Provide at railings, except where 4-inch or higher concrete curbs are installed, at gates, or on stairways unless shown otherwise.
2. Accurately measure in field for correct length; after railing post installation, cut and secure to posts.
3. Dimension between bottom of toeboard and walking surface not to exceed 1/4 inch.
4. Install plumb and aligned to within 1/8 inch in 12 feet.

E. Railing System Gate: Install in accordance with manufacturer’s installation instructions.

3.03 FIELD FINISHING

A. Corrosion Protection: Prevent galvanic action and other forms of corrosion caused from direct contact with concrete and dissimilar metals by coating metal surfaces as specified in Section 09 90 00, Painting and Coating.

3.04 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Post-installed anchors supporting railing systems require special inspection.
B. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

C. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

3.05 CLEANING

A. Wash railing system thoroughly using clean water and soap. Rinse with clean water.

B. Do not use acid solution, steel wool, or other harsh abrasive.

END OF SECTION
SECTION 05 53 00
METAL GRATINGS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

2. ASTM International (ASTM):
   b. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
3. National Association of Architectural Metal Manufacturers (NAAMM):
   a. MBG 531, Metal Bar Grating Manual.
   b. MBG 532, Heavy-Duty Metal Bar Grating Manual.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Grating: Show dimensions, weight, size, and location of connections to adjacent grating, supports, and other Work.
   b. Grating Anchorage: Show details of anchorage to supports to prevent displacement from traffic impact.
   c. Product data for grating, grating clips, anchors, accessories, and other manufactured products specified herein.
   d. Manufacturer’s specifications, including coatings, surface treatment, and finishes.

B. Informational Submittals:

1. Special handling and storage requirements.
2. Installation instructions.
1.03 DELIVERY, STORAGE, AND HANDLING

A. Insofar as is practical, factory assemble items.

B. Package and clearly tag parts and assemblies that are, due to necessity, shipped unassembled.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:
   1. Alabama Metal Industries Corporation (AMICO), Birmingham, AL.
   2. HARSJO Industrial IKG, Houston, TX.
   3. Ohio Gratings, Inc., Canton, OH.

2.02 GRATING MATERIALS

A. Carbon Steel:
   1. Bearing Bars, Banding, and Rectangular Cross Bars: ASTM A1011/A1011M commercial steel Type II for hot rolled carbon steel sheet and strip, or ASTM A36/A36M.
   2. Cross Bars made from Wire Rods: Not permitted.
   3. Finish: Galvanized after fabrication.

B. Stainless Steel:
   1. Bearing Bars, Banding, and Cross Bars: ASTM A666, Type 304L.
   2. Finish: Mill.

2.03 METAL BAR GRATING

A. General Requirements:
   1. Maximum Service Load:
      a. Light Duty (Type A): 100 psf uniformly distributed load.
      b. Medium Duty (Type B): 500 psf uniformly distributed load.
   2. Maximum Deflection: Span/240 or 1/4 inch, whichever is less.
   3. Bearing Bar Spacing:
      b. Medium Duty: 15/16 inch maximum, center-to-center.
5. Bearing Bars, Cross Bars and Banding: Minimum thickness as specified in NAAMM MBG 531 or as shown on Drawings.

B. Grating Materials:

1. Galvanized steel welded, rectangular bar grating fabricated by electro-forging cross bars to bearing bars.
2. Stainless steel pressure-locked rectangular bar grating fabricated by swaging crossbars between rectangular bearing bars.

C. Surface: Plain.

D. Stair Treads:

1. Material and Type: Same as grating material and grating type as furnished for connecting walkway or work surface.
2. Nosings: Integral ribbing and serrated edge on one long axis of tread, or nonslip abrasive on each tread along one long edge.
3. Carrier Plate or Angle: Furnish at each end for connection to stair stringers.

2.04 HEAVY-DUTY METAL BAR GRATING (TYPE C)

A. General Requirements:

5. Bearing Bars, Cross Bars and Banding: Minimum thickness as specified in NAAMM MBG 532 or as shown on Drawings.
6. Grating Type: Galvanized steel, heavy-duty, rectangular bar grating fabricated by welding crossbars between rectangular bearing bars.

2.05 ACCESSORIES

A. Embedded Frames: As indicated on Drawings and as specified in Section 05 50 00, Metal Fabrications.

B. Grating Clamps:

1. Use at flanged beam and bolted angle frame supports.
2. Removable from above grating walkway surface.
3. Provide hat bracket, recessed bolt, and bottom clamp of same material as grating.
4. Manufacturers and Products:
   a. Direct Metals Company, LLC, Kennesaw, GA; Grating Clamp.
   b. Grating Fasteners, Inc., Harvey, LA; G-Clip.

C. Anchor Stud and Saddle Clip:
   1. Use at embedded angle frame supports with stud anchor and nut recessed below top of grating surface.
   2. Removable from above grating walkway surface.
   3. Provide Type 316 stainless steel welded threaded stud anchor, nut, washer, and saddle clip.
   4. Manufacturers and Products:
      a. Welded Stud Anchor:
         1) Nelson Stud Welding, Inc., Elyria, OH.
         2) Stud Welding Associates, Inc., Elyria, OH.
      b. Saddle Clip:
         1) Direct Metals Company, LLC, Kennesaw, GA; Saddle Clip.
         2) Grating Fasteners, Inc., Harvey, LA; Saddle Clip.
         3) Struct-Fast, Inc., Baltimore, MD; Gratefast.

2.06 FABRICATION

A. General:

1. In accordance with NAAMM MBG 531 or NAAMM MBG 532.
2. Do not weld aluminum grating.
3. Conceal fastenings where practical.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Cutouts:
   a. Fabricate in grating sections for penetrations indicated.
   b. Arrange to permit grating removal without disturbing items penetrating grating.
   c. Edge band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.
6. Do not notch bearing bars at supports to maintain elevation.
7. Field measure areas to receive grating. Verify dimensions of new fabricated supports, and fabricate to dimension required for specified clearances.
8. Section Length: Sufficient to prevent section from falling through clear opening when oriented in the span direction and one end is touching either the concrete or the vertical leg of grating support.
9. Minimum Bearing: 1 inch for grating depth up to 2-1/4 inches and 2 inches for grating depth greater than 2-1/4 inches.
10. Banding and Toe Plates: Same material as grating and welded to bearing bars in accordance with requirements of NAAMM MBG 531 and NAAMM MBG 532.

B. Metal Bar Grating: A single grating section shall be not less than 1.5 feet or greater than 3 feet in width, or weigh more than 150 pounds.

C. Heavy Duty Metal Bar Grating: Minimum width of grating sections shall be 2 feet regardless of length and weight.

D. Supports:
   1. Same material as grating, except that supports which are to be embedded in concrete shall be Type 316 stainless steel, unless part of an extruded aluminum system.
   2. Coordinate dimensions and fabrication with grating to be supported.

PART 3 EXECUTION

3.01 PREPARATION

A. Electrolytic Protection:
   1. Protect aluminum surfaces in contact with dissimilar metals, or embedded or in contact with masonry, grout, or concrete as specified in Section 09 90 00, Painting and Coating.
   2. Allow paint to dry before installation of material.

3.02 INSTALLATION

A. Until grating sections are securely fastened in place, area shall be appropriately barricaded or flagged to alert people working in the area of potential fall hazard.

B. Install manufactured products in accordance with manufacturer’s recommendations.

C. Install supports such that grating sections have a solid bearing on both ends, and that grating sections will not rock or wobble under design loads.

D. Install grating supports plumb and level as applicable.

E. Install sections of welded frames with anchors to straight plane without offsets.

F. Field locate and install fasteners to fit grating layout.
G. Anchor grating securely to supports using minimum of four fastener clips and bolts per grating section.

H. Each grating or plank section shall be easily removable and replaceable.

I. Completed installation shall be rigid and neat in appearance.

J. Protect painted and galvanized surfaces during installation.

K. Repair damaged coatings as specified in Section 09 90 00, Painting and Coating.

END OF SECTION
PART 1 GENERAL

1.01 SCOPE

A. The Work to be performed in accordance with this Specification consists of furnishing all materials, equipment, supplies, and accessories and of performing all operations required in connection with the fabrication and installation of all miscellaneous metalwork shown on Drawings within the Flume and as specified herein.

1.02 RELATED WORK

A. Section 11 38 00, WaveShapers and Gates.
B. Section 31 35 00, Start-up and Tuning.

1.03 REFERENCES

A. American Institute of Steel Construction (AISC).
B. American National Standards Institute (ANSI).
C. American Society for Testing and Materials (ASTM).
D. American Welding Standards (AWS).

1.04 CONTRACTOR SUBMITTALS

A. Submit in accordance with Section 01 33 00, Submittal Procedures. Prior to fabrication or delivery, obtain Engineer’s approvals. Show materials and specifications list, construction and fabrication details, layout and erection diagrams, and method of anchorage to adjacent construction. Give location, type, size and extent of welding and bolted connections, and clearly distinguish between shop and field connections. Prior to submittal, coordinate shop drawings with related trades to insure proper mating of assemblies. Catalog work sheets showing illustrated cuts of item to be furnished, scale, details, and dimensions may be submitted for standard manufactured items.

B. Submit ICBO ES Evaluation Reports for each type of anchor proposed for use.
C. Where items must fit and coordinate with finished surfaces or constructed spaces, take measurements at site and not from Drawings. Where concrete, masonry or other materials must be set to exact locations to receive work, furnish assistance and direction necessary to permit other trades to properly locate their work. Where welded connectors, concrete, or masonry inserts are required to receive work, shop drawings shall show exact locations required, and all such drawings shall be furnished to the trades responsible for installing the connectors or inserts.

1.05 QUALITY ASSURANCE

A. Unless otherwise specified all work shall conform to the applicable requirements of the following specifications and codes:


3. Weld Quality: All field and shop welding shall be performed by welders qualified and certified in accordance with AWS D1.0 “Welding in Building Construction.” Welding shall conform to AWS D1.1, Structural Welding Code.

4. Welding Inspection: All field and shop welds may be inspected and tested by the Owner at their option. Contractor shall facilitate such inspections and coordinate inspections with engineer and provide at least 5 working days’ notice prior to requested inspection. Welds may be visually inspected by an AWS CWI and some (assume approximately 25 percent) of the welds will be radiographed for the full length/circumference. If a weld fails to meet acceptance standards then all welds completed by the welder performing the failed weld will be 100 percent radiographed. Defective welds shall be repaired and tested at the expense of the Contractor.
1.06 GENERAL REQUIREMENTS

A. Fabrication: All miscellaneous metalwork shall be manufactured using the best practices of modern sheet metal, structural steel, and foundry shops. Welding shall be performed by qualified welders with all exposed welds being ground smooth.

B. Steel structural built-up members shall have full-length continuous welded joints to seal inaccessible surfaces.

C. Painting: Painting shall generally be done at the shop and in conformance with these Specifications. Where metalwork is required to be painted in the field, the prime coat of paint shall be shop applied on all.

PART 2 PRODUCTS

2.01 GENERAL PRODUCTS AND REQUIREMENTS

A. Structural Steel: Structural steel and miscellaneous metalwork not otherwise specified shall meet the requirements of ASTM Designation A36. Items covered by this requirement include lintel beams, angles, channels, trolley hoist beams, support angles, baffle supports, metal stairs and walkways, weirs, troughs, etc.

B. Aluminum: Fabrication of aluminum shall be in accordance with ASCE “Specification for Structures of Aluminum Allow 6061-T6, Second Progress Report of the Committee of the Structural Division on Design in Lightweight Structural Alloys.”

C. Galvanizing:

1. Steel items which are specified or shown to be galvanized shall be coated with zinc by the hot-dip process. Individual items shall be welded or assembled as a complete assembly prior to galvanizing in one piece; DO NOT cut or weld after galvanizing.

2. Both the inside and the outside of open hollow members shall be coated.

3. The zinc used for the coating shall conform to ASTM Specification B-6. The weight of zinc coating shall be an average of 2.0 ounces per square foot and not less than 1.8 ounce per square foot. The zinc coating process shall conform with the requirements of ASTM Specifications A123 and A153.

4. Galvanized coatings marred or damaged during erection or fabrication shall be repaired by use of DRYGALV as manufactured by the American Solder and Flux Company, Galvalloy, Galvion, “or-equal,” applied in accordance with the manufacturer’s instructions.
D. **Bolts and Connectors:** All steel bolts and washers shall conform to ASTM Standard A-307, Grade A. Where called for on Drawings, Specifications, or where submerged, normally or occasionally, bolts shall be fabricated from stainless steel, Type 316, (B8M, B8MA) in accordance with ASTM Standard A-193. When fastening to galvanized steel, galvanized or cadmium plated bolts shall be used. Hoisting eyes shall be galvanized.

E. **Expansion Bolts:** Expansion bolts and anchors shall be stainless steel and used only where specifically noted or detailed. Expansion bolts shall not be acceptable for anchorage of any vibrating machinery or equipment. Where expansion bolts are used in Interior Dry Locations provide snap-off or flush shell concrete anchors produced by Phillips Self-Drilling Concrete Anchors, Star Selfdril Shields, “or-equal.” For exterior or wet locations to fasten to concrete, they shall be similar and equal to Molly Parabolt or Phillips Redhead. Where expansion bolts are used to fasten to concrete block, they shall be similar and equal to Rawl anchors.

F. **Epoxy Anchors:**

1. **Adhesive:** Two-component epoxy base resin and hardener meeting the requirements of ASTM C881, Types I, II, IV, and V, Grade 3, Classes B and C. Adhesive shall be supplied in manufacturer’s standard side-by-side cartridge and dispensed through a static-mixing nozzle supplied by the manufacturer.

2. **Anchor Rod or Insert:** Stainless steel, AISI Type 316L or AISI Type 304 meeting the requirements of ASTM F593 (Condition CW). Chamfered threaded end for ease of starting the nut, and 45-degree chisel or cut point on the opposite end. Furnish nuts and washers to meet the requirements of the rod or insert.

3. **Manufacturer:** Hilti HIT RE 500, Simpson Strong Tie Epoxy-Tie ET or ETF (fast cure), Power Fastening Power-Fast Plus, “or-equal.” For fastening to materials with voids, such as hollow-block masonry, provide Simpson Strong-Tie ETS for Epoxy-Tie, “or-equal.”

### 2.02 IN-FLUME METALS

A. **WaveShaper Racks:** The WaveShaper Racks shall be of the bar screen style basket, having 2-inch clear opening between 1/4-inch thick bars and solid sides. The heavy-duty guide rail system shall be of 3-inch structural stainless steel channel. The basket will have four 2-1/2-inch solid aluminum wheels with 1/2-inch stainless steel axles. An aluminum basket stop shall be supplied loose for field mounting to insure proper basket position. The trash rack unit shall be similar, and equal to Halliday Series B4B.
B. Stop Gate: The frame shall be a one-piece 1/4-inch 6061-T6 aluminum extrusion, with an inside mounting gate. The extruded aluminum frame shall be metered and welded continuously and shall incorporate a one-piece extruded polymer channel liner. The gate shall be 1/4-inch thick 6061-T6 aluminum and reinforced to deflect no more than 1/360th of the span. The bottom edge of the gate shall be beveled for positive seating and two handles shall be used. The stop gate shall be guaranteed against defects in material and/or workmanship for a period of 3 years. The unit shall be similar and equal to Halliday Series N1 Stop Gate, Model 203.

C. Stop Logs: Metal items embedded in concrete shall be Type 316 stainless steel. Stop logs shall be aluminum as shown on Drawings.

D. Bolts and Hardware for Tuning Blocks and Pool Blocks: Bolts, anchor bolts, nuts, washers all fasteners and other mounting hardware and other hardware shall be Type 316 stainless steel with threads to match fastener system. Washers shall be of similar material and coatings compatible for use with bolts.

PART 3 EXECUTION

3.01 GENERAL

A. All fabrication shall be equal to the best practice in modern sheet metal and structural shops. Welding shall be performed by qualified welders, and welds exposed to view shall be ground smooth. Bolt hole templates shall be furnished or obtained where required, to or from other subcontractors and equipment suppliers to insure accurate locations for connections.

3.02 HANDLING

A. Care shall be exercised in the handling and shipping of all miscellaneous metalwork to prevent bending and distortion, scratching, and exposure to the elements.

B. Provide temporary shoring and bracing with connections of sufficient strength to bear imposed loads. Provide temporary guy lines to achieve proper alignment of the structures as erection proceeds. Design and placement of temporary shoring and bracing shall be the complete responsibility of the Contractor.

3.03 ASSEMBLY

A. Set structural members to the lines and elevations shown on Drawings with all parts aligned and properly adjusted before permanently fastening. Unaligned bolt holes shall be re-drilled or reamed to permit bolting. Gas cutting torches
shall not be used for correcting fabrication errors or discrepancies. Field welding is not permitted except where specifically allowed or called out on Drawings.

B. Where connections are required between weirs, troughs, and walls, the bolted connections shall be sealed with neoprene sheet. Weirs shall be set exactly level. No leakage shall be permitted around plates, weirs, connections or through bolt holes.

3.04 HANDRAIL AND GUARDRAIL

A. Install in accordance with the manufacturer’s instructions. Sleeves shall be manufactured from larger diameter pipe of the same material as the posts. All flanges shall be fastened to concrete with expansion anchors. Mounting sleeves for side wall locations shall be welded to a flat plat extending a minimum of 3 inches into the sleeve. All sleeves shall be 6 inches in length. When in place, all railing shall be straight and level without kinks. Rail height shall be 42 inches above the floor level. Provide 4-inch toeboard along the perimeter of all elevated floors, installed with 1/2-inch gap above the floor. After alignment is accepted, posts shall be caulked in place. All aluminum in contact with or embedded in concrete, masonry, or grout shall be coated with asphalt bituminous coating on the mating face to prevent direct contact.

3.05 ANCHORING SYSTEMS

A. Install in accordance with ICBO ES Evaluation Report for the specific anchor provided. Immediately notify the Engineer of any discrepancies between the ICBO report and the requirements shown on Drawings for resolution prior to proceeding.

1. Mechanical Anchors: (to be added later)
2. Epoxy Anchors:
   a. Drill hole to the specified depth and diameter.
   b. Clean hole with a wire brush. Remove dust from the hole with compressed air. Jetting holes with water is not permitted.
   c. Install in clean holes free of standing water.
   d. Dispense a bead of adhesive off to the side to check for proper mixture before injecting in the hole.
   e. Fill hole halfway to 2/3 of the way, starting from the bottom of the hole to prevent air pockets. Withdrawal the nozzle as the hole fills.
   f. Insert the anchor, turning slowly until the anchor contacts the bottom of the hole. Do not disturb the anchor during the specified cure time.
3.06 ACCESS HATCHES

A. Deliver hatches to job site in time for installation with the concrete pour. Ensure all surfaces to be in contact with concrete are coated with asphaltic isolation coating; touch up or recoat as necessary. Bare aluminum shall not be in contact with concrete. Prior to the concrete pour, install the PVC drain line, with p-trap, within the concrete formwork from the frame drain coupling to a free discharge opening flush with the ceiling of the wet well structure. Install in conformance with the manufacturer’s installation instructions. Set frame level and true to plane at all four corners, and flush with adjacent finished surfaces. Doors, when closed, shall be flush with frames and flush with each other.

3.07 PAINTING

A. Shop paint all structural steel work, except members or portions of members to be embedded in concrete or mortar. Paint embedded steel on exposed portions and the initial 2 inches of embedded areas only. Do not paint contact surfaces which are to be welded, high-strength bolted or riveted. See Painting Specification for requirements on surface preparations and painting.

B. Hidden surfaces caused by bolted connections shall have finished painting completed prior to assembly.

C. Do not paint aluminum surfaces unless specifically required by Drawings or Specifications; EXCEPT that ALL aluminum to be embedded or in contact with concrete or masonry shall be coated with an 8-mil dry film thickness of zinc chromate paint or bituminous coating.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):


1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer’s product literature identifying products proposed for use.
   b. Drawings or letter indicating proposed locations of holes for injection of foam-in-place insulation in exposed, unpainted walls.

1.03 DELIVERY, STORAGE, AND HANDLING

A. On packaging clearly identify manufacturer, contents, brand name, applicable standard, and R-value.

B. Store materials off ground and keep them dry. Protect against weather, condensation, and damage.

PART 2 PRODUCTS

2.01 RIGID INSULATION

A. Rigid Insulation:

1. Expanded Polystyrene Foam, ASTM C578, Type IV.
2. Compressive Strength: 25 psi per ASTM D1621.
3. Flame Spread: Less than 25 when tested in accordance with ASTM E84.
4. Thickness: As shown on Drawings.
5. R-Value: 5 minimum per inch.
6. Manufacturers and Products:
   a. Dow Chemical Co.; Styrofoam Cavitymate.
   b. Owens Corning; CW25.

B. Adhesives and Fasteners: As recommended by insulation manufacturer.

C. Joint Sealant or Tape: As recommended by insulation manufacturer.

2.02 NAIL BASE ROOF INSULATION

A. Polyisocyanurate Foam Core:
   1. Faced on upper side with 5/8-inch CDX plywood and on reverse side
      with foil or asphalt-coated fiberglass.
   2. R-Value: 30 minimum in multi-layer assembly with nail base roof
      insulation over insulation manufacturer’s polyisocyanurate foam.
   3. Manufacturers and Products:
      b. Dow Chemical Co.; Hy-Therm Nail-Line Roof Insulation.
      c. Rmax, Inc.; Nailable Base-3.

B. Nail Base Fasteners: Type, size, and spacing of fasteners by nail base roof
   insulation manufacturer.

2.03 FACED WALL INSULATION

A. Panel Facing:
   1. 0.030 inch minimum thick white textured fiberglass (FRP) laminated to
      3/4 inch fir exterior plywood.
   2. Limit number of joints and provide joint moldings and fasteners as
      recommended by panel manufacturer.
   4. Attached FRP Panels with 18-gauge galvanized zee furring at 24 inches
      on center.

B. Insulation:
   1. Allowable Average Heat Loss in hr/sq ft/degree F/Btu: R-value of
      15 minimum.
   2. Aluminum foil faced polyisocyanurate insulation.
   3. Seal insulation joints with foil tape.
PART 3 EXECUTION

3.01 RIGID INSULATION

A. Install in accordance with the following:

1. Install boards in location and in thickness and R value as shown on Drawings.
2. Cut insulation with saw, knife, or other sharp tool to fit tightly around obstructions.
3. Butt insulation boards together tightly at joints and seal or tape joints.
4. Apply to masonry or concrete with adhesive recommended by insulation manufacturer and follow manufacturer’s recommendations for preparing surfaces and applying adhesive.

3.02 NAIL BASE ROOF INSULATION

A. Install in accordance with manufacturer’s recommendations, and as specified below:

1. Place insulation boards, sized as large as practical, with oriented strand board side up, long dimension parallel to eaves, and end joints staggered.
2. Use nails or mechanical fasteners as recommended by insulation manufacturer.
3. Install wood nailing strips equal to thickness of insulation board along eaves and rake edges.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI): 302, Guide for Concrete Floor and Slab Construction.
2. ASTM International (ASTM):
   d. E1745, Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

1.02 SUBMITTALS

A. Action Submittals: Manufacturer’s material specifications.
B. Informational Submittals:

   1. MSDS for proposed materials.
   2. Manufacturer’s Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers’ Field Services.
   3. Manufacturer’s written instructions for preparation, installation/application, repair, protection and maintenance.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in labeled packages. Store and handle in strict compliance with manufacturer’s instructions. Protect from damage from weather, excessive temperature and construction operations. Remove and dispose of damaged material in accordance with applicable regulations.
PART 2                PRODUCTS

2.01 UNDERSLAB VAPOR RETARDER

A. Meet or exceed ASTM E1745, Class A, with the following properties:

1. Water Vapor Permeance: 0.03 perm maximum when tested in accordance with ASTM E96/E96M or ASTM F1249.
2. Tensile Strength: 45-foot-pounds per inch minimum, when tested in accordance with ASTM D882.
3. Puncture Resistance: 2,200 grams minimum, when tested in accordance with ASTM D1709.
4. Thickness: 10 mils minimum, in accordance with ACI 302.

B. Manufacturers and Products:

1. Fortifiber Building Systems Group; Moistop Ultra 10.
3. Stego Industries, LLC; Stego Wrap Class A Vapor Retarder.

2.02 ANCILLARY MATERIALS

A. Fasteners, Tape, Adhesive, or Sealant: As recommended by vapor retarder manufacturer.

B. Pipe Boots: Manufacturer’s recommended prefabricated or field fabricated item.

PART 3                EXECUTION

3.01 PREPARATION

A. Examine conditions of substrates and other conditions under which Work is to be performed. Do not proceed with Work until satisfactory conditions are obtained.

3.02 INSTALLATION

A. Underslab Vapor Retarder:

1. Apply in accordance with manufacturer’s instructions.
2. After base for slab has been leveled and tamped, apply vapor retarder with roll width parallel to direction of concrete pour.
3. Lap vapor retarder over footings and seal to foundation walls.
4. Overlap joints 6 inches and seal with tape.
5. Seal penetrations with pipe boots.
6. Repair damaged areas with patches of vapor retarder, overlapping damaged area by 6 inches and sealing sides of patch with tape.

3.03 CLEANING

A. Upon completion of vapor retarder installation, remove waste materials and debris resulting from this operation and dispose offsite.

END OF SECTION
SECTION 07 41 13
METAL ROOF PANELS

PART 1  GENERAL

1.01  REFERENCES

A.  The following is a list of standards which may be referenced in this section:

2.  ASTM International (ASTM):
3.  FM (Factory Mutual) Global (FMG):
   a.  Approval Guide.
   b.  4471, Approval Standard for Class 1 Panel Roofs.

1.02  SYSTEM DESCRIPTION

A.  Design Requirements: Provide professional engineering services needed to design roof system and assume engineering responsibility.

B.  Performance Requirements:

1.  Wind Uplift Resistance: Provide metal panel assemblies that comply with UL 580 for Class 90 and as required by Design Criteria in the General Structural Notes on Drawings.
1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Drawings showing thickness and dimensions of parts and accessories, fastening and anchoring methods, details, and locations of seams, joints, and other provisions for thermal movement. Distinguish between factory-assembled and field-assembled work. Include drawings at not less than 1/4-inch to 1-foot scale and details at not less than 3-inch to 1-foot scale.

2. Manufacturer’s literature.

3. Samples: 12-inch square Samples of specified metal. Samples will be reviewed for color and texture only.

B. Informational Submittals:

1. Manufacturer’s printed installation instructions.

2. A letter from roofing manufacturer stating roofer is approved by manufacturer to apply the roof.

3. Preinstallation Conference meeting minutes.

4. Special guarantee.

5. Certificate of Proper Installation per Section 01 43 33, Manufacturer’s Field Services (or alternately, test results or calculations), that assure item’s and its anchorage’s design criteria meets requirements of Section 01 88 15, Anchorage and Bracing, for loads provided in General Structural Notes on Drawings.

1.04 QUALITY ASSURANCE

A. Applicator’s Qualifications: Approved and trained by materials manufacturer.

B. Preinstallation Conference:

1. Before starting metal roof installation, conduct a conference with Engineer, roofing applicator, roofing system materials manufacturer, Subcontractors likely to be on roof, and installers whose work affects metal roof installation.

2. Items to be reviewed and discussed include, but are not limited to, the following items:
   a. Examine roof deck or substrate conditions for compliance with requirements for flatness and tolerance of structural members.
   b. Review structural loading limitations of roof deck or purlins and rafters during roofing installation.
c. Review flashing details, roof drainage, roof insulation, roof penetrations, roof-mounted mechanical equipment, and other construction and conditions that might affect metal roof panel installation.

d. Review governing regulations and requirements for insurance, certificates, and testing and inspecting as applicable.

e. Review temporary protection requirements for metal roof panels during and after installation.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver components and metal roof panels so as not to be damaged or deformed. Package for protection during transportation and handling.

B. Storage and Handling:

1. Protect against damage and discoloration.
2. Handle panels with nonmarring slings.
3. Do not bend panels.
4. Store panels aboveground on pallets or platforms, with one end elevated for drainage.
5. Protect strippable protective covering from exposure to sunlight except as necessary for metal roof installation.
6. Stack panels to prevent twisting, bending, or abrasion, and to provide ventilation.
7. Protect panels against standing water and condensation between adjacent surfaces.
8. If panels become wet, immediately separate sheets, wipe dry with clean cloth, and separate sheets for air-drying.
9. During storage prevent contact with materials that may cause discoloration or staining.

1.06 COORDINATION

A. Coordinate work with construction of decks, walls, and other adjoining work.

1.07 SPECIAL GUARANTEE

A. Product: Provide manufacturer’s extended guarantee or warranty, with Owner named as beneficiary, in writing, as Special Guarantee. Special Guarantee shall provide for correction or, at the option of the Owner, removal and replacement of roofing panels, flashing, finish, and accessories found defective during a period of 20 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified the General Conditions.
B. Conditions:
   1. Roofing Panels: No rupture, structural failure, or perforation.
   2. Finish: No cracking, blistering, flaking, chipping, checking, chalking, peeling, or fading.
   3. Components: Watertight and weathertight with normal usage.

PART 2 PRODUCTS

2.01 ROOFING AND FASCIA PANELS

A. Loads: Wind uplift Class 90 rating and other loads as listed in Structural General Notes on Drawings.

B. Material: Aluminum, ASTM B209, Alloy 3003H-16, 0.040-inch thick, minimum metal thickness.

C. Surface: Smooth, flat finish.

D. Finish:
   1. Polyvinylidene Fluoride: Kynar 500, two coats minimum.

E. Color: As selected from manufacturer’s standard color range.

F. Standing Seam, Snap-Joint:
   1. Formed with vertical ribs at panel edges and flat pan between vertical ribs designed for sequential field installation by mechanically attaching panels to supports using concealed clips located under one side of panel and engaging opposite edge of adjacent panels and snapped together.
   2. Panel Coverage: 12 inches to 14 inches.
   3. Panel Height: 1 inch minimum.
   4. Manufacturers and Products:
      a. Petersen Aluminum Corp.; PAC-CLAD Snap on Standing Seam.
      c. Merchant & Evans, Inc.; 306.

G. Snow Retention System:
   1. Continuous snow fence along the eaves that attaches to the standing seams with S-5 clamps.
2.02 METAL SOFFIT PANELS

A. General: Provide factory-formed metal soffit panels designed to be field-assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fastening in side laps; included accessories for a complete, weathertight installation.

B. V-Groove Profile: Perforated panels formed with vertical panel edges and flat pan between panel edges with v-groove between panels.
   1. Material: Aluminum sheet 0.032-inch minimum metal thickness.
   2. Finish and Color: Same as Roofing Panels.
   5. Manufacturers and Products:
      b. Merchant & Evans, Inc.; 150.
      c. Petersen Aluminum Corp.; PAC-CLAD PAC-850.

2.03 ACCESSORIES


B. Slip Sheet: Coated-glass fiber fire-resistant slip sheet as recommended by sheet metal roofing manufacturer.

C. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal by means of plastic caps or factory-applied coating.
   1. Fasteners for Roof Panels: Self-drilling or self-tapping Type 410 stainless steel or zinc-alloy steel hex washer head with EPDM or PVC washer.
   2. Fasteners for Flashing and Trim: Self-drilling screws with hex washer head or blind fastener rivets of high-strength aluminum or stainless steel.

D. Holddown Clips: System manufacturer’s ASTM A792/A792M standard shape steel.

E. Closures: Manufacturer’s standard neoprene blocks shaped to fit roof metal profile.
ZINK DAM IMPROVEMENTS

F. Nail Base Roof Insulation: As specified in Section 07 21 00, Thermal Insulation.

G. Treated Wood Nailers:
   1. Waterborne salt preservatives; AWPA C2.
   2. Apply two brush coats of same preservative used in original treatment to all sawed or cut surfaces of treated lumber.
   3. Minimum Grade: Standard or Better, or Stud Grade.
   5. Creosote and asphaltic preservatives are not acceptable.

H. Sealant:
   1. Joint Sealant: Type 5 as specified in Section 07 92 00, Joint Sealants.
   2. Butyl Sealant: Butyl-rubber based, solvent-release sealant per ASTM C1311.

I. Isolation Paint: As specified in Section 09 90 00, Painting and Coating, System No. 27.

J. Flexible Base Pipe Seals
   1. Prefabricated one-piece aluminum flanged base with stepped, graduated EPDM cap and adjustable stainless steel clamps. Aluminum base shall be capable of bending to match profile of sheet metal roofing panels.
   2. Manufacturers and Products:
      a. Pate Co.; Dektite.
      b. Portals Plus, Inc.; Deck-Mate.

2.04 FABRICATION

A. Fabricate and finish metal roof panels and accessories at factory to the greatest extent possible.

B. Provide panel profile, including major ribs and any intermediate stiffening ribs for full panel length.

C. Panel Length: Roof panels shall be full length from eave to ridge, unless otherwise indicated or limited by shipping limitations.

D. Where indicated, fabricate metal roof panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact.
E. Form and fabricate sheets, battens, strips, cleats, valleys, ridges, edge treatments, integral flashings, gutters, downspouts, and other components of specified metal roofing panels to profiles, patterns, and drainage arrangement shown, and as required for permanent leakproof construction, and as recommended by SMACNA’s “Architectural Sheet Metal Manual.”

F. Provide for thermal expansion and contraction of Work.

G. Conceal fasteners and methods of expansion where possible. Do not use exposed fasteners on faces of accessories where exposed to view.

H. Finishes:

1. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half the range of approved sample. Noticeable variations within same piece are not acceptable. Variations in other component appearances are acceptable if within range of approved samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with alignment tolerances required by metal roof panel manufacturer. Examine solid roof sheathing to verify sheathing joints are supported by blocking or framing, and flatness is within tolerances required by metal roof panel manufacturer.

B. Prior to beginning installation, examine rough-in location for items penetrating metal roof panels and coordinate with seam locations.

3.02 PREPARATION

A. Deck: Firm, dry, free of foreign materials, and smooth. Report immediately to Engineer cracks, breaks, holes, or other unusual irregularities in surface.

B. Layout Pattern:

1. Lay out to place seams equidistant from corners and aligned with seams on other side of hip or ridge.
2. Coordinate Work of this section with flashing, trim, and other construction to provide a permanently leakproof, secure, and noncorroding installation.
3.03 INSTALLATION

A. General:

1. Apply roofing only in dry weather and where weather conditions permit.
2. Install in accordance with manufacturer’s written instructions and warranty requirements.
4. Install metal roofing, fascia, and soffit system consisting of nonstructural sheet metal panels held to substrate with concealed fasteners.
5. Conceal expansion joint provisions wherever possible in exposed Work; locate so as to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
6. Closures and Trim:
   a. Provide ridges, hips, valleys, eaves, rakes, fascia, coping, gutters, downspouts, and other exposed trim and flashing for a weather-tight roofing, fascia, and soffit system.
   b. Provide metal closures at rake edges and each side of ridge caps.
   c. Flash and seal metal roof panels with weather closures at eaves, rakes, and at perimeter of openings. Fasten with self-tapping screws.
7. Install ridge caps as the metal roof panel work proceeds.
8. Dissimilar Metals:
   a. Separate from each other where electrolysis might occur.
   b. Separate metal panels where contact with corrosive substrates may occur.
   c. Separation is satisfactorily accomplished by coating metals with isolation Paint.
   d. Comply with various metals producers’ recommendations for other forms of protection against contamination from corrosive materials or agents.
9. Lap metal flashing over metal roof panels to allow moisture to run over and off the material.
10. Cutting and Fitting: Neat, square, and true. Saw cut panels, deburr, and use touchup paint immediately as recommended by roofing panel manufacturer. Torch cutting is prohibited.
11. Gutters, Downspouts, and Flashings:
   a. Straight, weather-tight, exposed surfaces free of dents, scratches, abrasions, stains, and other visible defects.
   b. Extend gutter lining under metal roofing 6 inches minimum and terminate in 3/4-inch folded edge secured by cleats.
B. Underlayment and Slip Sheet:

1. Install ice and water shield and slip sheet on roof sheathing as recommended by metal roof panel manufacturer.
2. Apply ice and water shield lapped shingle fashion, 3 inches at head and 6 inches at sides.
3. Cover with loose-laid slip sheet similarly lapped and with joints staggered.
4. Install no more than can be covered by metal roofing or other approved protection, in same day.
5. Use adhesive for temporary anchorage, where possible, to minimize use of mechanical fasteners under metal roof panels.

C. Standing-Seam Metal Roof:

1. Install as recommended by metal roof panel manufacturer’s installation instructions and recommendations.
2. Begin at eaves. Rigidly fasten eave end of metal roof panels and allow ridge end free movement for thermal expansion and contraction.
3. Install clips in panel side joints at location, spacing, and with fasteners as recommended by manufacturer for type of substrate and wind loading specified.

D. Metal Soffit Panels: Provide full width of soffit. Install perpendicular to support framing. Flash and seal panels with weather closures where metal soffit panels meet walls and at perimeter of openings and joints.

E. Fascia Panels: Align bottom edge for a straight true line. Flash and seal panels with weather closures where metal fascia panels meet walls, along lower panel edges, and at perimeter of all openings and joints.

3.04 CLEANING AND PROTECTION

A. Cleaning:

1. At the end of each day, sweep metal clean of foreign materials, especially metal particles and scrap.
2. Peel off strippable film.
3. Where needed, clean metals in conformance with metals industry recommendations or use Basic H organic metal cleaner, Shaklee Products, Hayward, CA.
B. Protection:

1. Protect material from exposure to chlorides, hydrochloric-based and muriatic acids. If contaminated, wash affected areas immediately with 5 percent soda and water solution and rinse with clear water.
2. Avoid walking on roof after completion.

C. Final Cleanup:

1. Remove debris, metal clips, nails, and other materials that could prevent adequate drainage or produce corrosion products through electrolysis.
2. Repair and touch up damage.
3. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Surface preparation instructions. Indicate where each product is proposed to be used.
2. Samples: Material proposed for use showing color range available.

B. Informational Submittals:

1. Installation instructions.
2. Documentation showing applicator qualifications.
3. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
4. Special guarantee.

1.03 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum of 5 years’ experience installing sealants in projects of similar scope.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Ambient Temperature: Between 40 degrees F and 80 degrees F (4 degrees C and 27 degrees C) when sealant is applied. Consult manufacturer when sealant cannot be applied within these temperature ranges.
1.05 SPECIAL GUARANTEE

A. Product: Furnish manufacturer’s extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction or, at the option of the Owner, removal and replacement of Work specified in this section found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

B. Conditions: No adhesive or cohesive failure of sealant.

C. Sealed Joints: Watertight and weathertight with normal usage.

PART 2 PRODUCTS

2.01 SEALANT MATERIALS

A. Characteristics:

1. Uniform, homogeneous.
2. Free from lumps, skins, and coarse particles when mixed.
3. Nonstaining, nonbleeding.
4. Hardness of 15 minimum and 50 maximum, measured by ASTM C661 method.
5. Immersible may be substituted for nonimmersible.

B. Color: Unless specifically noted, match color of the principal material adjoining area of application. Color as selected by Owner or Engineer.

C. Type 1—Silicone, Nonsag, Nonimmersible:

1. Silicone base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 25.
2. Capable of withstanding movement up to 50 percent of joint width.
3. Manufacturers and Products:
   a. Dow Corning Corp.; No. 790.
   b. General Electric; Silpruf.
   c. BASF; Sonneborn, Omniseal-50.

D. Type 2—Multipart Polyurethane, Self-leveling, Immersible:

1. Polyurethane base, multicomponent, chemical curing; ASTM C920, Type M, Grade P, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturers and Products:
   a. BASF; Sonneborn, SL-2.
   b. Pecora Corp.; Urexspar NR-200.
   c. Tremco; THC-900/901.
   d. Sika Chemical Corp.; Sikaflex 2c SL.

E. Type 3—Multipart Polyurethane, Nonsag, Immersible:
   1. Polyurethane base, multicomponent, chemical curing; ASTM C920, Type M, Grade NS, Class 25.
   2. Capable of being continuously immersed in water.
   3. Manufacturers and Products:
      a. Pecora; DynaTrol II.
      b. Tremco; Dymeric 240.
      c. BASF; Sonneborn NP-2.
      d. Sika Chemical Corp.; Sikaflex 2c NS.

F. Type 5—One-part Polyurethane, Immersible:
   1. Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS or P, Class 25.
   2. Capable of being continuously immersed in water.
   3. Manufacturers and Products for Nonsag:
      a. Sika Chemical Corp.; Sikaflex-1a.
      b. Tremco; Vulkem 116.
   4. Manufacturers and Products for Self-leveling:
      a. BASF; MasterSeal, SL-1.
      b. Tremco; Vulkem 45.
      c. Sika Chemical Corp.; Sikaflex 1c SL.

2.02 BACKUP MATERIAL

A. Nongassing, extruded, closed-cell round polyurethane foam or polyethylene foam rod, compatible with sealant used, and as recommended by sealant manufacturer.

B. Size: As shown or as recommended by sealant material manufacturer. Provide for joints greater than 3/16 inch wide.

C. Manufacturers and Products:
   1. BASF; Sonneborn, Sonolastic Closed-cell Backing Rod.
   2. Tremco; Closed-cell Backing Rod.
   3. Pecora Corporation; Green Rod.
2.03 ANCILLARY MATERIALS

A. Bond Breaker: Pressure sensitive tape as recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Noncorrosive and nonstaining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Primer: Nonstaining type recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 GENERAL

A. Use of more than one material for the same joint is not allowed unless approved by sealant manufacturer.

B. Install joint sealants in accordance with ASTM C1193.

C. Horizontal and Sloping Joints up to 1 Percent Maximum Slope: Use self-leveling (Grade P) joint sealant.

D. Steeper Sloped Joints, Vertical Joints, and Overhead Joints: Use nonsag (Grade NS) joint sealant.

E. Use joint sealant as required for the applicable application and as follows:

<table>
<thead>
<tr>
<th>Joint Size</th>
<th>Sealant Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1”</td>
<td>1, 2, 3, or 5</td>
</tr>
<tr>
<td>Less than 2”</td>
<td>1, 2, or 3</td>
</tr>
<tr>
<td>Over 2”</td>
<td>Follow manufacturer’s recommendation</td>
</tr>
</tbody>
</table>

3.02 PREPARATION

A. Verify that joint dimensions, and physical and environmental conditions, are acceptable to receive sealant.

B. Surfaces to be sealed shall be clean, dry, sound, and free of dust, loose mortar, oil, and other foreign materials.

1. Mask adjacent surfaces where necessary to maintain neat edge.
2. Starting of work will be construed as acceptance of subsurfaces.
3. Apply primer to dry surfaces as recommended by sealant manufacturer.
C. Verify joint shaping materials and release tapes are compatible with sealant.
D. Examine joint dimensions and size materials to achieve required width/depth ratios.
E. Follow manufacturer’s instructions for mixing multi-component products.

3.03 INSTALLATION

A. Use joint filler to achieve required joint depths, to allow sealants to perform intended function.
   1. Install backup material as recommended by sealant manufacturer.
   2. Where possible, provide full length sections without splices; minimize number of splices.
B. Use bond breaker where recommended by sealant manufacturer.
C. Seal joints around window, door and louver frames, expansion joints, control joints, and elsewhere as indicated.
D. Joint Sealant Materials: Follow manufacturer’s recommendation and instructions, filling joint completely from back to top, without voids.
E. Joints: Tool slightly concave after sealant is installed.
   1. When tooling white or light color sealant, use a water wet tool.
   2. Finish joints free of air pockets, foreign embedded matter, ridges, and sags.

3.04 CLEANING

A. Clean surfaces next to the sealed joints of smears or other soiling resultant of sealing application.
B. Replace damaged surfaces resulting from joint sealing or cleaning activities.

3.05 JOINT SEALANT SCHEDULE

A. Use sealant Type 1, 2, 3, or 5 for building joints and elsewhere as indicated.

END OF SECTION
SECTION 08 11 16
ALUMINUM DOORS AND FRAMES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1.02 SUBMITTALS

A. Action Submittals:
   1. Applicable information for each type of door and frame, including:
      a. Frame conditions and complete anchorage details, supplemented by suitable schedules covering doors and frames.
      b. Connections of door frames to structural steel framing concealed in frames.
      c. Product literature.
      d. Relate to door numbers used on Drawings.

B. Informational Submittals: Certificate of Compliance per Section 01 43 33, Manufacturer’s Field Services (or alternately, test results or calculations), that assure items and its anchorages design criteria meets requirements of Section 01 88 15, Anchorage and Bracing, for loads provided in General Structural Notes on Drawings.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Properly identify each item with number used on Drawings.

B. Store doors upright, in protected dry area, at least 1 inch off ground or floor and at least 1/4 inch between individual pieces.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Cline Aluminum Doors, Inc.; Series 100BE with specified rigid insulation.
2.02 MATERIALS

A. Design Requirement: Complete assembly, each component and anchorage to building to withstand a wind load of 30 pounds per square foot. See Structural General Notes for additional load requirements.

B. Aluminum Frames:
   1. Extruded from 6063-T5 aluminum alloy meeting ASTM B209.
   2. Minimum Wall Thickness: 0.125 inch.
   3. Mechanically fastened corners.
   4. Reinforcements: 6061-T6 aluminum of 1/4-inch minimum thickness.
   5. Size and Profile: 6 inches by 1-3/4 inches, with open or closed back and applied stop with integral weatherstripping.
   6. Concealed fasteners or welding are preferred to through-the-face fasteners.

C. Flush Aluminum Doors: 6063-T5 extrusions and 5005-H14, smooth face sheets.
   1. Minimum component thicknesses as follows:
      a. Base Sheets: 0.090 inch.
      b. Beveled Lock Rail Edge: 0.125 inch.
      c. Hinge Rail Edge: 0.190 inch.
      d. Internal Grid Sections: 0.080 inch.
   2. R-Value: 9 minimum.

2.1 DOOR HARDWARE

A. Hinges: Continuous heavy-duty aluminum hinge furnished by door manufacturer, finish to match door.

B. Exit Devices:
   1. BHMA A156.3.
   2. Finish: Satin stainless steel No. 630.
   3. Keying: Key new locks into existing master key system as directed by Owner.
4. Types and Manufacturers:

<table>
<thead>
<tr>
<th>Type Description</th>
<th>Sargent</th>
<th>VonDuprin</th>
<th>BHMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rim type</td>
<td>8813ETL</td>
<td>99L</td>
<td>Type 1</td>
</tr>
<tr>
<td>Concealed vertical rod type for pairs</td>
<td>8606ETL and 8610</td>
<td>9947L and 9947EO</td>
<td>08 and 01</td>
</tr>
</tbody>
</table>

A. Closers:
1. BHMA A156.4.
2. Size closers in accordance with manufacturer’s standards. Mount regular arm closers on pull side of doors. Mount parallel arm closers on push side of doors. On pair of doors provide closer on active leaf only, unless noted otherwise.
3. Finish: Manufacturer’s standard painted or powder coated finish, with special rust inhibiting (SRI) pretreatment in gray color.
4. Type and Manufacturers:

<table>
<thead>
<tr>
<th>Type/Description</th>
<th>LCN</th>
<th>Sargent</th>
<th>BHMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parallel arm with integral stop and hold-open</td>
<td>4110H Cush-N-Stop Series</td>
<td>351-PSH Series</td>
<td>C02061</td>
</tr>
</tbody>
</table>

B. Thresholds:
1. One-piece full width of opening; extend beyond jamb where indicated.
2. Provide with stainless steel machine screws in threaded expansion anchors at concrete.
3. Finish: Mill finish aluminum, unless indicated otherwise.
4. Type and Manufacturers:

<table>
<thead>
<tr>
<th>Type Description</th>
<th>Pemko</th>
<th>Reese</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saddle (smooth, 4” x 1/2”)</td>
<td>175A</td>
<td>S104A</td>
</tr>
</tbody>
</table>

C. Weatherstripping: Seals, astragal seals, and door sweep by door manufacturer.
2.03 MISCELLANEOUS ITEMS
   A. Filler or Transom Panels: Furnish of same construction and finish as door.
   B. Furnish manufacturer’s standard core filler, anchors, fasteners, and other ancillary items.

2.04 FACTORY FINISHING REQUIREMENTS
   A. Aluminum Door and Frame Finish: Clear anodized AA-M12C22A41.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Frames:
      1. Installation: Maintain scheduled dimensions, hold head level, and maintain jambs plumb and square.
      2. Secure anchorages and connections to adjacent construction.
      3. Wherever possible, leave frame spreader bars intact until frames are set perfectly square and plumb and anchors are securely attached.
      4. Install following manufacturer’s recommendations.
   B. Doors:
      1. Follow manufacturer’s recommendations.
      2. Hardware: In accordance with manufacturer’s templates and instructions.
         a. Adjust operable parts for correct function.
         b. Remove hardware, with exception of prime coated items, tag, box, and reinstall after finish paint work is completed.

3.02 PROTECTION
   A. Protect installed doors and frames against damage from other construction work.

3.03 SCHEDULES
   A. For tabulation of door and frame characteristics, such as size, type, detail, and finish hardware requirements, see Door and Hardware Schedule on Drawings.

END OF SECTION
PART 1  GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

2. ASTM International (ASTM):

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Shop Drawings showing construction and installation details, and electrical characteristics and control diagrams for motor operators.
   b. Identify each door with same reference as used on Drawings.
   c. Anchorage and bracing drawings and/or catalog information, as required by Section 01 88 15, Anchorage and Bracing, for loads provided in General Structural Notes on Drawings.

B. Informational Submittals: Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing, for loads provided in General Structural Notes on Drawings. Submit with Action Submittal for the same item.

1.03 QUALITY ASSURANCE

A. Qualifications: Experienced, factory authorized installer.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors with separators and wrapping to protect units from damage during and after installation.

B. Store doors in protected dry area following manufacturer’s requirements.
C. Handle doors according to manufacturer’s instructions.

D. Protect exposed finish surfaces of prefinished items with wrapping.

PART 2 PRODUCTS

2.01 OVERHEAD COILING (ROLL UP) DOORS

A. Manufacturers:
   1. Alpine Overhead Doors, Inc.
   2. Cornell Iron Works, Inc.
   3. Wayne-Dalton Corp.
   4. Overhead Door Corp.
   5. The Cookson Co.

B. Design Requirement: Complete assembly, each component and anchorage to building to withstand a wind load of 30 pounds per square foot. See Structural General Notes on Drawings for additional load requirements.

C. Insulated Curtain: Interlocking insulated flat slats of 16-gauge (B & S) minimum ASTM B209, 5052-H32 aluminum alloy with maximum U-value of 0.40 and backing to match face slat thermally separated from face slat.

D. Hood: Match curtain material and finish.

E. Slide Guides: ASTM B308/B308M, 6061-T6 aluminum alloy, shapes as appropriate for conditions.

F. Brackets, Gears, and Barrel: Manufacturer’s standard items.

G. Operation: Chain operated.

H. Locking: Manufacturer’s standard slide bolt locking mechanism.

I. Finish:
   2. All Other Surfaces: One coat of corrosion-inhibiting primer.
   3. Finish painting as specified in Section 09 90 00, Painting and Coating, System No. 4.
J. Special Features:

1. Bottom Bar:
   a. Provide extruded aluminum bottom bar with flexible weatherstripping astragal on exterior doors.
   b. Finish to match curtain slats.
   c. Provide limit switch and automatic stop and reversing feature in astragal.

2. End Locks and Wind Locks:
   a. Ends of each slat shall have end locks of material compatible with curtain.
   b. Provide wind locks at ends of every other slat minimum on exterior doors.

3. Weather Seals:
   a. Provide rubber, neoprene, or vinyl water seal at hood to prevent airflow around coil on exterior doors.
   b. Provide weather seal sealing strip on guide to close space between guide and curtain on exterior doors.

4. Vision Panels: Manufacturer’s insulated glazed vision panels as indicated on Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install special doors in accordance with the manufacturer’s recommendations and printed instructions.

B. Adjust doors for smooth, satisfactory operation.

3.02 PRIME COAT TOUCHUP

A. Damaged Prime Coat:
   1. Remove rust.
   2. Sand smooth.
   3. Use same primer as shop.
   4. Touch up so it is not obvious.

3.03 PROTECTION

A. Protect installed doors against damage from other construction work.
3.04 SCHEDULE

A. For tabulation of door and frame characteristics, such as size, type, detail, and finish hardware requirements, see Door and Hardware Schedule on Drawings.

END OF SECTION
SECTION 08 90 00
LOUVERS

PART 1 GENERAL

1.01 REFERENCES
A. The following is a list of standards which may be referenced in this section:

1.02 DESIGN REQUIREMENTS
A. Design Requirement: Complete assembly, each component and anchorage to building to withstand a wind load of 30 pounds per square foot. See Structural General Notes on Drawings for additional load requirements.

1.03 SUBMITTALS
A. Action Submittals:
   1. Shop Drawings: Large scale details of louvers, anchorage, and relationship to adjoining construction.
      a. Manufacturer’s Literature: Descriptive and performance data of louvers, including standard drawings and louver-free area.
      b. Seismic anchorage and bracing drawings and data sheets, as required by Section 01 88 15, Anchorage and Bracing.
   2. Samples: Manufacturer’s standard finishes and colors.

B. Informational Submittals:
   1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
   2. Factory test data.
   3. Certificates of AMCA ratings.
   4. Installation instructions.
   5. Special guarantee.
PART 2  PRODUCTS

2.01  GENERAL

A. Nonacoustical louver sizes are based on 50 percent free area and 800 fpm maximum velocity through free area. If louvers furnished do not meet these parameters, Contractor is responsible for resizing louvers and wall openings, and for making other adjustments to allow for larger openings.

B. Water Penetration Rate: No greater than 0.02 ounce per square foot.

C. Louvers: Rated and tested in accordance with AMCA 500-L.

D. Furnish louvers with interior duct collars.

2.02  FIXED STORMPROOF LOUVERS (TYPE SP)

A. Frame: Extruded aluminum channel, 0.081 inch thick, 4 inches deep, with concealed mullions.

B. Blades: Extruded aluminum, 0.081 inch thick, Z-shaped, 35-degree to 45-degree pitch angle, spaced 3 inches to 4.25 inches on center.

C. Pressure Loss: AMCA certified rating of no greater than 0.10-inch WC.

D. Sizes: As shown on Drawings.

E. Screen: Inside mounted, aluminum insect screen.

F. Finish: AA-M1022A41, clear anodized.

G. Manufacturers and Products:

1. Construction Specialties; Model 4110.
2. Dowco; Series LEB-4.
3. Ruskin; Model ELF-375DXH.

2.03  ACCESSORIES

A. Anchors and Fasteners: Stainless steel.

B. Flashings: Match louver frame.

C. Isolation Tape: Tremco 440, 3M EC1202, or Presstite 579.6.

D. Isolation Paint: Section 09 90 00, Painting and Coating, System No. 27.
E. Insulated Blank-Off Panels:

1. Panels: Urethane core faced on both sides with 0.032-inch stucco embossed 5005-H134 aluminum sheet in finish and color to match louvers.
2. Frames: 6063-T52 extruded aluminum sections 0.080 inch thick, with mitered corners.
3. Perimeter Gaskets: Closed-cell PVC, to ensure tight fit of panel to louver.
4. Thickness: 2 inches.
5. U-Value: 0.10.

2.04 SOURCE QUALITY CONTROL

A. Factory Performance Tests:

1. Airflow versus pressure loss.
2. Rain penetration data.

PART 3 EXECUTION

3.01 EXAMINATION

A. Check openings to ensure dimensions conform to Drawings.
B. Ensure openings are free of irregularities that would interfere with installation.
C. Do not install louvers until defects have been corrected.

3.02 INSTALLATION

A. Install louvers as shown on reviewed Shop Drawings. Coordinate with heating or ventilation ductwork to be connected.
B. Follow procedures in manufacturer’s recommended installation instructions.
C. Install insulated blank-off panels where indicated, completely closing space between ducts and louver frames.
D. Separate aluminum from other metals with isolation tape or paint.
3.03 CLEANING

A. After erection, protect exposed portions from damage by machines, paint, lime, acid, cement, or other harmful compounds.

B. Remove protective materials and clean with plain water, water with soap, or household detergents.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Environmental Protection Agency (EPA).
3. Occupational Safety and Health Act (OSHA).
4. The Society for Protective Coatings (SSPC):
   a. PA 2, Procedure for Determining Conformance to Dry Coating Thickness Requirements.
   b. PA 10, Guide to Safety and Health Requirements for Industrial Painting Projects.
   c. SP 1, Solvent Cleaning.
   d. SP 7, Joint Surface Preparation Standard Brush-Off Blast Cleaning.
   e. SP 10, Near-White Blast Cleaning.
   f. SP 13, Surface Preparation of Concrete.
   g. SP 16, Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.

1.02 DEFINITIONS

A. Terms used in this section:

1. Coverage: Total minimum dry film thickness in mils or square feet per gallon.
2. HCl: Hydrochloric Acid.
3. MDFT: Minimum Dry Film Thickness, mils.
5. PPDS: Paint Product Data Sheet.
7. SFPG: Square Feet per Gallon.
8. SFPGPC: Square Feet per Gallon per Coat.
9. SP: Surface Preparation.
1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Data Sheets:
      1) For each product, furnish a Paint Product Data Sheet (PPDS), the manufacturer’s technical data sheets, and paint colors available (where applicable). The PPDS form is appended to the end of this section.
      2) For each paint system, furnish a Paint System Data Sheet (PSDS). The PSDS form is appended to the end of this section.
      3) Technical and performance information that demonstrates compliance with specification.
      4) Furnish copies of paint system submittals to the coating applicator.
      5) Indiscriminate submittal of only manufacturer’s literature is not acceptable.
   b. Coating manufacturer’s approval of proposed abrasive material.

2. Samples: As required for color selection.

B. Informational Submittals:

1. Applicator’s Qualification: List of references substantiating experience.
2. Coating manufacturer’s Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers’ Field Services.
3. Factory Applied Coatings: Manufacturer’s certification stating factory applied coating system meets or exceeds requirements specified.
4. Manufacturer’s written verification that submitted material is suitable for the intended use.
5. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer’s written confirmation that materials are compatible.
6. Manufacturer’s written instructions and special details for applying each type of paint.

1.04 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum 5 years’ experience in application of specified products.

B. Regulatory Requirements:

1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.
2. Perform surface preparation and painting in accordance with recommendations of the following:
   a. Paint manufacturer’s instructions.
   b. SSPC PA 10.
   c. Federal, state, and local agencies having jurisdiction.

C. Mockup:
   1. Before proceeding with Work under this section, finish one complete space or item of each color scheme required showing selected colors, finish texture, materials, quality of work, and special details.
   2. After Engineer approval, sample spaces or items shall serve as a standard for similar work throughout the Project.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Shipping:
   1. Where precoated items are to be shipped to the Site, protect coating from damage. Batten coated items to prevent abrasion.
   2. Protect shop painted surfaces during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.

B. Storage:
   1. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.
   2. Primed surfaces shall not be exposed to weather for more than 2 months before being topcoated, or less time if recommended by coating manufacturer.

1.06 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Do not apply paint in temperatures or moisture conditions outside of manufacturer’s recommended maximum or minimum allowable.
   2. Do not perform final abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dew point of ambient air.
PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Nationally recognized manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.

B. Minimum of 5 years’ verifiable experience in manufacture of specified product.

C. Each of the following manufacturers is capable of supplying most of the products specified herein:

1. Tnemec.
2. International Paints.
3. PPG Industries.

2.02 ABRASIVE MATERIALS

A. Select abrasive type and size to produce surface profile that meets coating manufacturer’s recommendations for specific primer and coating system to be applied.

2.03 PAINT MATERIALS

A. General:

1. Manufacturer’s highest quality products suitable for intended service.
2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.
3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.

B. Products:

<table>
<thead>
<tr>
<th>Product</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bituminous Paint</td>
<td>Single-component, coal-tar pitch based</td>
</tr>
<tr>
<td>Epoxy Filler/Surfacer</td>
<td>100% solids epoxy trowel grade filler and surfacer, nonshrinking, suitable for application to concrete and masonry</td>
</tr>
<tr>
<td>Product</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Epoxy Nonskid (Aggregated)</td>
<td>Polyamidoamine or amine converted epoxies aggregated; aggregate may be packaged separately</td>
</tr>
<tr>
<td>Epoxy Primer—Ferrous Metal</td>
<td>Anticorrosive, converted epoxy primer containing rust-inhibitive pigments</td>
</tr>
<tr>
<td>Epoxy Primer—Other</td>
<td>Epoxy primer, high-build, as recommended by coating manufacturer for specific galvanized metal, copper, or nonferrous metal alloy to be coated</td>
</tr>
<tr>
<td>High Build Epoxy</td>
<td>Polyamidoamine epoxy, minimum 69% volume solids, capability of 4 MDFT to 8 MDFT per coat</td>
</tr>
<tr>
<td>Polyurethane Enamel</td>
<td>Two-component, aliphatic or acrylic based polyurethane; high gloss finish</td>
</tr>
</tbody>
</table>

2.04 MIXING

A. Multiple-Component Coatings:

1. Prepare using each component as packaged by paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple-component coatings that have been mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.
5. Mix only components specified and furnished by paint manufacturer.
6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Colors: Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

2.05 SHOP FINISHES

A. Shop Blast Cleaning: Reference Paragraph Shop Coating Requirements.

B. Surface Preparation: Provide Engineer minimum 7 days’ advance notice to start of shop surface preparation work and coating application work.

C. Shop Coating Requirements:

1. When required by equipment specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.
2. Where manufacturer’s standard coating is not suitable for intended service condition, Engineer may approve use of a tie-coat to be used between manufacturer’s standard coating and specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer’s standard coating with field coating manufacturer.

PART 3 EXECUTION

3.01 GENERAL

A. Provide Engineer minimum 7 days’ advance notice to start of field surface preparation work and coating application work.

B. Perform the Work only in presence of Engineer, unless Engineer grants prior approval to perform the Work in Engineer’s absence.

C. Schedule inspection of cleaned surfaces and all coats prior to succeeding coat in advance with Engineer.

3.02 EXAMINATION

A. Factory Finished Items:

1. Schedule inspection with Engineer before repairing damaged factory-finished items delivered to Site.

2. Repair abraded or otherwise damaged areas on factory-finished items as recommended by coating manufacturer. Carefully blend repaired areas into original finish. If required to match colors, provide full finish coat in field.

B. Surface Preparation Verification: Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.

3.03 PROTECTION OF ITEMS NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

D. Mask openings in motors to prevent paint and other materials from entering.

E. Protect surfaces adjacent to or downwind of Work area from overspray.

3.04 SURFACE PREPARATION

A. Field Abrasive Blasting:

1. Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed or coated.

2. Refer to coating systems for degree of abrasive blasting required.

3. Where the specified degree of surface preparation differs from manufacturer’s recommendations, the more stringent shall apply.

B. Metal Surface Preparation:

1. Where indicated, meet requirements of SSPC Specifications summarized below:
   a. SP 1, Solvent Cleaning: Removal of visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants by cleaning with solvent.
   b. SP 7, Brush-Off Blast Cleaning: Removal of visible rust, oil, grease, soil, dust, loose mill scale, loose rust, and loose coatings. Tightly adherent mill scale, rust, and coating may remain on surface.
   c. SP 10, Near-White Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 5 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
   d. SP 16, Brush Blasting of Nonferrous Metals: A brush-off blast cleaned nonferrous metal surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, metal oxides (corrosion products), and other foreign matter. Intact, tightly adherent coating is permitted to remain. A coating is considered tightly adherent if it cannot be removed by lifting with a dull putty knife. Bare metal substrates shall have a minimum profile of 19 micrometers (0.75 mil).
2. The words “solvent cleaning,” “hand tool cleaning,” “wire brushing,” and “blast cleaning,” or similar words of equal intent in these Specifications or in paint manufacturer’s specification refer to the applicable SSPC Specification.

3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers’ recommendations for wet blast additives and first coat application shall apply.

4. Hand tool clean areas that cannot be cleaned by power tool cleaning.

5. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.

6. Welds and Adjacent Areas:
   a. Prepare such that there is:
      1) No undercutting or reverse ridges on weld bead.
      2) No weld spatter on or adjacent to weld or any area to be painted.
      3) No sharp peaks or ridges along weld bead.
   b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.

7. Preblast Cleaning Requirements:
   a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
   b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
   c. Clean small isolated areas as above or solvent clean with suitable solvent and clean cloth.

8. Blast Cleaning Requirements:
   a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer’s recommendations.
   b. Select type and size of abrasive to produce surface profile that meets coating manufacturer’s recommendations for particular primer to be used.
   c. Use only dry blast cleaning methods.
   d. Do not reuse abrasive, except for designed recyclable systems.
   e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.

9. Post-Blast Cleaning and Other Cleaning Requirements:
   a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and
other areas where dust settling is a problem and wipe with a tack cloth.

b. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.

C. Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation:

1. Remove soil, cement spatter, and other surface dirt with appropriate hand or power tools.
2. Brush blast in accordance with SSPC SP 16.
3. Obtain and follow coating manufacturer’s recommendations for additional preparation that may be required.

D. Concrete Surface Preparation:

1. Do not begin until 30 days after concrete has been placed.
3. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.
4. Brush-off blast clean to remove loose concrete and laitance, and provide a tooth for binding. Upon approval by Engineer, surface may be cleaned by acid etching method. Approval is subject to producing desired profile equivalent to No. 80 grit flint sandpaper. Acid etching of vertical or overhead surfaces shall not be allowed.
5. Secure coating manufacturer’s recommendations for additional preparation, if required, for excessive bug holes exposed after blasting.
6. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

E. Masonry Surface Preparation:

1. Complete and cure masonry construction for 14 days or more before starting surface preparation work.
2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
   a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.
   b. Brush-off blasting.
   c. Water blasting.
4. Do not damage masonry mortar joints or adjacent surfaces.
5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.

6. Masonry Surfaces to be Painted: Uniform texture and free of surface imperfections that would impair intended finished appearance.

F. Brush-off Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC SP 7.
2. Abrasive: Either wet or dry blasting sand, grit, or nutshell.
3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
5. Engineer will review acceptable trial blast cleaned area and use area as a representative sample of surface preparation.
6. Repair or replace surface damaged by blast cleaning.

G. Acid Etching:

1. After precleaning, spread the following solution by brush or plastic sprinkling can:
   a. One part commercial muriatic acid reduced by two parts water by volume. Adding acid to water in these proportions gives an approximate 10 percent solution of HCl.
2. Application:
   a. Rate: Approximately 2 gallons per 100 square feet.
   b. Work acid solution into surface by hard-bristled brushes or brooms until complete wetting and coverage is obtained.
   c. Acid will react vigorously for a few minutes, during which time brushing shall be continued.
   d. After bubbling subsides (10 minutes), hose down remaining slurry with high pressure clean water.
   e. Rinse immediately to avoid formation on the surface of salts that are difficult to remove.
   f. Thoroughly rinse to remove any residual acid surface condition that may impair adhesion.
3. Ensure surface is completely dry before application of coating.
4. Apply acid etching to obtain a “grit sandpaper” surface profile. If not, repeat treatment.
H. Solvent Cleaning:

1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.
2. Meet requirements of SSPC SP 1.

3.05 APPLICATION

A. General:

1. The intention of these Specifications is for new interior masonry and concrete, and new metal surfaces to be painted, whether specifically mentioned or not, except as specified otherwise.
2. Apply coatings in accordance with these Specifications and paint manufacturers’ printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
3. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
4. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
5. Keep paint materials sealed when not in use.
6. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.

B. Galvanized Metal, Copper, and Nonferrous Metal Alloys:

1. Concealed galvanized, copper, and nonferrous metal alloy surfaces (behind building panels or walls) do not require painting, unless specifically indicated herein.
2. Prepare surface and apply primer in accordance with System No. 10 specification.
3. Apply intermediate and finish coats of the coating system appropriate for System No. 4.

C. Porous Surfaces, Such as Concrete and Masonry:

1. Filler/Surfacer: Use coating manufacturer’s recommended product to fill air holes, bug holes, and other surface voids or defects.
2. Prime Coat: May be thinned to provide maximum penetration and adhesion.
   a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.
D. Film Thickness and Coverage:

1. Number of Coats:
   a. Minimum required without regard to coating thickness.
   b. Additional coats may be required to obtain minimum required
      paint thickness, depending on method of application, differences
      in manufacturers’ products, and atmospheric conditions.

2. Application Thickness:
   a. Do not exceed coating manufacturer’s recommendations.
   b. Measure using a wet film thickness gauge to ensure proper
      coating thickness during application.

3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
   a. Perform with properly calibrated instruments.
   b. Recover and repair as necessary for compliance with Specification.
   c. Coats are subject to inspection by Engineer and coating
      manufacturer’s representative.

4. Visually inspect concrete, masonry, and nonferrous metal surfaces to
   ensure proper and complete coverage has been attained.

5. Give particular attention to edges, angles, flanges, and other similar
   areas, where insufficient film thicknesses are likely to be present, and
   ensure proper millage in these areas.

6. Apply additional coats as required to achieve complete hiding of
   underlying coats. Hiding shall be so complete that additional coats
   would not increase the hiding.

3.06 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

A. Unless otherwise shown or specified, paint surfaces in accordance with the
   following application schedule. In the event of discrepancies or omissions in
   the following, request clarification from Engineer before starting work in
   question.

B. As shown in Interior Finish Schedule on Drawings. Additional requirements
   are included in the Piping Schedule.
C. System No. 4 Exposed Metal:

<table>
<thead>
<tr>
<th>Surface Prep.</th>
<th>Paint Material</th>
<th>Min. Coats, Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP 10, Near-White Blast Cleaning</td>
<td>Epoxy Primer—Ferrous Metal</td>
<td>1 coat, 2.5 MDFT</td>
</tr>
<tr>
<td></td>
<td>High Build Epoxy</td>
<td>1 coat, 4 MDFT</td>
</tr>
<tr>
<td></td>
<td>Polyurethane Enamel</td>
<td>1 coat, 3 MDFT</td>
</tr>
</tbody>
</table>

1. Use on exposed metal surfaces, such as metal decking, steel trusses, structural steel, miscellaneous metals, guard posts, and overhead sectional doors and frames.

D. System No. 10 Galvanized Metal, Copper, and Nonferrous Metal Alloy Conditioning:

<table>
<thead>
<tr>
<th>Surface Prep.</th>
<th>Paint Material</th>
<th>Min. Coats, Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>In accordance with Paragraph Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation</td>
<td>Epoxy Primer—Other</td>
<td>As recommended by coating manufacturer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remaining coats as required for exposure</td>
</tr>
</tbody>
</table>

1. Use on galvanized surfaces requiring painting.
2. After application of System No. 10, apply finish coats as required for System No. 4.

E. System No. 21 Skid-Resistant—Concrete:

<table>
<thead>
<tr>
<th>Surface Prep.</th>
<th>Paint Material</th>
<th>Min. Coats, Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>In accordance with Paragraph Concrete Surface Preparation</td>
<td>Epoxy Nonskid (Aggregated)</td>
<td>2 coats, 160 SFPGPC</td>
</tr>
</tbody>
</table>

1. Use on concrete floors as scheduled.
F. System No. 22 Chemical-Resistant Wall, Heavy-Duty—Masonry:

<table>
<thead>
<tr>
<th>Surface Prep.</th>
<th>Paint Material</th>
<th>Min. Coats, Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>In accordance with Paragraph Masonry Surface Preparation</td>
<td>Epoxy Filler/Surfacer</td>
<td>1 coat as required to fill voids and smooth surface; apply to 100 percent of surface</td>
</tr>
<tr>
<td></td>
<td>High Build Epoxy</td>
<td>1 coat, 160 SFPG</td>
</tr>
<tr>
<td></td>
<td>High Build Epoxy, Gloss</td>
<td>1 coat, 160 SFPG</td>
</tr>
</tbody>
</table>

1. Use on concrete masonry unit walls as scheduled.

G. System No. 27 Aluminum and Dissimilar Metal Insulation:

<table>
<thead>
<tr>
<th>Surface Prep.</th>
<th>Paint Material</th>
<th>Min. Coats, Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solvent Clean (SP 1)</td>
<td>Prime in accordance with manufacturer’s recommendations</td>
<td>1 coat, 10 MDFT</td>
</tr>
<tr>
<td></td>
<td>Bituminous Paint</td>
<td></td>
</tr>
</tbody>
</table>

1. Use on aluminum surfaces embedded or in contact with concrete and for dissimilar metal insulation.

3.07 COLORS

A. Provide as designated herein and as selected by Owner or Engineer.

B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.

C. Equipment Colors:

1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.

2. Paint nonsubmerged portions of equipment the same color as the piping it serves, except as itemized below:
   a. Dangerous Parts of Equipment and Machinery: OSHA Orange.
   c. Radiation Hazards: OSHA Purple.
d. Physical hazards in normal operating area and energy lockout devices, including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.

3.08 FIELD QUALITY CONTROL

A. Testing:

1. Thickness and Continuity Testing:
   a. Measure coating thickness specified in mils with a magnetic type, dry film thickness gauge, in accordance with SSPC PA 2. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.
   b. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low voltage wet sponge electrical holiday detector in accordance with NACE SP0188.
   c. Holiday detect coatings in excess of 20 mils dry with high voltage spark tester as recommended by coating manufacturer and in accordance with NACE SP0188.
   d. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Engineer.

B. Inspection: Leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.

C. Unsatisfactory Application:

1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
3. Repair defects in accordance with written recommendations of coating manufacturer.

D. Damaged Coatings, Pinholes, and Holidays:

1. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
2. Remove rust and contaminants from metal surface. Provide surface cleanliness and profile in accordance with surface preparation requirements for specified paint system.
3. Feather edges and repair in accordance with recommendations of paint manufacturer.
4. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

3.09 MANUFACTURER’S SERVICES

A. In accordance with Section 01 43 33, Manufacturers’ Field Services, coating manufacturer’s representative shall be present at Site as follows:
   1. On first day of application of any coating system.
   2. A minimum of two additional Site inspection visits, each for a minimum of 4 hours, in order to provide Manufacturer’s Certificate of Proper Installation.
   3. As required to resolve field problems attributable to or associated with manufacturer’s product.
   4. To verify full cure of coating prior to coated surfaces being placed into immersion service.

3.10 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.
B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.
C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

3.11 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification:
   1. Paint System Data Sheet (PSDS).
   2. Paint Product Data Sheet (PPDS).

END OF SECTION
Complete this PSDS for each coating system, include all components of the system (surface preparation, primer, intermediate coats, and finish coats). Include all components of a given coating system on a single PSDS.

<table>
<thead>
<tr>
<th>Paint System Number (from Spec.):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paint System Title (from Spec.):</td>
</tr>
<tr>
<td>Coating Supplier:</td>
</tr>
<tr>
<td>Representative:</td>
</tr>
</tbody>
</table>

### Surface Preparation:

<table>
<thead>
<tr>
<th>Paint Material (Generic)</th>
<th>Product Name/Number (Proprietary)</th>
<th>Min. Coats, Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PAINT PRODUCT DATA SHEET (PPDS)

Complete and attach manufacturer’s Technical Data Sheet to this PPDS for each product submitted. Provide manufacturer’s recommendations for the following parameters at temperature (F)/relative humidity:

<table>
<thead>
<tr>
<th>Temperature/RH</th>
<th>50/50</th>
<th>70/30</th>
<th>90/25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Induction Time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pot Life</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shelf Life</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drying Time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curing Time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min. Recoat Time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. Recoat Time</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Provide manufacturer’s recommendations for the following:

- Mixing Ratio: _____
- Maximum Permissible Thinning: _____
- Ambient Temperature Limitations: min.: ___ max.: _____
- Surface Temperature Limitations: min.: ___ max.: _____
- Surface Profile Requirements: min.: ___ max.: _____
PART 1   GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:
   2. Occupational Safety and Health Act (OSHA).

1.02 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings:
      a. Drawings showing layouts, actual letter sizes and styles, and Project-specific mounting details.
      b. Manufacturer’s literature showing letter sizes and styles, sign materials, and standard mounting details.
   2. Anchorage and bracing data sheets and drawings as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:
   1. Manufacturer’s installation instructions.
   2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

PART 2   PRODUCTS

2.01 SIGN TYPES

A. Metal Sign (Type B):
   1. Material: Baked enamel finished 18-gauge (minimum) aluminum signs.
   2. Manufacturers:
      a. Seton Identification Products.
      b. Nutheme Illustrated Safety Co.
2.02 IDENTIFICATION LABELS

A. Pipe Labels:
   1. Snap-on, reversible type with lettering and directional arrows, sized for outside diameter of pipe and insulation.
   2. Provided with ties or straps for pipes of 6 inches and over diameter.
   3. Designed to firmly grip pipe so labels remain fixed in vertical pipe runs.
   4. Material: Heavy-duty vinyl or polyester, suitable for exterior use, long lasting, and resistance to moisture, grease, and oils.
   5. Letters and Arrows: Contrasting Black or White background.
   7. Message: Piping system name as indicated on Piping Schedule.
   8. Manufacturers and Products:
      b. Seton Identification Products; Ultra-mark Pipe Markers.

B. Equipment Labels:
   1. Applies to equipment with assigned tag numbers, where specified.
   3. Background: Black.
   4. Materials: Aluminum or stainless steel with a baked-on finish suitable for use on wet, oily, exposed, abrasive, and corrosive areas.
   5. Furnish 1-inch margin with holes at each end of label, for mounting. On fiberglass labels, furnish grommets at each hole.
   6. Size:
      a. 2 inches minimum and 3 inches maximum high, by 14 inches minimum and 18 inches maximum long.
      b. Furnish same size base dimensions for all labels.
   7. Message: Equipment names and tag numbers as used in sections where equipment is specified.
   8. Manufacturers:
      a. Brady Signmark.
      b. Seton Identification Products.

2.03 ANCILLARY MATERIALS

A. Fasteners: Stainless steel screws or bolts of appropriate sizes.
PART 3       EXECUTION

3.01 INSTALLATION—GENERAL

   A. In accordance with manufacturer’s recommendations.

   B. Mount securely, plumb, and level.

3.02 SIGNS

   A. General:

      1. Fasten to walls or posts, or hang as scheduled.
      2. Anchor in place for easy removal and reinstallation with ordinary hand tools.

   B. Information and Safety Signs:

      1. Install facing traffic. Locate for high visibility with minimum restriction of working area around walkways and equipment.
      2. Install as scheduled.

3.03 IDENTIFICATION LABELS

   A. Pipe Labels:

      1. Locate at connections to equipment, valves, or branching fittings at wall boundaries.
      2. At intervals along piping not greater than 18 feet on center with at least one label applied to each exposed horizontal and vertical run of pipe.
      3. At exposed piping not normally in view, such as above suspended ceilings and in closets and cabinets.
      4. Supplementary Labels: Provide to Owner those listed on Piping Schedule that do not receive arrows.
      5. Apply to pipe after painting in vicinity is complete, or as approved by Engineer.
      6. Install in accordance with manufacturer’s instructions.

   B. Equipment Labels:

      1. Locate and install on equipment or concrete equipment base.
      2. Anchor to equipment or base for easy removal and replacement with ordinary hand tools.
3.04 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this Specification.

1. Sign Schedule: Tabulation of characteristics and mounting information for informational and safety signs numbered on Drawings. Provide items as scheduled. Meet requirements of Occupational Safety and Health Act (OSHA).

END OF SECTION
### SIGN SCHEDULE

<table>
<thead>
<tr>
<th>Sign Type</th>
<th>Number</th>
<th>Detail Reference</th>
<th>Size</th>
<th>Width</th>
<th>Height to Top</th>
<th>Color</th>
<th>Method</th>
<th>Mounting</th>
<th>Lettering</th>
<th>Message</th>
<th>Height Style</th>
<th>Other Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>C-1</td>
<td>13</td>
<td>20&quot;</td>
<td>14&quot;</td>
<td>5'-6&quot;</td>
<td>1&quot;</td>
<td>Helvetica Black</td>
<td>Wall Screws or Bolts</td>
<td>1</td>
<td>CAUTION: EQUIPMENT STARTS AUTOMATICALLY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D-1</td>
<td>C</td>
<td>12</td>
<td>20&quot;</td>
<td>14&quot;</td>
<td>5'-6&quot;</td>
<td>1&quot;</td>
<td>Helvetica Black</td>
<td>Door Screws</td>
<td>1</td>
<td>DANGER: HIGH VOLTAGE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D-2</td>
<td>C</td>
<td>12</td>
<td>20&quot;</td>
<td>14&quot;</td>
<td>5'-6&quot;</td>
<td>1&quot;</td>
<td>Helvetica Black</td>
<td>Hatch Screws or Bolts</td>
<td>1</td>
<td>DANGER: CONFINED SPACE AUTHORIZED EMPLOYEES ONLY</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
1. Numbers refer to a particular sign type with a particular message.
2. Letters refer to Sign Types specified in this section.
3. Numbers refer to Architectural Details that show sign layout.
4. Verify requirements for this sign with Regulations to state where Project is located.
SECTION 10 44 00
FIRE PROTECTION SPECIALTIES AND SAFETY EQUIPMENT

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

3. Occupational Safety and Health Administration (OSHA).

1.02 PERFORMANCE REQUIREMENTS

A. Conform to NFPA 10 and 2015 International Building Code as modified by the Oklahoma Uniform Building Code Commission Rules and as supplemented by these Specifications.

B. Provide extinguishers classified and labeled by UL purpose specified and indicated.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Fire Extinguishers: Manufacturer’s product data for each item, including sizes, ratings, UL listings, or other certifications, and mounting information.
   b. Product Data: Extinguisher operational features, color and finish, and anchorage details.

B. Informational Submittals:

1. Manufacturer’s Installation Instructions.
2. Manufacturer’s Certificate: Certify products meet or exceed specified requirements.
3. Operation and Maintenance Data: Submit test, refill or recharge schedules and recertification requirements.
1.04 ENVIRONMENTAL REQUIREMENTS

A. Section 01 61 00, Common Product Requirements: Environmental conditions affecting products onsite.

B. Do not install extinguishers when ambient temperatures are capable of freezing extinguisher ingredients.

PART 2 PRODUCTS

2.01 PORTABLE FIRE EXTINGUISHERS

A. Manufacturers:

1. JL Industries.
2. Larsen’s Manufacturing Co.
3. Nystrom Products Co.
4. Potter Roemer.

B. General:

1. Conform to NFPA 10 for fire extinguishers.
2. Furnish fire extinguishers and cabinets from one manufacturer.
3. UL listed, charged and ready for service.

C. Multipurpose Hand Extinguisher (F.EXT-1):

1. Tri-class dry chemical extinguishing agent.
2. Pressurized, redenameled steel shell cylinder.
3. Activated by top squeeze handle.
4. Agent propelled through hose or opening at top of unit.
5. For use on A, B, and C class fires.

D. Clean Agent Hand Extinguisher (F.EXT-2):

1. Clean agent with nonozone depleting potential extinguishant.
2. Pressurized, redenameled steel shell cylinder.
3. Activated by top squeeze handle.
4. Colorless, odorless, electrically non-conductive clean agent which discharges as a liquid and flashes to a gas.
5. Environmentally friendly, with zero ozone depletion potential, containing no chlorofluorocarbons, hydrochlorofluorocarbons, or halon.
6. For use on Class A, B, or C fires.
2.02 FIRST-AID CABINETS AND SUPPLIES

A. Manufacturers:
   1. Afassco, Inc.
   2. Johnson & Johnson.
   3. Zee Medical Products Co., Inc.

B. Cases:
   1. Enameled metal or break-resistant plastic.
   2. Carrying handles.
   3. Made to hang on wall.

C. Supplies:
   1. ANSI Z308.1, Class A first-aid kit includes the following minimum items:
      a. 16 - Adhesive bandages, 1-inch by 3-inch.
      b. 1 - Adhesive tape, 2.5 yards.
      c. 10 - Antibiotic treatment applications, 1/57 ounce.
      d. 10 - Antiseptic applications, 1/57 ounce.
      e. 1 - Breathing barrier.
      f. 1 - Burn dressing, gel-soaked, 4-inch by 4-inch.
      g. 10 - Burn treatments, 1/32 ounce.
      h. 1 - Cold pack.
      i. 2 - Eye coverings.
      j. 1 - Eye wash, 1 ounce.
      k. 1 - First-aid guide.
      l. 6 - Hand sanitizers, 0.9 g.
      m. 2 - Pair exam gloves.
      n. 1 - Roller bandage, 2-inch by 4 yards.
      o. 1 - Scissors.
      p. 2 - Sterile pads, 3-inch by 3-inch.
      q. 2 - Trauma pads, 5-inch by 9-inch.
      r. 1 - Triangular bandage, 40-inch by 40-inch by 56-inch.

2.03 ACCESSORIES

A. Extinguisher Brackets: For hand extinguishers, furnish heavy-duty brackets with clip-together strap for wall mounting.

B. Fire Extinguisher Signage: Provide wall mounted 2-sided aluminum fire extinguisher sign with pictogram and label above each fire extinguisher, minimum 9 inches by 7 inches.
C. Graphic Identification: Provide graphic identification marking for each fire extinguisher type. OSHA approved pictorial markings to indicate the extinguisher uses and nonuses on a single label.

D. Fasteners: Furnish necessary screws, bolts, brackets, and other fastenings of suitable type and size to secure items of fire and safety equipment in position.
   1. Metal expansion shields for machine screws at concrete and masonry.
   2. Stainless steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install where indicated or directed and in accordance with manufacturer’s recommendations.

B. Secure cabinets and brackets rigidly to structure.

C. Provide adequate backing for mounting surfaces.

D. Place extinguishers on wall brackets.

E. Position fire extinguisher signs above fire extinguishers.

3.02 PORTABLE FIRE EXTINGUISHERS AND CABINETS

A. Provide at locations shown or as directed by Engineer or Owner.

B. Mount hangers securely in position, following manufacturer’s recommendations.

C. Top of Extinguisher: No more than 54 inches above floor.

END OF SECTION
PART 1 GENERAL

1.01 SCOPE OF WORK

A. General: There shall be designed, furnished and installed adjustable WaveShapers and Gates (Wave Shapers) to adjust and control the shape of waves in the waterway. These shall collectively be referred to as Gates. The equipment shall include plates, hinges, actuators, valves and seals as schematically shown on Drawings. Hydraulic cylinders to move the various panels of the gates are referred to as “actuators.”

B. Related Work:

1. Division 03, Concrete.
2. Division 05, Metals.
3. Division 09, Finishes.
4. Division 11, Equipment.
5. Division 31, Earthwork.

1.02 SUPPLIER

A. The equipment specified in this Section shall be as designed and supplied by Obermeyer Hydro, Inc., telephone: (970) 568-9844. The Supplier shall have previously designed, manufactured, and supplied equipment similar in function and size and have at least 15 years’ experience. All reinforced rubber components shall be fabricated in the Supplier’s own facilities. Substitute equipment, if allowed, must be modified as necessary to provide the specified Gates and to meet the specified operating conditions. The Supplier shall have expertise in the hydraulics of flow that impacts the Gates.

1.03 QUALITY ASSURANCE

A. References: Reference in this Section of a Standard, such as ASTM, AWWA, or ACI, is to be interpreted to be the latest revision of that Standard.

B. Industry Standards and Specifications:

1. American Society for Testing and Materials:
   b. A36/A36M: Structural Steel.
c. A53: Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
e. A153: Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
g. F593: Stainless Steel Bolts, Hex Cap Screws, and Studs.
h. A536: Ductile Iron Castings.
i. D751: Cated Fabrics, Test Method.
j. D1149: Rubber Deterioration – Surface Ozone Cracking in a Chamber (Flat Specimens), Test Method.


4. Obermeyer Hydro, Inc.: The Gates and controls shall meet the requirements of Obermeyer Hydro, Inc.

1.04 SUBMITTALS

A. Submit the following in accordance with requirements presented in Section 01 33 00, Submittal Procedures:

1. Final design drawings, computations and engineering analysis of Gates prior to commencement of Shop Drawings, fabrication submittals and fabrication of Gates. Design Loads, including dead loads, safety factors, etc. are to be included. Drawings computations and engineering analysis are to be sealed by a licensed Professional Engineer. Shop drawings detailing connections, fabrication details, all final dimensions, clearances, tolerances, finishes, etc.


3. Handling and storage plan and requirements, prior to delivery of Gates, and any components to the project site. Written instructions from manufacturer will be provided.

4. Work plan and schedule for construction, including foundation work, anchors, concrete forming and steel placement, placement of embeds and anchors, hydraulic lines and sensing piping, special concrete work to fill areas of difficult placement, concrete finishing and placement, testing of anchor bolts, work area plan for placement, detailed sequential steps of placement, equipment for placement, controls and sensing line installation, and all testing procedures.
5. Specific minimum tolerances required by manufacturer for construction of reinforced concrete, painting, torque for anchor bolts and fasteners, pressures, deadbands, dimensions and related construction. Manufacturer’s requirements do not supersede other more strict requirements elsewhere in these specifications and as shown on Drawings.

6. Written instructions regarding concrete embedded anchor system hardware, to include tolerances, 30 days prior to anticipated delivery of the concrete embedded anchor system hardware.

7. Installation Inspection Report by Supplier: This report shall include report from on-site inspection by Supplier. Inspections will be periodic as required for installation of critical components or at critical times. At least one inspection report approving installation of each Gate prior to running water over the Gate during the construction dewatering phase. The Engineer shall be informed of the date for each inspection at least 2 weeks prior to all onsite inspections by the Supplier.

8. Leakage Test Records prior to final inspection by Engineer.


1.05 JOB CONDITIONS

A. The Supplier shall provide a 5-year warranty on the Gates commencing at final acceptance of the Work.

1.06 DESIGN

A. The shape, overall dimensions, and range of motions of Gates are as specified on Drawings. The Lips of the WaveShaper shall be adjusted manually (from manually actuated valves in the control vault) to form the desired hydraulic jump formation.

1.07 GATE DESCRIPTION

A. Gates shall consist of composite panels with elastomeric hinges anchored to concrete and elastomeric hinges between composite panels where shown on Drawings. Actuators shall include hydraulic cylinders mounted between the hinged gate panels and the concrete foundation. Actuators for the WaveShaper shall be hydraulic cylinders unless another system meeting the requirements of this specification is accepted by the Engineer. The elastomeric hinges shall allow the Gates to operate through a range from fully raised to fully lowered and as otherwise shown on Drawings.
1.08 HYDRAULIC LOADING

A. The Gates, including attachments hinges, bearings, and connectors, shall be analyzed and designed using the loadings and considerations shown in the figures below and as described herein. The moveable Gates shall be designed to move within the limits as shown on Drawings with water flowing in the waterway. The general shape of Gates is shown schematically, and the overall dimensions and shape shall not be changed significantly.

B. The WaveShaper gate will be in a rapidly varying flow regime (transition from super critical to sub critical flow) at a hydraulic jump. Depending on the hydraulic jump formation the gate will experience downward or upward (uplift) loading. The WaveShaper gate and system components (including actuators) shall be designed to withstand the loads shown in the table below. Loads shown do not include dead loads, and do not include a safety factor. Supplier shall assign an appropriate safety factor based on their experience with similar systems.

<table>
<thead>
<tr>
<th>Gate</th>
<th>Gate Loading Type</th>
<th>Live Load (lbf/ft^2)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrance Gate – Crest Gate</td>
<td>Downward Hydraulic Loading</td>
<td>94</td>
<td>No Safety Factor Applied</td>
</tr>
<tr>
<td>Entrance Gate – WS Gate</td>
<td>Upward Hydraulic Loading (Uplift)</td>
<td>97</td>
<td>No Safety Factor Applied</td>
</tr>
<tr>
<td></td>
<td>Downward Hydraulic Loading</td>
<td>154</td>
<td>No Safety Factor Applied</td>
</tr>
<tr>
<td>Drop 3</td>
<td>Upward Hydraulic Loading (Uplift)</td>
<td>106</td>
<td>No Safety Factor Applied</td>
</tr>
<tr>
<td></td>
<td>Downward Hydraulic Loading</td>
<td>168</td>
<td>No Safety Factor Applied</td>
</tr>
<tr>
<td>Drop 4</td>
<td>Upward Hydraulic Loading (Uplift)</td>
<td>118</td>
<td>No Safety Factor Applied</td>
</tr>
<tr>
<td></td>
<td>Downward Hydraulic Loading</td>
<td>149</td>
<td>No Safety Factor Applied</td>
</tr>
</tbody>
</table>
1.09 OTHER LOADING

A. The Gate supplier shall evaluate and include in the design other loads on the system, including momentum, impact, shear, dead loads, and others identified by supplier based on experience with similar systems.

1.10 UNEQUAL CYLINDER LOADING

A. The Gates, including the frame, panels, cylinders, connections, pivots, and attachments, shall be designed so as to accommodate an unequal loading of any individual cylinder of 50 percent of its maximum design loading without excessive deflection or stresses of the Gate, including the frame, connections, supports, pivots, clevises, etc.

PART 2 MATERIALS

2.01 GATE MANUFACTURER SUPPLIED COMPONENTS

A. The Gates and all necessary ancillary components required to allow successful operation of the Gates shall be provided by Obermeyer Hydro, Inc. of Fort Collins, Colorado. Equipment to be so provided includes the following:

1. Final design drawings and calculations, shop drawings, computer modeling (if conducted) results and engineering analysis of gate system forces prior to commencement of fabrication of the gate.
2. Steel gate panels and associated piping attachments.
4. Seals with attachment hardware.
5. Gate clamping hardware with anchor bolts, nuts, and washers.
6. Hydraulic system controls including hydraulic pump and reservoir, all valves and control components.
7. The hydraulic cylinders including all bearings, attachments, pivots, hoses that attach to the stainless steel hydraulic lines, attachment fittings, clevises, etc.
8. Tilt gauges (inclinometers) with LCD output display.

2.02 STEEL COMPONENTS

A. Hinge retainers, splitters, and restraining strap clamps will be manufactured from ASTM A572, Grade 50 steel, or approved equal.

1. Other non-structural components to be manufactured from ASTM A36 steel, or approved equal.
2. All threaded fasteners, including anchor bolts and attachment hardware, shall be Type 304 stainless steel, or approved equal. (Except that hardware, connectors, etc. related to hydraulic cylinders shall be Type 316 stainless steel.) Anchor bolt allowable shear and tension stresses for attachment to concrete shall not exceed that recommended by the anchor bolt manufacturer.

3. Stainless steel plates and other stainless items shall be from Type 316 stainless steel, 3CR12 stainless steel, or approved equal.

4. All steel components to be designed so that the maximum stress level in each component is less than 40 percent of yield strength and less than 25 percent of ultimate strength.

5. All attachment hardware shall not protrude above adjacent surfaces. All bolts on exposed faces of steel gates shall be countersunk flush to surface.

2.03 EDGES AND GAPS

A. Exposed edges on gates shall have a minimum radius of 2 inches as shown on Drawings. All other exposed edges on all panels, hinge attachments, steel, etc., shall be rounded to no less than 1/4 of an inch. Edges of panels and hinges shall have no gaps between gate panels/frames and concrete walls greater than 1/4 of an inch. All gaps between gate panels and concrete walls shall be filled with rubber securely attached to the frame so as to prevent fingers or lose articles of clothes from becoming entrapped.

2.04 TILT GAUGES

A. Tilt gauges shall be accurate to at least 0.5 degree, be reliable and suitable for river conditions and be as supplied by Obermeyer Hydro, Inc. Gauges shall be mounted so as to facilitate maintenance and replacement.

B. Tilt gauges (a total of three) shall be installed on:

1. Three gate panels to provide feedback signal to display the angle/slope in the upstream to downstream orientation of the panel to the operator.

2.05 HYDRAULIC CYLINDERS AND ATTACHMENTS

A. Cylinders shall be double acting and designed to support the entire design hydraulic load and dead loads. The Cylinders and all hardware shall be designed for submerged conditions and for vegetable oil based hydraulic fluid. Cylinders shall have a stainless steel body. The cylinders shall have an operating pressure of at least 3,000 psi. All bolts, rods, clevises, rod eyes, pivoting hardware, and all other hardware shall be Type 316 stainless steel. Seals shall be designed for vegetable oil operation and submerged conditions. Cylinder supports, pivots, clevises, etc shall be designed to allow for
inaccuracies in construction, unequal loadings, etc. so as to not put any non-axial loading or moment on the hydraulic cylinders. Cylinders shall be provided with a 4-year manufacturer’s warranty.

2.06 WAVE SHAPER HYDRAULIC SYSTEM

A. The hydraulic system supplying and controlling the hydraulic cylinders of the WaveShaper Gates shall provide smooth, reliable, and efficient operations of the WaveShaper Gates. The hydraulic system shall be designed so that there is not a loss of hydraulic pressure over time and that the cylinders and the gate panels stay in-place when the system is turned off or unattended.

1. Hydraulic Fluid: The hydraulic system will be supplied and all components designed to operate with vegetable base hydraulic fluid. Hydraulic fluid shall be readily and totally biodegradable, maintain low viscosity at minus 20 degrees F, and be stable for a period longer than 25 years. Base fluid shall be canola (rapeseed) oil as manufactured by Hydro Safe® Oil Division, Inc., or approved equal. The grade shall be as determined for the application. Ten gallons of additional fluid for future use shall be supplied.

2. Hydraulic Line: Hydraulic Line (tubing) shall be 3/8-inch diameter Type 316 stainless steel with a minimum wall thickness of 0.049 inch and a maximum working pressure of greater than 3,000 psi. Fittings shall be stainless steel with equivalent or greater strength than the tubing. Hydraulic hoses shall be rated for a working pressure of 3,000 psi and be attached with stainless steel quick connects and stainless steel fittings, or approved equal. Hose and fittings shall be approved for Marine Applications (SAEJ1942), and shall be Global M3K Mega3000® Hose – SAE 100R17, or approved equal. Where routed under lip plates, tubing shall be fastened to the gate support slab at no greater than 4 feet intervals with stainless steel straps.

3. Hydraulic Control Valves: Valves shall be the directional control type with a single lever operator per gate. Valves shall operate such that in one position the gates raise, in the other position the gates are lowered, and the hydraulic cylinders do not move when the valve is in the neutral position.

4. Valves: Ball and check valves shall be stainless steel.

5. Pressure Relief Valves (PRV) Valves: PRV valves in the hydraulic system of the Wave Shaper Gates shall release pressure so as not to allow over pressuring of any cylinder at any time. PRV valves shall be self-actuated safety valves designed to relieve excess upstream pressure from the line. The PRV valves shall be adjustable from 1,000 psi to 3,000 psi. The PRV valves shall be connected to a drain valve so that hydraulic fluid is released back to the hydraulic pump reservoir.
6. Hydraulic Pump: The Contractor shall supply a hydraulic pump capable of operating the hydraulic cylinders required to operate the WaveShapers. The pump single speed with a minimum reservoir capacity equal to at least 1.5 times the difference between the volume of hydraulic fluid between all cylinders up and all cylinders down. It shall have an operating pressure of 3,000 psi. The pump shall be capable of lifting lip panels at full range within 5 minutes. The pump shall have a pressure regulating valve to adjust the maximum operating outlet pressure from 1,000 psi to 3,000 psi. The pump shall be designed to work with vegetable based hydraulic fluid.

7. Hydraulic Valves and Manifold: The hydraulic valves and manifold shall be neatly arranged into a well and uniform layout control panel. The valves shall be labeled as to each cylinder that they control.

2.07 WAVESHAPER RACKS

A. The WaveShaper racks shall be of the bar screen style, having a 6-inch or less clear opening between 1/4-inch minimum thicknesses steel bars and solid sides.

1. The clearance between the bottom portion of the frame and foundation surface shall be from 4 inches to 6 inches.
2. The bar racks shall be designed to allow the Gates to be rotated up to allow access during maintenance.

2.08 REMOVEABLE ACCESS PLATES

A. A total of four steel removable access plates and all attachment hardware, as shown on Drawings, shall be supplied with the Gates. These shall allow access to hydraulic cylinders and have adequate clearances to allow access below the gate for a 6-inch diameter hose for removal of sediment/debris.

2.09 HINGES

A. The hinges shall be reinforced elastomeric type. Hinges and attachment hardware shall be flush or slightly recessed below the concrete foundation upstream of the hinge.

2.10 FINISHES

A. See Section 09 90 00, Painting and Coating, for all steel members other than fasteners, and stainless steel components.
2.11 TESTING RECORDS

A. Submit written certificate attesting to product compliance with physical material requirements of this Section prior to installation of the Gates and any related equipment.

PART 3 EXECUTION

3.01 PIPING, FOUNDATION SLAB AND WALL GENERAL REQUIREMENTS

A. The Contractor shall store, protect, and install all manufacturer provided components listed in Part 2 of this Section.

B. The Contractor shall prepare the foundations for the Gates, including all anchors and embedments.

C. The Contractor shall furnish and install all auxiliary components necessary to make a complete and operational Gate. Neversieze, or other approved lubricating compound, shall be used for all stainless steel anchor bolts and fasteners, 100 percent polyurethane caulk for all interpanel seals, and condensate piping.

D. The reinforcing steel and embeds will be placed in the foundation slab, with careful placement to achieve pull out capacity requirements of anchors as specified by the gate manufacturer and structural engineering requirements. Care will be taken such that complete concrete penetration under and around embeds is achieved.

E. A steel trowel finish will be used on the base slabs below and downstream of the gates. Any rough points, edges or other defects will be ground smooth and as directed.

F. The foundation walls will be placed with a tolerance of plus or minus 1/8-inch of the designated vertical plane, with no edges, form ridges or other defects.

G. Embedment plates or other provisions to provide a uniform and low-friction surface may be required at the foundation walls adjacent to the moveable panels of the WaveShapers and Flashboards. These surfaces will be in contact with the Article Reinforced Rubber Spacer (see below).

H. Reinforced Rubber Spacer shall be provided to fill the gap between all WaveShaper panels and the concrete foundation walls. The design and detailing of this Reinforced Rubber Spacer shall prevent the formation of gaps during operations and shall provide for the longest practical life without maintenance. Smallest practical gaps and rubber spacers shall be used.
I. All embeds will be cleaned, threads cleaned, and bolts temporarily placed to determine that threads are clean and in good condition. Torque test pull-out resistance as directed.

J. Hydraulic piping shall be run in conduit or in covered raceway as shown on Drawings. Conduits shall have long-radius bends and pull boxes at bends to facilitate pulling hydraulic piping lines through the conduit. Outside of conduits all lines shall be securely fastened with stainless steel connectors to prevent vibration and to uniformly support the hydraulic piping. Connectors from the hydraulic piping to the hoses shall be mounted with stainless steel bulkheads and bulkhead fittings so as to prevent movement of the hydraulic piping. Bulkheads shall be at least 4-inch square and 1/4-inch thick.

3.02 INSTALLATION

A. General Requirements:

1. Installation Plan and Facilities: The contractor will develop an installation plan describing site storage and work areas, equipment needs, and other details in consultation with the Gate manufacturer so that the Gates and controls can be installed, tested, and operated.

2. Installation: The Gates will be installed to achieve the requirements of the plans and specifications, and as directed by the manufacturer. All materials and surfaces will be protected against damage. The sequence of construction will be as directed by the Gates manufacturer's technical advisor and to achieve the gate operational characteristics.

3. Testing: The equipment, bladders, panels, hinges, and controls will be tested in advance and during initial operation. Thereafter, any defects repaired as directed.

B. Manufacturer’s Technical Advisor and Engineer’s Representative:

1. General: The manufacturer shall provide a factory-trained technical advisor to oversee installation of the Gates, startup and testing of the operating equipment, and to instruct operating personnel. A representative of the Engineer will attend all meetings and installations as may be designated.

2. Pre-installation Meeting: A pre-installation meeting to be attended by the manufacturer's technical advisor, District, Engineer, and Contractor personnel will be held within 2 weeks prior to the scheduled installation of any Gate or gate component. The technical advisor shall provide the attendees with information regarding the proper procedures for installing the Gates and related equipment.
3. Pre-installation Inspection: The manufacturer's technical advisor and Engineer shall inspect the concrete foundation with anchoring system hardware and reinforcing steel prior to placement of concrete. The engineer and manufacture shall receive 10 days advance notice of the scheduled concrete placement.

4. The installation of the hydraulic cylinders and gate panels, including preparatory work, shall be done with the Gate manufacture’s technical advisor at the site. The engineer and the manufacture will receive 10 days advance notice of scheduled installation. The technical advisor shall notify the Engineer as soon as possible of any discrepancies discovered in the work which may hinder successful installation of the Gates.

5. Final Testing: The installed systems shall be leak tested, as specified elsewhere, for leakage by the Contractor with the assistance of the gate manufacturer's technical advisor.

6. Final Inspection: A final inspection of the Gate installation and related equipment will be performed by the Engineer with the assistance of the gate manufacturer's technical advisor in conjunction with the final testing.

C. Testing:

1. General:
   a. The Contractor shall be responsible for conducting testing of the installed system. Tests shall be conducted in the presence of the Engineer and the manufacturer's technical advisor.
   b. All hydraulic lines shall be tested and accepted before installation of the Gates commences.
   c. Hydraulic lines and hoses shall be tested by pressurizing to 3,000 psi. Pressure readings and ambient air temperature shall be recorded at six different times during each test. Any joints or fittings exhibiting leakage during this time shall be repaired or replaced.
   d. After installation of the system the Gates shall be fully raised and lowered three times. The Gates shall operate smoothly with no binding. WaveShaper gates shall be tested an additional three times, each time varying the position of the each lip throughout the range of operation.
   e. After installation of the Gates with hydraulic cylinders, the hydraulic system shall be isolated from the pump system and held at a pressure of 3,000 psi for 24 hours. All hydraulic lines and hoses shall have no drop in pressure over a 24-hour period.
2. Reporting: The manufacturer’s technical advisor shall prepare a written report of all tests. The report shall be attached to an Installation Acceptance, which shall be submitted within 2 weeks of the end of the testing period.

3. Adjustments: During the Starting of Systems (Tuning) Phase, the Gates shall be adjusted and tested as Directed by Engineer to verify a fully functioning system in the active flow condition.

4. Warranty: A written warranty with terms and conditions specified herein shall be submitted within 2 weeks following the final inspection. All equipment shall be warranted to be free from defects for a minimum period of 5 years from the date of final acceptance of the Work of this Contract.

END OF SECTION
SECTION 22 47 13
DRINKING FOUNTAINS, YARD HYDRANTS, AND SHOWERS

PART 1     GENERAL

1.01 RELATED DOCUMENTS

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

B. Examine all Drawings and other sections of the specifications for requirements therein affecting the work of this trade.

1.02 SUMMARY

A. Work of this Section includes all labor, materials, equipment, and drinking fountain units and related components of water utility services necessary to supply, deliver to the site and install drinking fountain and yard hydrant elements as shown on the Contract Drawings and/or specified herein, including, but not limited to, the following:

1. Drinking fountain.
2. Yard hydrant.
3. Shower column.
4. Include valves, valve boxes, access boxes, branch piping, fittings, etc. to complete work indicated.

B. The following Items of related work are specified and included in other Sections of the Specifications:

1. Section 03 30 00, Cast-in-Place Concrete.
2. Section 31 23 16, Excavation.
3. Section 31 23 23, Fill and Backfill.
4. Section 32 13 13, Concrete Paving.
5. Section 32 13 13.13, Exposed Aggregate Concrete Paving.
6. Division 33, Utilities Sections as appropriate.
7. All utility construction work shall be performed in accordance with:
   a. Oklahoma Department of Transportation (ODOT), 2009 Standard Specifications for Highway Construction.
   c. Civil Special Specifications and Special Provisions.
1.03 SUBMITTALS

A. General: Refer to and comply with Section 01 33 00, Submittal Procedures, for procedures and additional submittal criteria.

B. Product Data: Submit manufacturer’s technical product data, including specifications and installation instructions for each type drinking fountain required and related component items. Manufacturer’s specifications shall include finish type and application.

C. Samples for Verification: Submit representative sample of selected painted finish, minimum 6-inch square.

D. Contract Closeout Submittals:

1. Operation and Maintenance Data: Submit for the installed drinking fountain products.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with applicable requirements of FS WW-P-541, unless otherwise specified.


3. Materials and installations designated as handicapped accessible shall conform with the following:
   c. The Uniform Federal Accessibility Standards (UFAS), (Appendix A to 41 CFR Part 101-19.6).

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver drinking fountains with factory-applied end caps on pipes and/or tubes. Maintain end caps through shipping, storage, and handling to prevent pipe or tube end damage and to prevent entrance of dirt, debris, and moisture.
1.06 MAINTENANCE/EXTRA MATERIALS

A. Special Tools:

1. Deliver the following to Owner at location approved by Construction Manager:
   a. Tools for Vandal Resistant Fasteners, one tool for each different type and size of fastener clearly identified for intended purpose.

PART 2 PRODUCTS

2.01 DRINKING FOUNTAIN UNITS

A. Provide pedestal mounted drinking fountain units as indicated, with base, buried valve casing, and other components for complete installation.

1. General: Drinking fountains shown on Drawings are a Basis of Design product specified to be manufactured by Most Dependable Fountains, Inc., 5705 Commander Drive, Arlington TN 38002-0587, (Phone: (800) 552-6331, Fax: (901) 867-4008).
   a. Unit components shall be freeze resistant; include stainless steel receptor; stainless steel strainer; all exposed fittings chrome plated; jug filler faucet; bubbler; pushbutton operator, automatic stream regulator; valve box; and related components for underground connection to provide a complete system.
   b. Body: Satin (No. 4) finished Type 304 stainless steel, Schedule 10 or heavier; with rounded corners, anti-splash back, and receptor contoured to eliminate splashing and mounted to a 3/16-inch thick stainless steel pedestal and base.
   c. Features: Self-closing supply valve, automatic stream regulator, two stream mound building projector and removable brass strainer plate.
      1) All exposed brass trim polished and chrome plated.
      2) Front mounted pushbutton shall pneumatically activate water valve remotely mounted below frost line.
      3) Valve shall activate water flow through hooded bubbler having a nonsquirt feature.
      4) Internally mounted adjustable stream regulator shall control water flow.
      5) Integral drain strainer.
      6) Fasteners, Vandal Resistant Type: Provide drinking fountain units with Torx head with center pin vandal resistant fasteners.
7) Include, in addition to fountain manufacturer’s components, items of valve box cover, insulation, gravel drain, steel base plate with anchors, and other items as required for complete installation.

d. Drinking Fountain: Model 10150SMSS with Pet Fountain.

B. Drinking Fountain units shall comply with the following:

1. Water fountains shall be NSF 61 Section 9 Certified.

2.02 YARD HYDRANT UNITS

A. Provide nonpollutable, handle operated post hydrant units as indicated, with base, buried valve casing, and other components for complete installation.

1. General: Yard Hydrants as indicated on Drawings shall be Freeze Resistant Post Hydrant Model M-NP75 manufactured by Murdock Mfg., 15125 Proctor Avenue, City of Industry, CA 91746, (Phone: (800) 453-7465; Fax: (626) 855-4860) as a “Basis of Design.”
   a. Hydrant shall be ASSE 1057 certified as a potable hydrant. Hydrant shall not operate using venturi action. Hydrant shall have a flow rate of 2.5 gpm at 30 psi and serviceable from abovegrade.
   b. Unit components shall be freeze resistant; extend belowgrade level so that supply inlet, valve and reservoir are positioned below frost line. The water supply shall be protected against any surface or underground contamination.
   c. Stock, top, base and handle shall be fabricated of heavy, one-piece iron castings finished with a heavy grade of oil-based green enamel. Solid brass castings in nozzle and inner supply assembly shall conform to ASTM B61 and B62. Lead-free castings shall be used in all waterways.
   d. Nozzle shall be threaded for 3/4-inch hose connection and shall include an ASSE 1011 self-draining vacuum breaker.
   e. Include, in addition to fountain manufacturer’s components, items of valve box cover, insulation, gravel drain, steel base plate with anchors, and other items as required for complete installation.
2.03 SHOWER UNITS

A. Provide preplumbed column type exterior shower units as indicated, with base, buried valve casing, and other components for complete installation.

1. General: Showers shown on Drawings are a Basis of Design product specified to be manufactured by Britex, USA. 7336 Hinds Avenue, North Hollywood, CA 91605 (Phone: (818) 764-4145).
   a. Unit components shall be preplumbed, freeze resistant; including stainless steel components, all exposed fittings chrome plated; vandal resistant timed push button operator, automatic stream regulator; valve box; and related components for underground connection to provide a complete system.
   b. Body: Type 316 stainless steel, rounds post with integrated base plate for mounting.
   c. Features: Self-closing supply valve, automatic stream regulator, two stream mound building projector and removable brass strainer plate.
      1) All exposed brass trim polished and chrome plated.
      2) Surface mounted push-buttons shall pneumatically activate water valve remotely mounted below frost line.
      3) Fasteners, Vandal Resistant Type: Provide Shower units with Torx head with center pin vandal resistant fasteners.
      4) Include, in addition to shower manufacturer’s components, items of valve box cover, insulation, gravel drain, steel base plate with anchors, and other items as required for complete installation.

2. Shower: Model BSCR with two shower heads and one foot wash.

B. Shower units shall comply with ANSI A117.1-1992 and ADA frontal approach requirement.

2.04 ACCESSORY MATERIALS

A. Coarse Aggregate: As specified in Section 31 23 23, Fill and Backfill, as subsurface drainage fill material.

B. Valves and Valve Boxes: Refer to Drawings, Civil Special Specifications and Special Provisions and applicable City of Tulsa Standard Specifications.
PART 3    EXECUTION

3.01    INSTALLATION

A. Install the work of this Section in accordance with the drinking fountain manufacturer’s printed installation instructions.

B. Unless otherwise specified or indicated on Drawings, set inlet at such depth as to provide 4 feet 6 inches cover over pipe inlet.

C. Potable water system shall comply with the Safe Drinking Water Act Amendments and the 1988 Lead Contamination Control Act.

D. Install water-supply piping with shutoff valve in water supply to each drinking fountain. Use valve, valve box, and access box as indicated on Drawings or as specified. Comply with additional valve box installation requirements Standard Specifications, Special Specifications, and Special Provisions.

3.02    CLEANING, FLUSHING, AND ADJUSTMENT

A. Comply with requirements of the Standard Specifications, Special Specifications and Special Provisions.

B. After completing drinking fountain installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

C. Clean drinking fountains, showers and yard hydrants, on completion of installation, according to manufacturer’s written instructions.

D. Clean and polish fixture and trim.

E. Flush piping; clean strainers and traps.

F. Adjust units for proper function and water delivery.

END OF SECTION
SECTION 23 05 48
VIBRATION ISOLATION
FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

3. ASTM International (ASTM):
5. Vibration Isolation and Seismic Control Manufacturers Association (VISCMA).

1.02 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.
B. EPDM: Ethylene-Propylene-Diene Monomer.
C. OSHPD: Office of Statewide Health Planning and Development, for the State of California.
D. Withstand: Unit will remain in place without separation of any parts from the device when subjected to seismic forces specified.

1.03 DESIGN REQUIREMENTS

A. Seismic Control:

1. Provide seismic control as required to maintain integrity of mechanical piping, ductwork, and equipment installed in this Project, so they will “withstand” seismic forces.
2. Design shall comply with requirements of this specification, applicable codes, and requirements of Section 01 61 00, Common Product Requirements.
3. Design, size, and install for piping and equipment throughout facility, whether shown or not.
4. Designed by a registered professional engineer in the state where the Work is to be installed.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings, Vibration Isolators:
   a. Include, as a minimum, basic equipment layout, length and width, installed operating weights of equipment to be isolated and distribution of weight at isolation points.
   b. Product Data:
      1) Manufacturer’s product data including details of materials, construction, dimensions of individual components, installation details, and finishes.
      2) Schedule of vibration isolator type with location and static and dynamic load on each.
      3) Vibration Isolation Base Details:
         a) Detail fabrication, including anchorages and attachments to structure and to supported equipment.
         b) Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

2. Shop Drawings, Seismic Control Components:
   a. Include, as a minimum, basic equipment layout, length and width, installed operating weights of equipment to be isolated and distribution of weight at isolation points.
   b. Signed and sealed by a registered professional engineer registered in the state where the Project is located.
   c. Include, as a minimum, a tabulation of design data for each snubber, including specific anchorage details.
   d. Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
   e. Product Data:
      1) Manufacturer’s product data including details of materials, construction, dimensions of individual components, installation details, and finishes.
      2) Schedule of seismic control component type with location and static and dynamic load on each.
3) Interlocking Snubbers: Include load deflection curves up to 1/2-inch deflection in x, y, and z planes.

f. Anchorage and bracing data sheets and drawings as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Manufacturer’s Installation Instructions: Indicate special procedures and setting dimensions.

2. Certifications:
   a. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
   b. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.
   c. Welding Certificates: Welding procedures and personnel.
   d. Manufacturer’s Seismic Certification:
      1) Certification that specified equipment will withstand seismic forces. Include the following:
         a) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
         b) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
         c) Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

3. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

1.05 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Isolation materials, flexible connectors, and seismic restraints shall be same manufacturer. Select and certify using published or factory certified data.

C. Vibration isolation manufacturer shall be a member of the Vibration Isolation and Seismic Control Manufacturers Association (VISCMA).

D. Seismic Control:

1. Designer Qualifications:
   a. Professional engineer registered in state where Project resides.
   b. Minimum of 5 years’ work experience certifying seismic snubber and anchorage details.
2. Components shall bear anchorage preapproval “R” number, from agency acceptable to AHJ, showing maximum seismic restraint ratings.
3. Horizontal and vertical load testing and analysis shall be performed according to OSHPD requirements.

1.06 EXTRA MATERIALS

A. Furnish extra materials described below which match products installed and that are packaged with protective covering for storage and identified with labels describing contents.


PART 2 PRODUCTS

2.01 VIBRATION ISOLATION

A. General:

1. Provide for mechanical piping, ductwork, and equipment as identified by this Specification.
2. Select in accordance with equipment, pipe, or duct weight distribution to produce reasonably uniform deflections.
3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 30 percent and 60 percent of maximum deflection.

B. Elastomeric Pad:

1. Oil-resistant and water-resistant elastomer or natural rubber waffle pads, arranged in single or multiple layers, molded with a nonslip pattern.
2. Waffle pads bonded each side of minimum 1/4-inch-thick galvanized steel separator plate.
3. Height of waffle ribs shall not exceed 0.7 times width.
6. Separator plate of sufficient stiffness for uniform loading over pad area.
7. Factory cut to size that matches requirements of supported equipment.
9. Number of Layers: As required to support equipment load; refer to manufacturer’s data for load capacities.
C. Elastomeric Mount:
   1. Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements.
   2. Factory-drilled, encapsulated top plate for bolting to equipment.
   3. Baseplate for bolting to structure.

D. Open Spring Isolator:
   1. Freestanding, laterally stable, open-spring isolators.
   2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of required deflection at rated load.
   4. Lateral Stiffness: 80 percent minimum of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. Baseplate:
      a. Factory drilled for bolting to structure and bonded to 1/4-inch-thick rubber isolator pad attached to baseplate underside.
      b. Limit floor load to 100 psig.
   7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Restrained Spring Isolator:
   1. Freestanding, steel, open-spring isolators with seismic restraint.
   2. Housing: Steel with resilient vertical limit stops to prevent spring extension because of wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-thick elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   3. Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.
   4. Minimum Additional Travel: 50 percent of required deflection at rated load.
   5. Lateral Stiffness: 80 percent minimum of rated vertical stiffness.
   6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

F. Elastomeric Hanger:
   1. Double-deflection type.
   2. Molded, oil-resistant rubber or neoprene isolator elements bonded to steel housing.
   3. Threaded connections for hanger rods.
G. Spring Hanger:
1. Combination coil spring and elastomeric insert hanger with spring and insert in compression.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.
4. Minimum Additional Travel: 50 percent of required deflection at rated load.
5. Lateral Stiffness: 80 percent minimum of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element:
   a. Molded, oil-resistant rubber or neoprene.
   b. Steel washer reinforced cup to support spring and bushing projecting through bottom of frame.

H. Thrust Limit:
1. Combination coil spring and elastomeric insert with spring and insert in compression and with a load stop.
2. Rod and angle iron brackets for attaching to equipment.
3. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
4. Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.
5. Minimum Additional Travel: 50 percent of required deflection at rated load.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
9. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

I. Manufacturers:
1. Mason Industries, Inc.
2. Kinetics Noise Control, Inc.
3. California Dynamics Corp.
4. Isolation Technology, Inc.
7. Vibration Isolation Co., Inc.
8. The VMC Group.

2.02 FLEXIBLE CONNECTORS

A. Flexible Pipe Connectors:

1. Braided Nonferrous: For nonferrous piping systems, provide bronze hose covered with bronze wire braid with copper tube ends or bronze flanged ends, braze-welded to hose.
2. Braided Stainless Steel: For ferrous piping, provide stainless steel hose covered with Type 304 stainless steel wire braid with NPT steel nipples or 150-psi ANSI flanges, welded to hose.
3. Rubber:
   a. Neoprene or EDPM construction consisting of multiple piles of nylon tire cord fabric and elastomer, molded and cured in hydraulic rubber presses.
   b. Straight or elbow connector as indicated on Drawings, rated at 125 psi at 220 degrees F.
4. Manufacturers:
   1. Mason Industries, Inc.
   2. General Rubber.

B. Flexible Duct Connectors: Refer to Section 23 31 13, Metal Ducts and Accessories.

2.03 SEISMIC RESTRAINTS

A. Resilient Isolation Washers and Bushings: One-piece, molded neoprene, having a durometer 40, plus or minus 5, with a flat washer face.

B. Seismic Snubbers: Factory fabricated using welded structural steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

C. Restraining Cables: Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement.

D. Anchor Bolts:

1. Seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.
E. Manufacturers:

1. California Dynamics Corp.
2. Kinetics Noise Control, Inc.
3. Loos & Co., Inc.; Cableware Technology Division.
4. Mason Industries, Inc.
6. TOLCO Incorporated.
7. Unistrut Diversified Products Co.; Wayne Manufacturing Division.
8. Vibration Eliminator Co., Inc.
9. Vibration Isolation Co., Inc.
10. The VMC Group.

2.04 SHOP/FACTORY FINISHING

A. Manufacturer’s standard paint applied to factory-assembled and factory-tested equipment, before shipping.

1. Powder coating on springs and housings.
2. Electro-galvanized hardware.
3. Hot-dip galvanized metal components for exterior use.
4. Baked enamel coat metal components for interior use.

B. Color-code or otherwise mark vibration isolation devices to indicate capacity range.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.02 INSTALLATION

A. General:

1. Install products in accordance with manufacturers’ written instructions.
2. Connect wiring to isolated equipment with flexible hanging loop.
3. Install roof curbs, equipment supports, and roof penetrations as specified in Section 07 70 01, Roof Specialties and Accessories.
4. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.
5. Locate isolation hangers as near overhead support structure as possible.

B. Vibration Isolators:

1. Install spring hangers without binding.
2. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

C. Equipment Bases:

1. Adjust equipment level.
2. Bases with seismic snubbers shall have snubbers located close to isolators.
3. Structural Steel Bases: Set steel bases for 1-inch clearance between housekeeping pad and base.
4. Concrete Inertial Bases:
   a. Set concrete inertia bases for 2-inch clearance between housekeeping pad and base.
   b. Fill concrete inertia bases, after installing base frame, with concrete; trowel to a smooth finish.

D. Flexible Connectors:

1. Install at pumps, chillers, air handling units, hydronic coils, equipment on or with vibration isolation, and at building seismic joints.
2. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

E. Seismic Restraint Devices:

1. Notify local representative of seismic restraint materials manufacturer prior to installing seismic restraint devices.
2. No rigid connections between equipment and building structure shall be made which degrades seismic restraint system herein specified.
3. Electrical conduit to restrained equipment shall be looped to allow free motion of equipment without damage to electrical wiring.
4. Install seismic snubbers on isolated equipment.
5. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
6. Install restraining cables at each trapeze and individual pipe hanger. At trapeze anchor locations, shackle piping to trapeze. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.

7. Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers.

8. At trapeze anchor locations, shackle piping and equipment to trapeze.

9. Install resilient bolt isolation washers on equipment anchor bolts.

10. Upon completion of seismic restraint material installation and before startup of restrained equipment, clean debris from beneath protected equipment, leaving equipment free to contact snubbers.

3.03 FIELD QUALITY CONTROL

A. Testing:

1. Conduct the following field quality control testing:
   a. Isolator deflection.
   b. Isolator seismic restraint clearance.
   c. Snubber minimum clearances.

B. Seismic Control Component Inspection:

1. Conduct periodic inspections of material installation with assistance of manufacturer’s representative. Report in writing deviations from good installation practice.

2. Upon completion of seismic restraint device installation inspect completed system with assistance of manufacturer’s representative. Report in writing installation errors, improperly selected snubber devices, or other fault in the system that could affect performance of the system.

3.04 ADJUSTING

A. Vibration Isolation Devices:

1. Adjust isolators after piping systems have been filled and equipment is at operating weight.

2. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height.

3. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

4. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.
5. Adjust isolators to ensure units do not exceed rated operating deflections or bottom out under loading, and are not short circuit by other contacts or bearing points.

6. Adjust leveling devices as required to distribute loading uniformly on isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.

B. Seismic Control Components:

1. Adjust snubbers according to manufacturer’s written recommendations.
2. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.
3. Torque anchor bolts according to equipment manufacturer’s written recommendations to resist seismic forces.

3.05 CLEANING

A. After completing equipment installation, inspect vibration isolation devices. Remove paint splatters and other spots, dirt, and debris.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

4. National Environmental Balancing Bureau (NEBB):

1.02 SUBMITTALS

A. Informational Submittals:

1. Documentation of experience record of testing authority.
2. Documentation of current AABC or NEBB certifications for those technicians in responsible charge of the work under this Contract.
3. Submit detailed test and balance procedures, including test conditions for systems to be tested, prior to beginning the Work.
4. Written verification of calibration of testing and balancing equipment.
5. Balancing Log Report following completion of system adjustments including test results, adjustments, and rebalancing procedures.

1.03 QUALITY ASSURANCE

A. Air Balancing and Test Agency Qualifications:

1. Certification by AABC of NEBB for testing, adjusting and balancing of HVAC systems.
2. Corporately and financially independent organization functioning as an unbiased testing authority.
3. Professionally independent of manufacturers, suppliers, and installers of HVAC equipment being tested.
4. Have a proven record of at least five similar projects.
5. Employer of engineers and technicians regularly engaged in testing, adjusting and balancing of HVAC equipment and systems.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide materials, tools, test equipment, computers and instrumentation required to complete the work included.

B. Test Hole Plugs: Plug test holes in ducts with plugs made for that purpose and replace any insulation removed to specified conditions.

C. Drives for Belt-Driven Fans:
   1. Furnish cast iron or flanged steel sheaves.
   2. Sheaves and belt combination shall be capable of providing 150 percent of motor horsepower.

PART 3 EXECUTION

3.01 GENERAL

A. Adjust and balance air and water systems in accordance with standard procedures and recognized practices of the AABC or SMACNA.

B. Adjust and balance the following systems:
   1. Supply, return and exhaust air systems.

3.02 ADJUSTING AND BALANCING AIR SIDE

A. Preparation:

   1. Prior to beginning the Work, perform the following activities:
      a. Review shop drawings and installed system for adequate and accessible balancing devices and test points.
      b. Recommend to Engineer dampers that need to be added or replaced in order to obtain proper air control.
      c. Verify proper startup procedures have been completed on the system.
      d. Verify controls installation is complete and system is in stable operation under automatic control.
e. Verify test instruments have been calibrated to a recognized standard and are within manufacturer’s recommended calibration interval before beginning the Work.

B. General:

1. When adjustments are made to a portion of a fan system, reread other portions of that same system to determine effects imposed by adjustments. Readjust as necessary.
2. Lock and mark final positions of balancing dampers with permanent felt pen.

C. Equipment Data:

1. Collect the following data and included in final report:
   a. Type of unit.
   b. Equipment identification number.
   c. Equipment nameplate data (including manufacturer, model, size, type, and serial number).
   d. Motor data (frame, hp, volts, FLA rpm, and service factor).
   e. Sheave manufacturer, size, and bore.
   f. Belt size and number.
   g. Sheave centerline distance and adjustment limits.
   h. Starter and motor overload protection data.
   i. Include changes made during course of system balancing.

D. Fan Systems:

1. Measure fan system performance in accordance with AMCA 203.
2. In each system at least one airpath from fan to final branch duct termination shall have dampers fully open. Achieve final air quantities by adjusting fan speed.
3. Adjust Fan Air Volumes:
   a. Adjust fan speeds and motor drives for required equipment air volumes, with allowable variation of plus 10 percent minus 0 percent.
   b. After final adjustments, do not operate motor above nameplate amperage on any phase.
   c. After final adjustments, do not operate fan above maximum rated speed.
   d. Perform airflow test readings under simulated or actual conditions of full cooling, full heating, minimum outside air, full outside air and exhaust, and full return air.
   e. Provide and make drive and belt changes on motors or fans as required to adjust equipment to specified conditions. Drives shall
be able to deliver 150 percent of motor horsepower. Provide written notice to air handling unit manufacturer and Owner if drive or belt changes were made.

4. Adjust outside air dampers, return air dampers, relief air dampers, exhaust air dampers, and motorized louvers for maximum and minimum air requirements.

5. Read and record static pressures at unit inlet and discharge, each filter set, coils, dampers, plenums, and mixing dual-duct or adjustable-volume boxes, on every supply, return, and exhaust fan for each test condition.

6. Read and record motor amperage on all phases for each test condition.

E. Air Outlets and Inlets:

1. In each system at least one air path from fan to final branch duct termination shall have dampers fully open.

2. Adjust air volumes on supply diffusers and grilles, and on return and exhaust grilles, to the quantity shown, with allowable variation of plus or minus 10 percent.

3. Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and noise where possible.

4. After final adjustments are made secure dampers to prevent movement and mark final positions with permanent felt pen.

3.03 FIELD QUALITY CONTROL

A. General: Perform functional tests as required by Section 01 91 14, Equipment Testing and Facility Startup.

B. Performance Testing:

1. Vibration Testing:
   a. Upon completion of air and water system balance, perform vibration testing as specified below for the following rotating or reciprocating equipment:
      1) Supply Fans 30-SF-01 and 30-SF-02.
   b. Test Procedures:
      1) Identify maximum vibration velocity limits as specified for each piece of equipment to be tested.
      2) Take measurements at each bearing housing using calibrated electronic analyzer.
      3) Measure velocity in direction parallel to rotating shaft, and in two directions perpendicular to shaft and to each other. Align measurement directions where possible to the horizontal and vertical planes.
4) Record log shall include equipment symbol or tag, location, identification, specified vibration velocity limits, and maximum measured velocity in each direction.

5) Notify Engineer if amplitude exceeds upper limit specified.

C. Balancing Log Report Requirements:

1. Include narrative description for each system explaining TAB methodology and assumptions used. Clearly identify test conditions for tests performed. Include control setpoint.

2. Log and record operational information from every test for each system, as necessary to accomplish services described.

3. Include equipment data for units tested.

4. Include reduced set of HVAC Drawings or system schematic diagrams with each element uniquely identified and indexed to balance log.

5. Indicate recorded site values, and velocity and mass correction factors used to provide equivalent standard air quantities.

6. Include separate section in log, if necessary, describing operating difficulties in air or water systems that could not be eliminated by specified procedures. Identify these problems by system and location within building; include outline or summary of condition and its effect on building, and describe corrective actions attempted and recommended.

D. Quality Control Verification:

1. After adjustments have been completed and balance logs submitted, balancing and testing agency shall be available to demonstrate the following:

   a. Air and water balancing procedures, vibration tests, and verification of test results.

   b. Perform spot tests on a maximum of 20 percent of total diffusers and grilles, on two air handling fan devices per building, and on 10 percent of total water balance fittings, with measuring equipment used in original tests, at random points selected by Engineer.

   c. Results of these spot tests shall agree with balance logs within plus or minus 10 percent. Where this accuracy cannot be verified, rebalance portions of system as requested by Engineer.

   d. At completion of rebalance procedures, perform another spot test if required to verify results.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

3. ASTM International (ASTM):
   h. G22, Standard Practice for Determining Resistance of Plastics to Bacteria.
5. UL.

1.02 DEFINITIONS

A. Cold Air Ductwork: Designed to convey mechanically cooled air or return ducts in such systems.
B. Warm Air Ductwork: Designed to convey mechanically heated air or return ducts in such systems.

1.03 SUBMITTALS

A. Action Submittals: Product description, list of materials and thickness for each service or equipment scheduled, locations, and manufacturer’s installation instructions.

B. Informational Submittals:

1. Proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.
2. Operation and maintenance data as specified in Section 01 78 23, Operation and Maintenance Data.

1.04 QUALITY ASSURANCE

A. Materials furnished under this specification shall be standard, cataloged products, new and commercially available, suitable for service requiring high performance and reliability with low maintenance, and free from all defects.

B. Provide materials by firms engaged in the manufacture of insulation products of the types and characteristics specified herein, whose products have been in use for not less than 5 years.

C. UL listing or satisfactory certified test report from an approved testing laboratory is required to indicate fire hazard ratings for materials proposed for use do not exceed those specified.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer’s Stamp or Label:

1. Every package or standard container of insulation, jackets, cements, adhesives and coatings delivered to Project Site for use must have manufacturer’s stamp or label attached, giving name of manufacturer, brand, and description of material.

2. Insulation Packages and Containers: Marked “asbestos-free.”

PART 2 PRODUCTS

2.01 GENERAL

A. Insulation Exterior: Cleanable, grease-resistant, nonflaking, and nonpeeling.
B. Insulation: Conform to referenced publications and specified temperature ranges and densities in pounds per cubic foot.

C. Insulation for Fittings, Flanges, and Valves: Premolded, precut, or job-fabricated insulation of same thickness and conductivity as used on adjacent piping.

D. Fire Resistance:
   1. Insulation, Adhesives, Vapor Barrier Materials and Other Accessories, Except as Specified Herein: Noncombustible.
   2. Do not use fugitive or corrosive treatments to impart flame resistance.
   3. Flame proofing treatments subject to deterioration resulting from the effects of moisture or high humidity are not acceptable.
   4. Provide materials including facings, mastics, and adhesives, with fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke, developed as per tests conducted in accordance with ASTM E84 (NFPA 255) methods.

E. Materials exempt from fire-resistant rating:
   1. Nylon anchors.
   2. Treated wood inserts.

F. Materials exempt from fire-resistant rating when installed in outside locations, buried, or encased in concrete:
   1. Polyurethane insulation.
   2. PVC casing.
   3. Fiberglass-reinforced plastic casing.

2.02 DUCT INSULATION

A. Type D1—Blanket (ASTM C553, Type 1, Class B3):
   1. Fiberglass, nominal 1 pcf density blanket, K factor 0.31 maximum at 75 degrees F mean, with factory-applied FSK (foil-scrim-kraft) vapor barrier jacket, for temperatures to 250 degrees F.
   2. Manufacturers and Products:
      a. CertainTeed; Duct Wrap.
      b. Johns Manville; Microlite.
      c. Owens/Corning Fiberglass; Soft R.
      d. Knauf; Ductwrap.
B. Type D2—Board:

1. Fiberglass, minimum 2.75 pcf density board, K factor 0.23 maximum at 75 degrees F mean, with factory-applied FSK (foil-scrim-kraft) vapor barrier jacket, for temperatures from 0 degree F to 450 degrees F.

2. Manufacturers and Products:
   a. CertainTeed; CertaPro Commercial Board.
   b. Knauf; Duct Slab.
   c. Owens/Corning Fiberglass; TIW.
   d. Johns Manville; 1000 Series Spin-Glass.

C. Type D3—Liner (ASTM C1071, Type 1):

1. Fiberglass, nominal 1.5 pcf density liner, K factor 0.25 maximum at 75 degrees F mean, black composite coated surface exposed to airstream to prevent erosion of glass fibers, for temperatures to 250 degrees F.

2. Liquid water repellency rating not less than 4 when tested in accordance with INDA IST 80.6.

3. Potential heat value not exceeding 3,500 Btu/lb when tested in accordance with NFPA 259 and meeting the classification of “Limited Combustible” as defined by NFPA 90A.

4. Maximum rated velocity not less than 6,000 fpm when tested in accordance with ASTM C1071.

5. Resistant to microbial growth using a “no growth criteria” when tested in accordance with ASTM C1139, ASTM G21, and ASTM G22.

6. Manufacturers and Products:
   a. CertainTeed; Toughgard.
   b. Johns Manville; Linacoustic (rectangular), Spinacoustic (Round).
   c. Knauf; Acoustic Duct Liner.

2.03 INSULATION FINISH SYSTEMS

A. Type F2—Paint:

1. Acrylic latex paint, white, and suitable for outdoor use.


B. Type F3—Aluminum:

1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100 or 3105 to ASTM B209 with H-14 temper, minimum 0.016-inch thickness, with smooth mill finish.

2. Moisture Barrier: Provide factory applied moisture barrier, consisting of 40-pound kraft paper with 1-mil-thick low-density polyethylene film, heat and pressure bonded to inner surface of the aluminum jacketing.
3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/values, end caps, mechanical line couplings, and specialty fittings.

4. Manufacturer and Product:
   a. RPR Products; INSUL-MATE.
   b. ITW, Pabco-Childers.

PART 3 EXECUTION

3.01 APPLICATION OF PIPING INSULATION

A. Install insulation products in accordance with manufacturer’s written instructions, and in accordance with recognized industry practices.

B. Apply insulation over clean, finish painted, and dry surfaces.

C. Install insulation after piping system has been pressure tested and leaks corrected.

D. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.

E. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run. Do not use cut pieces of scraps abutting each other.

F. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

G. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage. Seal open ends of insulation with mastic. Sectionally seal all butt ends of chilled water and condensate drain piping insulation at fittings with white vapor barrier coating.

H. Cover valves, flanges, fittings, and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job-fabricated units. Finish cold pipe fittings with white vapor barrier coating and hot piping with white vinyl acrylic mastic, both reinforced with glass cloth.

I. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.

J. Install protective metal shields and foamglass inserts where pipe hangers bear on outside of insulation.
K. Insulation on piping that is to be heat traced shall be installed after installation of heat tape.

L. Insulate valve bodies, flanges, and pipe couplings.

M. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.

N. Do not insulate flexible pipe couplings and expansion joints.

O. Do not allow insulation to cover nameplates or code inspection stamps.

P. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.

Q. Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.

R. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.

S. Placement:
   1. Slip insulation on pipe or tubing before assembly, when practical, to avoid longitudinal seams.
   2. Insulate valves and fittings with sleeved or cut pieces of same material.
   3. Seal and tape joints.

T. Insulation at Hangers and Supports: Install under piping, centered at each hanger or support.

U. Vapor Barrier:
   1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
   2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
   3. Do not use staples and screws to secure vapor sealed system components.

3.02 INSTALLATION OF DUCTWORK INSULATION

A. General: Install insulation products in accordance with the manufacturer’s written instructions and in accordance with recognized industry practices.

B. Install insulation materials with smooth and even surfaces.
C. Clean and dry ductwork prior to insulation. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

D. Maintain integrity of vapor-barrier on ductwork insulation and protect it to prevent puncture and other damage. Tape all punctures.

E. Seal longitudinal and circumferential joints with FSK tape, and finish with fiberglass mesh fabric embedded in vapor barrier mastic.

F. Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations, except where otherwise indicated.

G. Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed.

H. Refer to Section 23 31 13, Metal Ducts and Accessories, for installation of internal duct liner.

3.03 INSTALLATION OF EQUIPMENT INSULATION

A. Application Requirements: Insulate where external surface temperature of equipment is below ambient temperature in the space, including surfaces that have a recognized possibility for condensation.

B. Install equipment thermal insulation products in accordance with manufacturer’s written instructions and in compliance with recognized industry practices to ensure that insulation serves intended purpose.

C. Install insulation materials with smooth and even surfaces and on clear and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gaping joints and excessive voids resulting from poor workmanship.

D. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.

E. Provide removable insulation sections to cover parts of equipment that must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames, and accessories.

F. Replace damaged insulation that cannot be repaired satisfactorily, including units with vapor barrier damage and moisture-saturated units.

G. Avoid using scrap pieces of insulation where larger sheets will fit.
3.04 INSTALLATION OF INSULATION FINISH SYSTEMS

A. Use a continuous friction type joint to hold jacket in-place, providing positive weatherproof seal over entire length of jacket.

B. Secure circumferential joints with preformed snap straps containing weatherproof sealant.

C. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.

D. Do not use screws or rivets to fasten the fitting covers.

E. Install removable prefabricated aluminum covers on exterior flanges and unions.

F. Caulk and seal all exterior joints to make watertight.

3.05 DUCTWORK INSULATION REQUIREMENTS

A. Outside Air Intake:
   1. Type D1, blanket.
   2. 1-1/2-inch thickness.

B. Unheated Supply Air:
   1. Type D3, liner.
   2. 1-inch thickness.

C. Sheet Metal Plenums:
   1. Type D3, liner.
   2. 1-1/2-inch thickness.

3.06 INSULATION FINISH REQUIREMENTS

A. Piping, Duct, and Equipment Insulation (Concealed Areas): Factory finish.

B. Ductwork Insulation (Exposed to View, Indoors): Factory finish.

C. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.
3.07 FIELD QUALITY CONTROL

A. Test factory-applied materials assembled. Field-applied materials may be tested individually.

END OF SECTION
SECTION 23 31 13
METAL DUCTS AND ACCESSORIES

PART 1        GENERAL

1.01        REFERENCES

A. The following is a list of standards which may be referenced in this section:

5. ASTM International (ASTM):
   b. A90/A90M, Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
   h. A653/A653M, Standard Specifications for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   k. A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-
Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.


   b. 90B Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
   d. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.

8. Sheet Metal and Air Conditioning Contractors’ National Association (SMACNA):
   a. Duct Construction Standards.
   c. Fibrous Glass Duct Construction Standards.
9. UL:
   b. 214, Standard for Tests for Flame-Propagation of Fabrics and Films.
   c. 555, Standard for Safety Fire Dampers.
   d. 555S, Standard for Safety Smoke Dampers.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

   1. CFM: cubic feet per minute.
   2. FPM: feet per minute.
   3. PCF: pounds per cubic foot.
   4. WC: water column.

B. Sealing Requirements:

   1. For the purpose of duct systems sealing requirements specified in this section, the following definitions apply:
      a. Seams: Joining of two longitudinally (in direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on perimeter are deemed to be joints.
      b. Joints, duct surface connections including:
         1) Girth joints.
         2) Branch and subbranch intersections.
         3) Duct collar tap-ins.
         4) Fitting subsections.
         5) Louver and air terminal connections to ducts.
         6) Access door, and access panel frames and jambs.
         7) Duct, plenum, and casing abutments to building structures.

1.03 SUBMITTALS

A. Action Submittals:

   1. Product Data:
      a. Rectangular, Rigid Round, and Oval Ductwork:
         1) Schedules of duct systems, materials, joints, sealing, gage and reinforcement.
         2) SMACNA Figure Numbers for each shop fabricated item.
         3) Reinforcing details and spacing.
         4) Seam and joint construction details.
5) Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

b. Ductwork Accessories:
   1) Manufacturer’s product data including catalog sheets, diagrams, standard schematic drawings, installation instructions and details, details of materials, construction, dimensions of individual components, and finishes, including the following items:
      a) Fittings and volume control damper installation (both manual and automatic) details.
      b) Duct liner.
      c) Sealing materials.
      d) Dampers; include leakage, pressure drop, and maximum back pressure data.
      e) Duct-mounted access panels and doors.
      f) Flexible ducts.
      g) Sheet metal fasteners.

2. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
3. Sound Attenuators Certified Test Data:
   a. Dynamic insertion loss.
   b. Self-noise power levels.
   c. Static pressure loss.
   d. Dimensions and weights.
4. Record Drawings: Include duct systems routing, fittings details, and installed accessories and devices.

1.04 QUALITY ASSURANCE

A. Industry Standards:

1. Unless otherwise indicated or specified, sheet metal ductwork shall be constructed and installed in accordance with SMACNA Duct Construction Standards relevant to ductwork system being provided. These standards are herein referenced as the SMACNA Manual, unless otherwise indicated.
2. Comply with ASHRAE Fundamentals Handbook recommendations, except as otherwise indicated.

3. NFPA Compliance: NFPA 90A and NFPA 90B.

B. Manufacturers: Firms regularly engaged in manufacture of ductwork products of types, materials, and sizes required, whose products have been satisfactorily used in similar service for not less than 5 years.

C. Suppliers of duct and fitting components shall provide on request the following information:

   1. Laboratory performance data for duct, including leakage rate, bursting strength, collapse strength, seam strength, and pressure loss.
   2. Laboratory performance data for fittings, including zero-length dynamic losses.

D. Installer shall be a firm with at least 3 years’ experience of successful installation on ductwork systems similar to that required for this Project.

E. Changes or alterations to layout or configuration of duct system shall be:

   1. Specifically approved in writing by Engineer.
   2. Proposed layout shall provide original design results, without increasing system total pressure.

1.05 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following special tools:

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special tools required to maintain or dismantle</td>
<td>One complete set for each different size unit</td>
</tr>
</tbody>
</table>

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect ductwork from dirt, water, and debris. During storage on Job Site, keep ends of ductwork covered to prevent foreign objects and water from entering ductwork.

B. If fabricated sound-lined ductwork or ductboard gets wet during installation, remove and dispose of ductwork from the Site.
C. Deliver sealant materials to Site in original unopened containers labeled with manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

D. Store and handle sealant materials in compliance with manufacturers’ recommendations to prevent deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

E. Deliver and store stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

PART 2 PRODUCTS

2.01 SCHEDULES

A. Ductwork Schedule: Refer to Article Supplements.

2.02 GENERAL

A. Specified components of this ductwork system, including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

B. Internally Lined Ductwork: Duct sizes indicated for internally lined ducts are the clear inside dimensions, and shall be increased in both dimensions by twice the thickness of the liner.

C. Ductwork thinner than 26-gauge will not be allowed.

D. Ductwork Interior Surfaces:

1. Smooth.
2. No sheet metal parts, tabs, angles, or other items may project into air ducts, unless otherwise specified.
3. Seams and joints shall be external.
4. For ductwork that is required to be reinforced, Contractor may use either external or internal reinforcing.

2.03 SHEET METAL MATERIALS

A. Construct metal duct systems from galvanized steel.

B. Where no specific ductwork materials are indicated in Specifications or on Drawings, galvanized steel sheet metal shall be basis of Contract.
C. Galvanized Steel Ductwork:

1. Comply with ASTM A653/A653M and ASTM A924/924M.
2. Product Name: Steel Sheet, Zinc Coated (Galvanized Steel).
3. Sheet Designation: CS Type B.
4. Applicable Specification: ASTM A653/A653M.
5. (Zinc) Coating Designation: G90.
6. Coating designation in accordance with Test Method A, ASTM A90/A90M, and ASTM A924/A924M.
7. Provide mill-phosphatized finish for ducts exposed to view and for ducts scheduled to be painted.
8. Provide sheet metal packaged and marked as specified in ASTM A700.

D. Reinforcement Shapes and Plates: Unless otherwise indicated, provide reinforcements of same material as ductwork.

2.04 DUCT SEALING MATERIALS

A. General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.

B. Adhesives, Cements, Sealant, and Installation Accessories: As recommended by duct manufacturer for application.

C. Solvent-Based Sealants:

1. Ultraviolet light resistant.
2. Mildew resistant.
3. Flashpoint: Greater than 70 degrees F, SETA CC.
4. Manufacturers and Products:
   a. Tremco; Vulkem 116.
   b. Duro-Dyne; DLSN.

D. Water-Based Sealants:

1. Listed by manufacturer as nonflammable in wet and dry state.
2. Manufacturers and Products:
   a. Foster; Series 32.
   b. Childers; CP-145A, 146.
   c. Rectorseal; Airlok 181.
2.05 DUCTWORK FASTENERS

A. General:
   1. Rivets, bolts, or sheet metal screws.
   2. Ductwork fasteners shall be same metal as duct being supported, unless otherwise noted.

B. Self-Drilling Screws:
   1. Galvanized Steel Ductwork System: Sheet metal screws shall be hex washer head (HWH) TEKS® self-drilling type, formed from heat-treated carbon steel with zinc electroplated finish.

2.06 DUCTWORK PRESSURE CLASS

A. Construct duct systems to pressure classifications indicated as follows:
   1. Supply Ducts: 3-inch WC.
   2. Exhaust Ducts: 2-inch WC, negative pressure.

B. Where no specific duct pressure designations are indicated in Specifications or on Drawings, 2-inch WC pressure class shall be basis of Contract.

2.07 RECTANGULAR DUCTWORK

A. Fabricate rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible unless specified otherwise.

B. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20-gauge or less, with more than 10 square feet of unbraced panel area, as indicated in SMACNA Manual, unless they are lined or are externally insulated.

2.08 RECTANGULAR DUCTWORK FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible.

B. Elbows:
   1. Fit square-turn elbows with vane side rails.
   2. Shop fabricate double-blade turning vanes of same material as ductwork.
   3. Fabricate with equal inlet and outlet.
4. Rectangular radius elbows with inside radius of 3/4 of duct width in direction of turn.

5. Manufacturers and Products:
   a. Elgen; All-Tight.
   b. Duro-Dyne; Type TR.

C. Turning Vanes:
   1. Double thickness, 4-inch radius except that 2-inch radius may be used on ducts 12 inches and smaller.
   2. Airfoil vanes minimum 3.5-inch radius.
   3. Vane metal thickness shall be min 24 gauge steel, and min G60 galvanized or equivalent. Vane material to be same as duct material.
   4. Vane rails on 20 inches and larger ducts shall be 22 gauge or heavier.
   5. Manufacturer:
      a. Aero-Dyne HEP.
      b. Ductmate.
      c. EZ Rail.

2.09 RECTANGULAR DUCTWORK BRANCH CONNECTIONS

A. Branch duct connections to rectangular duct mains shall be made using factory fabricated fittings with spot welded tap to main duct connections or with factory fabricated, field installed taps, with spin-in or mechanical fastened tap to main duct connections.

2.10 RECTANGULAR DUCTWORK INSULATION LINER

A. Location: Provide ductwork with internal insulation liner where indicated on Drawings or in Ductwork Schedule.

B. Material:
   1. Fiberglass, nominal 1.5 pcf density liner, K factor 0.25 maximum at 75 degrees F mean.
   2. Black composite coating on surface exposed to airstream to prevent erosion of glass fibers, for temperatures to 250 degrees F.
   3. Liquid water repellency rating not less than 4.0 when tested in accordance with INDA IST 80.6.
   4. Potential heat value not exceeding 3,500 Btu per hour per pound when tested in accordance with NFPA 259 and meeting classification of “Limited Combustible” as defined by NFPA 90A.
   5. Maximum rated velocity not less than 6,000 fpm when tested in accordance with ASTM C1071.
6. Resistant to microbial growth using a “no growth criteria” when tested in accordance with ASTM C1139.

7. Manufacturers and Products:
   a. CertainTeed; Toughgard.
   b. JohnsManville; Linacoustic RC.
   c. Knauf; Duct Liner M.

C. Liner Adhesive: In accordance with NFPA 90A and ASTM C916.

D. Mechanical Fasteners:
   1. Same material as ductwork, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct.
   2. Provide fasteners that do not damage liner when applied as recommended by manufacturer, that do not cause leakage in duct, and will indefinitely sustain 50-pound tensile dead load test perpendicular to duct wall.
   3. Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.
   4. Adhesive for Attachment of Mechanical Fasteners: In accordance with Fire Hazard Classification of duct liner system.

E. Liner Application:
   1. Ductwork liner shall be applied at time of ductwork manufacture in an approved sheet metal workshop.
   2. Adhere single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness is prohibited.
   3. Apply coat of adhesive to liner facing in direction of airflow not receiving metal nosing.
   4. Butt transverse joints without gaps and coat joint with adhesive.
   5. Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping.
   6. Longitudinal Joints:
      a. Shall not occur except at corners of ducts, unless size of duct and standard liner product dimensions make longitudinal joints necessary.
      b. Apply adhesive coating on longitudinal seams in ducts exceeding 2,500 fpm air velocity.
   7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter, at 3 inches from transverse joints, and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing airstream with metal nosing that are either channel or “Z” profile or are integrally formed from duct wall at the following locations:
   a. Fan discharge.
   b. Intervals of lined duct preceding unlined duct.
   c. Upstream edges of transverse joints in ducts.

9. Seal insulation edges.

10. Repair abrasions or tears with mastic.

2.11 RIGID ROUND DUCTWORK

A. Construct rigid round ducts in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless specified otherwise.

B. Basic Round Diameter: As used in this Article, is inside diameter of size of round duct.

C. Where space limitations prevent use of round duct or where shown on Drawings, provide ductwork of flat oval construction hydraulically equivalent to round ductwork.

D. Fabricate round ducts with spiral seam construction, except where diameters exceed 72 inches. Fabricate ducts having diameters greater than 72 inches with longitudinal butt-welded seams.

E. Ductwork seams of Snaplock type shall not be used.

2.12 RIGID ROUND DUCTWORK FITTINGS

A. Construct rigid round ductwork fittings in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless otherwise specified.

B. 90-Degree Tees, Laterals, and Conical Tees: Fabricate to conform to SMACNA manual with metal thicknesses specified for longitudinal seam straight duct.

C. Diverging Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.

D. Elbows:
   1. Fabricate in stamped (die-formed), pleated, or segmented (gored) construction 1.5 times elbow diameter. Two piece segment elbows are not allowed, except with turning vanes.
2. Fabricate nonstandard bend angle configurations or nonstandard sized (for example, 9-1/2 inches and 10-1/2 inches) elbows with segmented construction.
4. Round Elbows 8 Inches and Smaller: Stamped elbows for 45 degrees and 90 degrees configurations and pleated elbows for 30 degrees, 45 degrees, 60 degrees, and 90 degrees configurations.
5. Round Elbows 9 Inches Through 14 Inches: Segmented or pleated elbows for 30 degrees, 45 degrees, 60 degrees, and 90 degrees configurations.
6. Round Elbows 15 Inches and larger: Segmented elbows for 30 degrees, 45 degrees, 60 degrees, and 90 degrees configurations.

2.13 ROUND DUCTWORK BRANCH CONNECTIONS

A. Branch duct connections (taps) to round duct mains shall be made using factory fabricated fittings.

B. Field installed taps are not acceptable.

2.14 DUCTWORK HANGERS AND SUPPORTS

A. General:
   1. Attachments, hangers, and supports for ductwork shall be in accordance with SMACNA Manual referenced for type of duct system being installed.
   2. Duct hanging system shall be composed of three elements; upper attachment to building, hanger itself, and lower attachment to duct.
   3. Wire hangers are not acceptable.
   4. Hanger Spacing:
      a. Ducts Up to 60 inches in Largest Dimension: 10 feet, maximum.
      b. Ducts Over 61 inches in Largest Dimension: 8 feet, maximum.

B. Construction Materials:
   1. Supporting devices including, but not limited to, angles used for support and bracing, baseplates, rods, hangers, straps, screws, bolts shall be as follows:
      a. Galvanized Steel Ductwork:
         1) Indoors: Carbon steel, zinc electroplated.
         2) Outdoors: Carbon steel, hot-dipped galvanized after fabrication.
C. Building Attachments:
   1. Concrete inserts, powder-actuated fasteners, or structural steel fasteners appropriate for building materials.
   2. Do not use powder-actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.
   3. Upper Attachment (Concrete):
      a. Drive pin fastener and expansion nail anchor may be used for ducts up to 18-inch maximum dimension.
      b. Threaded stud fastener may be used for ducts up to 36-inch maximum dimension.
      c. Concrete attachments shall be made of steel.

D. Duct Fasteners: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials and conforming to requirements of Article Ductwork Fasteners.

E. Trapeze and Riser Supports: Steel shapes conforming to ASTM A36/A36M, hot-dipped galvanized after fabrication.

2.15 DUCTWORK FLEXIBLE CONNECTIONS

A. General:
   1. Factory fabricated metal-edged fabric flexible connectors for commercial or industrial applications.
   3. Comply with NFPA 90A and NFPA 90B requirements.
   4. Airtight and waterproof.

B. Materials:
   1. Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
   2. Metal Edges: Construct from same material as ductwork, unless otherwise noted.
   3. Fabric:
      a. Comply with NFPA 701 or UL 214 (except teflon coated).
      b. Woven polyester or nylon for most applications.
      c. Woven fiberglass for high temperature applications.
      d. Coating: Neoprene.
C. Construction:


D. Manufacturers:

1. Ductmate; PROflex, Commercial.
2. Ventfabrics.
3. Duro-Dyne.

2.16 DUCT INSPECTION DOORS

A. General:

1. Insulated, gasketed, and at least 15 inches by 15 inches when duct dimensions are large enough.
2. On ductwork where largest side dimension is less than 16 inches, furnish inspection doors at least 8 inches by 8 inches.
3. Complete with necessary hardware and either Amerlock 10 or Ventlock No. 100 latches, and Ventlock Series No. 100 hinges.
4. Fabricated of same material as ductwork.

B. Round Spin-in Type Access Doors:

1. Size: 18-inch and 24-inch diameter will be acceptable in lieu of comparable size square or rectangular access doors specified herein.
2. Complete with insulation, spin-in frame, inner door, attachment cable, gaskets, three latches, and pull ring.

C. Casing and Plenum Access Doors:

1. Size: 57 inches high by 24 inches wide minimum where possible.
2. Complete with hardware, hinges, seals, and latch handles.
3. Doors and frames shall be designed to close with pressure.
4. Latch Handles: Ventlock, Series No. 260.
5. Hinges: Ventlock, Series No. 200 and No. 300.
D. Manufacturers:

1. Ventlok.
2. Duro-Dyne.
3. Flexmaster.

2.17 BACK DRAFT DAMPERS

A. General: Damper pressure drop ratings shall be based on tests and procedures performed in accordance with AMCA 500.

B. Steel Frame, Nonmetallic Blades:

1. Fabrication:
   a. Frame: 2 inches by minimum 18-gauge (51 mm by minimum 1.6 mm) galvanized steel with windstops to reduce backflow.
   b. Blades:
      1) Style: Single piece, independent.
      2) Action: Parallel.
      4) Orientation: Horizontal.
      5) Width: Maximum 6 inches (152 mm).
   c. Rear Bird Screen: Galvanized expanded metal.
   d. Mounting:
      1) Suitable for mounting in vertical or horizontal airflow up positions.
      2) Configured for positions as shown on Drawings.
   e. Finish: Mill galvanized.

2. Performance Data:
   a. Temperature Rating: Withstand minus 30 degrees F to 200 degrees F (minus 34 degrees C to 93 degrees C).
   b. Maximum Back Pressure: 4-inch WC (1.0 kPa).
   c. Maximum System Air Velocity: 1,000 fpm (5.1 m/s).
   d. Maximum Spot Air Velocity: 1,200 fpm (6.1 m/s).

3. Accessories:
   a. Duct transition connection.
   b. Factory Sleeve: Minimum 20-gauge thickness, minimum 8 inch length.

4. Manufacturers and Products:
   a. Ruskin; Model NMS2.
   b. Vent Products, Co.

2.18 EXTERNAL DUCT INSULATION

A. Refer to Section 23 07 00, HVAC Insulation.
2.19 MISCELLANEOUS ACCESSORIES

A. Louver and Grille Blank-Off Sections:
   1. Fabricate from 20-gauge sheets of same material as louver/grille.
   2. Line with sound attenuation/insulating material.
   3. Shop-prime and paint outside face of blank-off section with two coats of flat black exterior paint.
      a. In lieu of drain connection, float switch may be installed. Float switch shall shut down air handling equipment upon sensing water.

B. Accessories Hardware:
   1. Instrument Test Holes:
      a. Cast metal, material to suit duct material, including screw cap and gasket and flat mounting gasket.
      b. Size to allow insertion of pitot tube and other testing instruments.
      c. Provide in length to suit duct insulation thickness.
   2. Flexible Duct Clamps:
      a. Stainless steel band with cadmium-plated hex screw to tighten band with worm-gear action.
      b. Provide in sizes from 3 inches to 18 inches to suit duct size.
   3. Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline, and grease.

2.20 DUCTWORK IDENTIFICATION

A. Painted Identification Materials:
   1. Stencils: Standard metal stencils, prepared for required applications with letter sizes generally comply with recommendations of ASME A13.1 for piping and similar applications, but not less than 1-1/4-inch high letters for ductwork and not less than 3/4-inch-high letters for access door signs and similar operational instructions.
   2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray can form and grade.
   3. Identification Paint: Standard identification enamel of colors indicated or in accordance with ASME A13.1 for colors for systems not identified herein.
B. Nomenclature:

1. Include the following:
   a. Direction of air flow.
   b. Duct service (supply, return, exhaust).

C. Manufacturers:

1. W.H. Brady, Co.
2. Seton Identification Products.
3. Craftmark.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Miscellaneous:

1. Install sheet metal ductwork and flexible ductwork in accordance with SMACNA Manual, NFPA 90A, and NFPA 90B.
2. Install ductwork using manufacturer’s recommended adhesives, cement, sealant, and insulation accessories.
3. Align ductwork accurately at connections, within 1/8-inch misalignment tolerance and with internal surfaces smooth.
4. Interface Between Ductwork and Louvers: At locations where ductwork is connected to louver for either intake or exhaust purposes, ductwork shall be installed, sloped, and connected to louver so water entering ductwork system positively drains back to and out of louver.

B. Ductwork Location:

1. Locate ductwork runs vertically and horizontally, unless otherwise indicated.
2. Avoid diagonal runs wherever possible.
3. As indicated by diagrams, details, and notations or, if not otherwise indicated, run ductwork in shortest route that does not obstruct usable space or block access for servicing building and equipment.
4. In general, install as close to bottom of structure as possible.
5. For ductwork concealed above ceiling, maximize clearance between bottom of ductwork and top of ceiling construction.
6. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
7. Ductwork that must transition and drop below piping or other ductwork shall be transitioned back to bottom of structure immediately adjacent to obstruction.

C. Penetrations:
   1. Provide duct sleeves or prepared openings for duct mains, duct branches, and ducts passing through roofs, walls and ceilings.
   2. Clearances:
      a. For uninsulated ducts, allow 1-inch clearance between duct and sleeve, except at grilles, registers, and diffusers.
      b. For insulated ducts, allow 1-inch clearance between insulation and sleeve, except at grilles, registers, and diffusers.
   3. Closure Collars:
      a. Minimum 4 inches wide on each side of walls or floors where sleeves or prepared openings are installed.
      b. Fit collars snugly around ducts and insulation.
      c. Same gauge and material as duct.
      d. Grind edges of collar smooth to preclude tearing or puncturing insulation covering or vapor barrier.
      e. Use fasteners with maximum 6-inch centers on collars.
   4. Packing: Mineral fiber in spaces between sleeve or opening and duct or duct insulation.

D. Concealment:
   1. Wherever possible in finished and occupied spaces, conceal ductwork from view by locating in mechanical shafts, hollow wall construction, or above suspended ceiling.
   2. Do not encase horizontal runs in solid partitions, except as specifically shown.
   3. Limit clearance to 1 inch where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any.

E. Coordination with Other Trades:
   1. Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls, and other associated work of ductwork system.
   2. Ductwork shall be configured, positioned, and installed to permit installation of light fixtures as indicated on Drawings.
   3. Coordinate ductwork layout with suspended ceiling, lighting and sprinkler head layouts and similar finished work.
   4. Electrical Equipment Spaces: Do not run ductwork through transformer vaults and other electrical equipment spaces and enclosures.
3.02 RECTANGULAR DUCTWORK

A. General:
   1. Where possible, install ductwork so seams and joints will not be cut for installation of grilles, registers, or ceiling outlets.
   2. If cutting of seams or joints is unavoidable, reinforce cut portion to original strength.

B. Low Pressure Taps:
   1. Use bell mouth or conical fittings with integral locking quadrant damper. Spin-in fitting shall be sealed at duct tap with a gasket or sealed with sealant as specified for medium pressure ductwork.
   2. Determine location of spin-in after outlet location is determined.
   3. Fitting shall be securely attached to shaft to prevent damper from rotating around shaft.

C. Fittings:
   1. Use bell-mouth or conical tee fittings for round duct takeoffs from rectangular mains.
   2. Use 45-degree entry fittings conforming to SMACNA requirements for rectangular takeoffs from rectangular or round mains.
   3. Make offsets with maximum angle of 45 degrees.
   4. Use fabricated fittings for changes in directions, changes in size and shape, and connections.

D. Rectangular Ductwork Transverse Joints:
   1. Install each run with a minimum of joints.
   2. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.
   3. Mechanical Joint Option:
      a. Construct transverse joints with Ductmate 25/35 duct connector systems, Ductmate W.D.C.I. Heavy/Lite duct connector systems, or Ductlok J/E duct connector system. Slip-on duct flange connectors shall have integral sealant pocket with permanently flexible sealant.
      b. When using Ductmate W.D.C.I. Heavy/Lite system, construct ductwork in accordance to the Ductmate W.D.C.I. Heavy J and Light H Assembly Manual and Duct Construction Standards.
      c. When using Ductlok J/E duct connector system, construct ductwork in accordance with Ductlok’s Rectangular Duct Construction Manual for Low, Medium, and High Pressure.
ZINK DAM IMPROVEMENTS

d. For longitudinal seams, use Pittsburgh lock seam sealed internally with permanently elastic sealer such as Ductmate 5511M mastic.
e. Conform to SMACNA Class A sealing requirements.

3.03 RIGID ROUND DUCTWORK

A. General: Except where interrupted by fittings, install round ducts in lengths as long as possible to minimize joints.

B. Rigid Round Ductwork Joints:

1. Rigid round ductwork joints: in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless otherwise specified.
2. Single and Double Wall Supply System Joints:
   b. 36 Inches and Larger: Flanged connector, Van Stone, or welded companion flange type.

3.04 DUCTWORK HANGERS AND SUPPORTS

A. Install ductwork with support systems in accordance with SMACNA Manual, unless otherwise noted.

B. Support ducts rigidly with suitable ties, braces, hangers, and anchors of type, which will hold ducts true-to-shape and to prevent buckling.

C. Install additional bracing on ductwork as required, to prevent ballooning or breathing.

D. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

E. Support vertical ducts at maximum interval of 16 feet and at each floor.

F. Upper attachments to structures shall have allowable load not exceeding 1/4 of failure (proof test) load, but are not limited to specific methods indicated.

G. In new construction, install concrete insert prior to placing concrete.

3.05 FLEXIBLE CONNECTIONS

A. Flexible Collars and Connections:

1. Use between fans and ducts.
2. For round ducts, securely fasten flexible connections by zinc-coated steel clinch-type draw bands.
3. For rectangular ducts, lock flexible connections to metal collars.

3.06 DAMPERS

A. General:

1. Inspection:
   a. Inspect areas to receive dampers.
   b. Notify Engineer of conditions that would adversely affect installation or subsequent utilization of dampers.
   c. Do not proceed with installation until unsatisfactory conditions are corrected.
2. Install dampers at locations indicated on Drawings and in accordance with manufacturer’s installation instructions.
3. Install square and level.
4. Handle damper using sleeve or frame. Do not lift damper using blades or jack-shaft.
5. Damper blades and hardware shall operate freely without obstruction.
6. Damper blades and hardware that bind within frame or obstructed by adjacent construction will not be acceptable.
7. When installed, damper frames shall be gasketed or caulked to eliminate leakage between duct and damper frames.
8. Head and sill shall have stops.
9. Suitable for installation in mounting arrangement shown.
10. Do not compress or stretch damper frame into duct or opening.

B. Back Draft Dampers:

1. Install dampers square and free from racking with blades running horizontally.
2. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

3.07 ACCESS DOORS

A. Ductwork:

1. Install access doors in ductwork, in accordance with manufacturer’s instructions, at each:
   a. Duct mounted fire damper.
   b. Duct mounted smoke or ionization detector.
   c. Electric duct heater.
   d. Booster coil.
ZINK DAM IMPROVEMENTS

e. Humidifier.
f. Motorized damper.
g. Sail switch.
h. Turning vane.
i. Volume damper.
j. Automatic damper.
k. Temperature controller.
l. Coil, on both upstream and downstream side.

3.08 EXTERNAL DUCT INSULATION

A. Refer to Section 23 07 00, HVAC Insulation.

3.09 MISCELLANEOUS ACCESSORIES

A. Louver and Grille Blank-Off Sections: Attach airtight to louver or grille and install to allow for easy removal.

B. Inspection Plates and Test Holes:
   1. Where required in ductwork for balance measurements.
   2. Test holes shall be airtight and noncorrosive with screw cap and gasket.
   3. Extend cap through insulation.

3.10 DUCT SEALING

A. Seal duct seams and joints as follows:
   1. In accordance with SMACNA requirements.
   2. In addition to other requirements, provide the following duct sealing:
      a. For interior ductwork, tape joints with Hardcast Lag-Rite tape and bonder or Ray-Chem shrink tape.

B. If no specific duct sealing requirements are specified, requirements of SMACNA manual shall govern.

C. Seal externally insulated ducts prior to insulation installation.

D. Provide additional duct sealing as required to comply with Article Ductwork Leakage Testing.

E. Seal all audible leaks.
3.11 DUCTWORK LEAKAGE TESTING

A. General:

1. Tests shall be conducted on completed ductwork systems.
2. Testing of partial installations or limited sections of ductwork will not be acceptable.
3. All ductwork leakage test procedures and results shall be submitted to Engineer for review.
4. Engineer shall retain the right to witness some or all ductwork leakage testing procedures.
5. Contractor shall notify Engineer in writing at least 5 working days prior to ductwork testing.

B. Leakage Criteria:

1. Assemble and install ductwork with maximum leakage limited as follows:
2. Supply and Exhaust Air Systems:
   a. Supply Ductwork:
      1) Operating Pressure: 0-inch to 2-inch WC.
         a) Allowable Leakage: 2 percent of design airflow.
      2) Operating Pressure: 3-inch and over WC.
         a) Allowable Leakage: 1 percent of design airflow.
   b. Exhaust Ductwork:
      1) Operating Pressure: All.
      2) Allowable Leakage: 2 percent of design airflow.

C. Leakage Testing Method:

1. Contractor shall be responsible for providing all necessary test fans and calibrated measuring devices to accomplish ductwork leakage test and to demonstrate that ductwork systems leakage rate is less than maximum rate specified.
2. Pressure testing shall be accomplished using a pressure blower with a calibrated orifice and manometer.
3. Blower shall maintain SMACNA construction pressure classification during test.
4. Perform testing in accordance with procedures given in SMACNA HVAC Air Duct Leakage Test Manual.

3.12 BALANCING OF AIR SYSTEMS

A. Perform air balancing in accordance with requirements of Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
3.13 PROTECTION OF INSTALLED WORK

A. Open ends of installed ductwork systems shall be covered to prevent dust, foreign objects and water from entering ductwork.

B. Ductwork systems shall not be used for air conveyance until adequate air filtration devices are installed in air handling equipment, to prevent ingress of construction dust.

3.14 CLEANING

A. Ductwork shall be cleaned of rust, dust, and debris, both internally and externally, before placing in operation.

B. Before installing air outlets, use air handler to blow dry air through entire system at maximum attainable velocity. Provide temporary air filters for this operation.

C. If duct systems are found to contain construction debris at time of construction completion Contractor shall provide complete ductwork system cleaning in accordance with NADCA Standards.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

2. Air Movement and Control Association International (AMCA):
   b. 201, Fans and Systems.
   c. 203, Field Performance Measurement of Fan Systems.
   d. 204, Balance Quality and Vibration Levels for Fans.
   e. 210, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
   f. 300, Reverberant Room Method for Sound Testing of Fans.
   g. 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
5. ASTM International (ASTM):
   d. D3363, Standard Test Method for Film Hardness by Pencil Test.
8. Occupational Safety and Health Act (OSHA).
9. Society for Protective Coatings (SSPC):
   a. SP 3, Power Tool Cleaning.
   b. SP 5, White Metal Blast Cleaning.
   c. SP 6, Commercial Blast Cleaning.
   d. SP 10, Near-White Blast Cleaning.


1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. AC: Alternating Current.
2. CISD: Chemical Industry, Severe-Duty.
3. dB: Decibel.
4. DWDI: Double Width, Double Inlet.
5. ECM: Electronically Commutated Motor.
7. hp: Horsepower.
8. ODP: Open Drip Proof.
11. UV: Ultra Violet.
12. XP: Explosion Proof.

1.03 SUBMITTALS

A. Action Submittals:

1. Provide following for specified products:
   a. Identification as referenced in Contract Documents.
   b. Manufacturer’s name and model number.
   c. Descriptive specifications, literature, and drawings.
   d. Dimensions and weights.
   e. Fan sound power level data (reference 10 to power minus 12 watts) at design operating point.
   f. Fan Curves:
      1) Performance Curves Indicating:
         a) Relationship of flow rate to static pressure for various fan speeds.
         b) Brake horsepower curves.
         c) Acceptable selection range (surge curves, maximum revolutions per minute).
         d) Static pressure, capacity, horsepower demand and overall efficiency required at duty point, including drive losses.
2) For variable air volume applications, indicate operating points at 100, 80, 60 and 40 percent of design capacity on fan curves including data to indicate effect of capacity control devices such as inlet vanes on flow, pressure, and brake horsepower.

g. Capacities and ratings.

h. Construction materials.

i. Fan type, size, class, drive arrangement, discharge, rotation, and bearings.

j. Wheel type, diameter, maximum revolutions per minute for fan class, operating revolutions per minute, and tip speed.

k. Motor data, including service factor and operating horsepower, as specified in Section 26 20 00, Low-Voltage AC Induction Motors.

l. Fan shaft first critical speed.
m. Belt service factor.

n. Drive assembly horsepower rating.
o. Sheave horsepower rating.
p. Power and control wiring diagrams, including terminals and numbers.

q. Factory run test and vibration test reports.
r. Vibration isolation.
s. Factory finish system.
t. Color selection charts where applicable.

2. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

3. “Or Equal” Equipment:

a. Where submitted equipment results in change to fan inlet or outlet ductwork configuration shown on Drawings, submit system effect factor calculations indicating increased static pressure requirements as described in AMCA 201.

b. Where submitted equipment results in change to ductwork and equipment configuration shown on Drawings, submit detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement to equipment furnished.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

2. Recommended procedures for protection and handling of products prior to installation.

3. Manufacturer’s installation instructions.
4. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for the following:
   a. Motors specified to be premium efficient type.
   b. FRP fans.
5. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
6. Test reports.
7. Operation and maintenance data in conformance with Section 01 78 23, Operation and Maintenance Data. Include as-built version of equipment schedules.

1.04 QUALITY ASSURANCE
   A. Performance Ratings: Tested in accordance with AMCA 210.
   B. Sound Ratings: Tested in accordance with AMCA 300.
   C. Fabrication: In accordance with AMCA 99.

1.05 EXTRA MATERIALS
   A. Furnish, tag, and box for shipment and storage the following special tools and materials:

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special tools required to maintain or dismantle</td>
<td>One complete set for each different size unit</td>
</tr>
</tbody>
</table>

   B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 EQUIPMENT SCHEDULES
   A. Some specific equipment requirements are listed in Equipment Schedule. Refer to Article Supplement.

2.02 GENERAL
   A. Operating Limits: Fans designated to meet a specified fan class shall comply with requirements of AMCA 99-2408.
B. Acoustical Levels: Equipment selections shall produce sound power levels in each octave band no greater than shown in Equipment Schedule in Article Supplements.

C. Fan Drives:

1. Drive assembly shall be sized for a minimum 140 percent of fan motor horsepower rating.
2. Furnish multiple drive belts where motor horsepower is 2 hp or larger.
3. Sheaves:
   a. Capable of providing 150 percent of motor horsepower.
   b. Unless otherwise noted, furnish belt-driven fans with cast iron or flanged steel sheaves.
4. Drive Adjustment:
   a. When fixed-pitch sheaves are furnished, accomplish system air balancing by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves.
   b. Provide trial and final sheaves, as well as drive belts, as required.
5. Fan Shafts: First critical speed of at least 125 percent of fan maximum operating speed.
6. Provide speed test openings at shaft locations.
7. Belts: Oil and heat resistant, nonstatic type.
8. Motors:
   a. Motors 20 hp or Smaller:
      1) Variable pitch V-belt sheaves allowing at least 20 percent speed variation.
      2) Final operating point shall be at approximate sheave midpoint.
   b. Motors Larger than 20 hp: Fixed-pitch sheaves.
   c. Furnish motors for V-belt drives with adjustable rails or bases.
9. Weather Cover: For outdoor applications, factory fabricated drive assembly of same material as fan housing, unless specified otherwise.
10. Belt and Shaft Guards:
    a. Easily removable and to enclose entire drive assembly, meeting federal, OSHA, and State of Oklahoma requirements.
    b. Guard faces of expanded metal having minimum 60 percent free area for ventilation.
    c. Bright yellow finish.

D. Finishes:

1. Carbon Steel Parts: Factory finish as follows, unless indicated otherwise.
   a. Parts cleaned and chemically pretreated with phosphatizing process.
b. Alkyd enamel primer.
c. Air dry enamel topcoat.

2. Aluminum Parts: Finished smooth and left unpainted, unless stated otherwise.

2.03 INLINE FAN, CENTRIFUGAL, SQUARE (30-SF-01, 30-SF-02)

A. General:

1. Factory-assembled, centrifugal, inline fan, square housing configuration; including housing, fan wheel, drive assembly, motor and accessories.
2. Bearing AMCA Certified Ratings Seal for sound and air performance.

B. Housing:

2. Integral duct collars.
3. Removable side panels, for ease of service.
4. Field convertible for side air discharge configuration.
5. Predrilled universal mounting brackets for vertical or horizontal installation.
7. Corrosion-resistant fasteners.
8. Drive belt and bearings separated from air steam by enclosure.

C. Wheel:

1. Centrifugal backward inclined, 100 percent aluminum construction.
2. Precision machined cast aluminum hub.
3. Die-formed airfoil or backward inclined blades.
4. Matched to inlet venturi.
5. Attached to fan shaft with split taper lock bushing.

D. Shaft, Bearings, Drive:

1. Shafts:
   a. Turned, ground and polished carbon steel.
   b. Keyed for sheave installation.
2. **Bearings:**
   a. Grease lubricated, precision antifriction ball, self-aligning, pillow block style, relubricatable or sealed type.
   b. Selected for average life (ABMA 9 L50) of not less than 200,000 hours operation at maximum cataloged operating speed.

3. **Drives:**
   a. In accordance with Paragraph Fan Drives.
   b. Factory set to specified fan revolutions per minute.
   c. Type: Direct.

**E. Accessories:**

1. **Provide as follows:**
   a. **Motor and Drive Cover:**
      1) Factory fabricated, OSHA type.
      2) Sheet metal construction, same material as fan housing.
      3) Vented, openings sufficient size for proper motor cooling.
      4) Fan speed controller.
   b. **Insulated Housing:** Fiberglass insulation, 1-inch thick, on interior of housing.
   c. **Filter Box:** Refer to Article Filter Housings.
   d. **Inlet Screen:** Removable 1-inch mesh screen, aluminum construction, overexposed inlets.
   e. **Disconnect:** Factory installed, nonfused, NEMA Type 1.
   f. **Single Side Discharge:** Package consisting of side duct connection collar and rear-discharge blank-off panel.
   g. **Bearing Lubrication Lines:**
      1) Extended to outside of fan housing.
      2) Terminate with zerk fittings.
   h. **Corrosion Protection Coating:**
      1) Provide factory-applied corrosion protection coating on the following:
         a) Wheel.
         b) Housing.
         c) Accessories.
         d) Interior surfaces in contact with airstream.
      2) Coating system shall be baked enamel and shall be in accordance with Article Corrosion Protection Coating.

**F. Manufacturers and Products:**

1. Greenheck; Model SQ.
2. Loren Cook; Model SQND.
3. ACME; Centri-Master Model XD.
4. Twin City Fan (Aerovent); Model ISD.
2.04 FILTER HOUSING

A. General:

1. Air filtration section, complete with filter media and filter racks.
2. Designed for static pressure ranges of minus 3 inches WC to plus 3 inches WC.
3. Design temperature not to exceed 200 degrees F.
4. Leakage at rated airflow upstream to downstream of filter frame shall be less than 1 percent at 3 inches WC. Leakage in to or out of housing shall be less than 0.5 percent at 3 inches WC.
5. V-Bank housings to be used for airflow rates 1,000 acfm or greater.
6. Flanged units suitable for installation in a duct and for space indicated.
7. Housing to fit standard nominal filter sizes, either 24 inches by 24 inches or 24 inches by 12 inches or as shown on Drawings.
8. Maximum 500 fpm face velocity across filters.
9. Filters arranged in a suitable leak-tight frame and enclosure.

B. Housing:

1. Permanent reusable, side-loading 16-gauge galvanized or aluminized steel frame and retainer.
2. Housing to be supported on a structural steel frame.
3. Doors:
   a. Provide hinged, quick-opening doors for access, service and removal of filters.
   b. Side access doors to be locked closed and opened without use of tools.
   c. Plastic door hardware to be made of UV-resistant materials.
   d. Provide doors on both sides of unit.
4. Provide upstream and downstream outwardly turned flanges of same material as housing.
5. Provide gaskets for filter tracks and doors for positive sealing. Filter track gaskets to be replaceable.
6. Treat cabinet and accessory surfaces inside and out with rust-inhibitive surface coating and painted with prime and finish coat of machinery enamel.
7. Provide upstream and downstream static pressure taps, with 1/4-inch diameter tube connections for measuring pressure drop across filters.
8. Provide lifting lugs suitable for lifting and assembled housing and filters.
9. Provide housing hanging brackets of same material as housing suitable to supporting complete filter housing assembly.
C. Filters:

1. Filter Media Thickness: 2 inches.
4. Initial clean filter resistance of 0.28-inch WC. Maximum filter resistance of 1-inch WC.

D. Accessories:

1. Filter Pressure Gauge: Furnish each filter bank with magnehelic gauge (Dwyer Series 2000) with connecting polypropylene tubing and adjustable signal flag.

E. Manufacturers and Products:

1. V-Bank Filter Housings:
   a. Flanders Precisionaire; Sureflo.
   b. Tri-Dim Filter Corp.; Tri-Met VB.
   c. Airguard; Model VB.

2.05 CORROSION PROTECTION COATING

A. General:

1. Factory-applied corrosion protection coating for application to fan components and accessories, where required by this section.
2. Quality Control:
   a. Verify dry film thickness before final baking.
   b. Finished coating system shall be free from voids, checks, cracks, and blisters.
3. Surface Cleaning:
   a. Clean parts to be coated as follows:
      1) Immerse parts in heated cleaning solution to remove lubricants, machining oils, and residual factory contamination.
      2) Follow with immersion in potable water bath to neutralize and remove cleaning solution.
      3) Chemical Pretreatment: Immerse parts in heated chemical solution, iron phosphate for steel, clear/yellow chromate for aluminum.
B. Baked Enamel:

2. Surface Preparation: Clean surface to SSPC SP 3.
4. Curing: Oven baked at a metal temperature not to exceed 300 degrees F.
5. Finished Thickness: 1-mil to 2-mil dry film thickness.
6. Performance: Coating shall meet or exceed following criteria:
   c. Service Temperature: Maximum 230 degrees F, continuous.

2.06 MOTORS

A. General:

1. Fan motors shall comply with provisions of Section 26 20 00, Low-Voltage AC Induction Motors.
3. Motors for fans specified for use with variable frequency drives shall be inverter duty type.
4. Motors shall not operate into service factor in any case.

B. Motor requirements shall be as follows, unless designated otherwise on Equipment Schedule:

1. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
2. Winding Thermal Protection: None.
5. Number of Windings: One.
7. Shaft Type: Solid, carbon steel.

2.07 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch-high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown on Drawings.
B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

2.08 SOURCE QUALITY CONTROL

A. General:

1. Fan shall operate at single stable point as indicated by fan curve. Fans having two potential operating points are not acceptable.
2. Fan and motor combination shall be capable of delivering 110 percent of scheduled air quantity and static pressure. Motor shall not operate into motor service factor in any listed case.
3. Consider drive efficiency in motor selection according to manufacturer’s published recommendation or according to AMCA 203, Appendix L.

B. Testing Provisions:

1. Provide tachometer access holes large enough to accept standard tachometer drive shaft.
2. Center punch fan shaft to accommodate tachometer readings.

C. Acoustical Levels:

1. Perform noise tests in accordance with AMCA 300 and AMCA 301.
2. Fan sound power levels (dB, Reference 10⁻¹² Watts) shall be no greater than scheduled values.

D. Balancing:

1. Unless noted otherwise, each fan wheel shall be statically and dynamically balanced to ASA S2.19 Grade G6.3.
2. Fans controlled by variable frequency drives shall be dynamically balanced at speeds 25 percent, 50 percent, 75 percent, and 100 percent of design revolutions per minute.

E. Vibration Test:

1. Each fan furnished with 5 hp or larger motor shall have factory run vibration test, including vibration signatures taken on each bearing in horizontal, vertical, and axial direction.
2. Vibration reading as measured at scheduled rotational speed shall not exceed the following values when fan is rigidly mounted:
   a. Belt Drive (except Vane Axial): 0.15-inch per second peak velocity.
   b. Belt Drive Vane Axial: 0.08-inch per second peak velocity.
   c. Direct Drive: 0.08-inch per second peak velocity.
3. Written records of run test and vibration test shall be made available upon request.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install fans level and plumb.

B. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

C. Scroll Drains: Pipe drain connection through running trap to floor drain.

D. Labeling:
   1. Label fans in accordance with Article Accessories.
   2. Mark exhaust fans serving fume hoods with arrows to indicate proper direction of rotation, in accordance with NFPA 45.

E. Service Access: Locate units to provide access spaces required for motor, drive, bearing servicing, and fan shaft removal.

F. Equipment Support and Restraints:
   1. Refer to Section 23 05 48, Vibration Isolation for HVAC Piping and Equipment.
   2. Secure vibration controls to concrete bases using anchor bolts cast in concrete base.
   3. Seismic Restraint Snubbers: Install with sufficient clearance so unit isolators are not restricted for proper free isolation, but do limit movement in all directions.

G. Connections:
   1. Refer to Section 23 31 13, Metal Ducts and Accessories.
   2. Isolate duct connections to fans.
   3. Install ductwork adjacent to fans to allow proper service and maintenance.
3.02 FIELD QUALITY CONTROL

A. Functional Tests:

1. Verify blocking and bracing used during shipping are removed.
2. Verify fan is secure on mountings and supporting devices, and connections to ducts and electrical components are complete.
3. Verify proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify cleaning and adjusting are complete.
5. Disconnect fan drive from motor; verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
6. Reconnect fan drive system; align and adjust belts and install belt guards.
7. Verify lubrication for bearings and other moving parts.
8. Verify manual and automatic volume control and fire and smoke dampers in connected ductwork are in fully open position.

B. Performance Tests:

1. Starting Procedures:
   a. Energize motor and adjust fan to indicated revolutions per minute.
   b. Measure and record motor voltage and amperage.
2. Operational Test:
   a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   b. Repair or replace malfunctioning units; retest as specified after repairs or replacement is made.
   c. Test and adjust control safeties.
   d. Replace damaged and malfunctioning controls and equipment.

3.03 MANUFACTURER’S SERVICES

A. Manufacturer’s Representative:

1. Present at site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
   a. 1 person-day for installation assistance and inspection.
   b. 1 person-day for functional and performance testing and completion of Manufacturer’s Certificate of Proper Installation.
   c. 1 person-day for prestartup classroom or site training.
   d. 1 person-day for facility startup.
   e. 1 person-day for post-startup training of Owner’s personnel.

B. Refer Section 01 43 33, Manufacturers’ Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.
3.04 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Balancing:
   
   1. Perform air system balancing as specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
   
   2. Replace fan and motor sheaves as required to achieve design airflow.

E. Vibration Testing:
   
   1. Perform field testing on rotating equipment, where specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC, to determine actual operating vibration.
   
   2. If vibration limits described therein are exceeded, rebalance equipment in-place until design tolerances are met.

3.05 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

B. On completion of installation, internally clean fans according to manufacturers’ written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

3.06 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this Specification.

   1. Fans Schedule.

END OF SECTION
<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SERVICE</th>
<th>TYPE</th>
<th>AIRFLOW</th>
<th>MAX CFM</th>
<th>IN W.G.</th>
<th>MIN CFM</th>
<th>SPEED</th>
<th>RPM</th>
<th>DRIVE TYPE</th>
<th>MIN. DIA.</th>
<th>BHP</th>
<th>MAXIMUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zink Dam Improvement</td>
<td>70-SF-01</td>
<td>ELECTRICAL ROOM SUPPLY</td>
<td>INLINE SQUARE CENTRIFUGAL</td>
<td>2,500</td>
<td>1.25</td>
<td>1,000</td>
<td>1392</td>
<td>DIRECT</td>
<td>BI</td>
<td>16.5</td>
<td>0.95</td>
<td>3.93</td>
</tr>
<tr>
<td></td>
<td>70-SF-02</td>
<td>COMPRESSOR ROOM SUPPLY</td>
<td>INLINE SQUARE CENTRIFUGAL</td>
<td>10,700</td>
<td>1.20</td>
<td>1,500</td>
<td>783</td>
<td>DIRECT</td>
<td>BI</td>
<td>30</td>
<td>3.39</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SERVICE</th>
<th>TYPE</th>
<th>AIRFLOW</th>
<th>MAX CFM</th>
<th>IN W.G.</th>
<th>MIN CFM</th>
<th>SPEED</th>
<th>RPM</th>
<th>DRIVE TYPE</th>
<th>MIN. DIA.</th>
<th>BHP</th>
<th>MAXIMUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zink Dam Improvement</td>
<td>70-SF-01</td>
<td>ELECTRICAL ROOM SUPPLY</td>
<td>INLINE SQUARE CENTRIFUGAL</td>
<td>2,500</td>
<td>1.25</td>
<td>1,000</td>
<td>1392</td>
<td>DIRECT</td>
<td>BI</td>
<td>16.5</td>
<td>0.95</td>
<td>3.93</td>
</tr>
<tr>
<td></td>
<td>70-SF-02</td>
<td>COMPRESSOR ROOM SUPPLY</td>
<td>INLINE SQUARE CENTRIFUGAL</td>
<td>10,700</td>
<td>1.20</td>
<td>1,500</td>
<td>783</td>
<td>DIRECT</td>
<td>BI</td>
<td>30</td>
<td>3.39</td>
<td></td>
</tr>
</tbody>
</table>

**SOUND DATA**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SERVICE</th>
<th>TYPE</th>
<th>AIRFLOW</th>
<th>MAX CFM</th>
<th>IN W.G.</th>
<th>MIN CFM</th>
<th>SPEED</th>
<th>RPM</th>
<th>DRIVE TYPE</th>
<th>MIN. DIA.</th>
<th>BHP</th>
<th>MAXIMUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zink Dam Improvement</td>
<td>70-SF-01</td>
<td>ELECTRICAL ROOM SUPPLY</td>
<td>INLINE SQUARE CENTRIFUGAL</td>
<td>2,500</td>
<td>1.25</td>
<td>1,000</td>
<td>1392</td>
<td>DIRECT</td>
<td>BI</td>
<td>16.5</td>
<td>0.95</td>
<td>3.93</td>
</tr>
<tr>
<td></td>
<td>70-SF-02</td>
<td>COMPRESSOR ROOM SUPPLY</td>
<td>INLINE SQUARE CENTRIFUGAL</td>
<td>10,700</td>
<td>1.20</td>
<td>1,500</td>
<td>783</td>
<td>DIRECT</td>
<td>BI</td>
<td>30</td>
<td>3.39</td>
<td></td>
</tr>
</tbody>
</table>

**ELECTRICAL DATA**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SERVICE</th>
<th>TYPE</th>
<th>AIRFLOW</th>
<th>MAX CFM</th>
<th>IN W.G.</th>
<th>MIN CFM</th>
<th>SPEED</th>
<th>RPM</th>
<th>DRIVE TYPE</th>
<th>MIN. DIA.</th>
<th>BHP</th>
<th>MAXIMUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zink Dam Improvement</td>
<td>70-SF-01</td>
<td>ELECTRICAL ROOM SUPPLY</td>
<td>INLINE SQUARE CENTRIFUGAL</td>
<td>2,500</td>
<td>1.25</td>
<td>1,000</td>
<td>1392</td>
<td>DIRECT</td>
<td>BI</td>
<td>16.5</td>
<td>0.95</td>
<td>3.93</td>
</tr>
<tr>
<td></td>
<td>70-SF-02</td>
<td>COMPRESSOR ROOM SUPPLY</td>
<td>INLINE SQUARE CENTRIFUGAL</td>
<td>10,700</td>
<td>1.20</td>
<td>1,500</td>
<td>783</td>
<td>DIRECT</td>
<td>BI</td>
<td>30</td>
<td>3.39</td>
<td></td>
</tr>
</tbody>
</table>

**APPLICABLE REMARKS:**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SERVICE</th>
<th>TYPE</th>
<th>AIRFLOW</th>
<th>MAX CFM</th>
<th>IN W.G.</th>
<th>MIN CFM</th>
<th>SPEED</th>
<th>RPM</th>
<th>DRIVE TYPE</th>
<th>MIN. DIA.</th>
<th>BHP</th>
<th>MAXIMUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zink Dam Improvement</td>
<td>70-SF-01</td>
<td>ELECTRICAL ROOM SUPPLY</td>
<td>INLINE SQUARE CENTRIFUGAL</td>
<td>2,500</td>
<td>1.25</td>
<td>1,000</td>
<td>1392</td>
<td>DIRECT</td>
<td>BI</td>
<td>16.5</td>
<td>0.95</td>
<td>3.93</td>
</tr>
<tr>
<td></td>
<td>70-SF-02</td>
<td>COMPRESSOR ROOM SUPPLY</td>
<td>INLINE SQUARE CENTRIFUGAL</td>
<td>10,700</td>
<td>1.20</td>
<td>1,500</td>
<td>783</td>
<td>DIRECT</td>
<td>BI</td>
<td>30</td>
<td>3.39</td>
<td></td>
</tr>
</tbody>
</table>

**ABBREVIATIONS:**

- FC: FORWARD CURVED
- BI: BACKWARD INCLINED
- AF: AIR FOIL

**REMARKS:**

- A: ELECTRONICALLY COMMUTATED MOTOR W/MFR CONTROLS
- B: INCLUDE TEMPERATURE CONTROL KIT FOR EC MOTOR. PROGRAM MIN AND MAX FAN CFM AS SCHEDULED.
- C: INCLUDE PRESSURE CONTROL KIT FOR EC MOTOR. PROGRAM MIN AND MAX FAN CFM AS SCHEDULED. MAINTAIN SPACE PRESSURE OF +0.05" WC.
- D: PROVIDE FILTER MODULE WITH DISPOSABLE MERV8 FILTERS.
- E: REFER TO SPECIFICATION 23 34 00 FOR ADDITIONAL REQUIREMENTS.
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

3. UL.

1.02 DEFINITIONS

A. NC: Noise Criteria; background sound rating method for indoor sound.
B. VAV: Variable air volume.
C. WC: Water column.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer’s data and descriptive literature products specified.
   b. Furnish the following information for each type of diffuser, register, and grille furnished.
      1) NC sound data.
      2) Static pressure loss data.
      3) Throw data.

PART 2 PRODUCTS

2.01 SUPPLY GRILLES AND Registers

A. Supply Grilles (SG-1):

1. Construction as follows:
   b. Finish: Baked white enamel face finish.
c. SR Register Accessories:
   1) Gang-operated opposed-blade volume control damper.
   2) Material to match grille.
2. Adjustable front horizontal and rear vertical vanes on 3/4-inch centers.
3. Continuous sponge rubber gasket at face flange.
4. 1-inch minimum flat rectangular frame.
5. Performance as follows:
   a. Maximum Pressure Drop: 0.1-inches WC.
   b. Sound: Maximum NC 30.
6. Manufacturers and Products:
   a. Krueger; 880/5880 Series.
   b. Titus; 300 Series.

PART 3 EXECUTION

3.01 INSTALLATION

   A. Install diffusers, grilles, and registers tight on their respective mounting surfaces, level, plumb, and true with room dimensions.

   END OF SECTION
SECTION 23 82 00
TERMINAL HEATING AND COOLING UNITS

PART 1  GENERAL

1.01  REFERENCES

A.  The following is a list of standards which may be referenced in this section:

2. American Gas Association (AGA).
4. ASTM International (ASTM):
5. Canadian Gas Association (CGA).
6. Electrical Test Laboratories (ETL).
7. National Electrical Manufacturer’s Association (NEMA).
   a. 54, National Fuel Gas Code.
   b. 70, National Electrical Code (NEC).
10. UL: Product Directories.

1.02  DEFINITIONS

A.  The following is a list of abbreviations which may be used in this section:

1. AC: Alternating Current.
2. CISD: Chemical Industry, Severe-Duty.
3. dB: Decibel.
4. DWDI: Double Width, Double Inlet.
5. FRP: Fiberglass Reinforced Plastic.
6. hp: Horsepower.
7. ODP: Open Drip Proof.
8. PSC: Permanent Split Capacitor.
11. UV: Ultraviolet.
12. XP: Explosion Proof.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings.
2. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics for products specified.
3. Manufacturer’s standard finish color selection for cabinet finishes.
4. Performance data, including sound power level data (reference 10 to minus 12 power watts) at design operating point, shall be based on AMCA 300.

B. Informational Submittals:

1. Manufacturer’s test reports for the following:
   a. Hot water unit heater(s) coil pressure test.
   b. Cabinet unit heater electric heating coil.
   c. Booster heating coil.
   d. Electric duct heater.
2. Recommended procedures for protection and handling of equipment and materials prior to installation.
3. Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt the arrangement or details shown to the equipment furnished.
4. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data. Include as-built version of equipment schedules.

1.04 QUALITY ASSURANCE

A. Heating Equipment: Minimum operating efficiencies, specified in Chapter 6 of ASHRAE 90.1 IP/SI and the State of Oklahoma Energy Code if applicable.
PART 2 PRODUCTS

2.01 UNIT HEATER, ELECTRIC, SUSPENDED (70-UH-01, 70-UH-02, 70-UH-03, 70-UH-04)

A. Characteristics:

1. Factory assembled including casing, heater elements, fan wheel, drive assembly, motor, controls and accessories.
2. UL listed.
4. Three phase heaters shall have balanced phases.
5. Casing:
   a. Heavy gauge steel casing.
   b. Baked enamel finish.
   c. Individual adjustable discharge louvers.
   d. Protective air inlet louvers or fan guards.
6. Heating elements shall be one of the following types:
   a. Aluminum finned, copper clad, steel sheath.
   b. High mass, all steel tubular finned type, copper brazed, in fixed element banks.
   c. Nickel-chromium wire elements enclosed in powder filled aluminum coated steel tubes with permanently fused fins.
   d. Steel tubes with nickel chromium resistance wire embedded in a dielectric with steel fins crimped and brazed to the tube.
   e. Corrosion-resistant steel fins brazed to tubular heating elements.
7. Fan and Motor:
   a. Totally enclosed motor.
   b. Direct drive fan.
   c. Sealed bearings. Permanently lubricated.
8. Controls:
   a. Thermal overload protection with automatic reset.
   b. Controls, transformers, and contactors shall be factory assembled, except wall mounted thermostats when indicated.

B. Accessories and Features:

1. Provide as follows:
   a. Airflow discharge shall be horizontal.
   c. Voltage: 480-volt, three-phase.
   d. Wall mounting bracket.
   e. Thermostat: Adjustable, unit mounted, low voltage with a minimum temperature range of 40 degrees F to 85 degrees F.
C. Manufacturers and Products:

1. Chromolox; Series LUH (horizontal discharge).
2. Qmark; Type MUH.
3. Trane; Type UHEC.
4. Modine: Type HER (horizontal discharge).
5. Markel; Series 5100.

2.02 ELECTRICAL

A. General:

1. Units shall include high and low voltage terminal block connections.
2. Control voltage to indoor unit fan shall be 24 volts.
3. Motor Starters/Contactors: Factory installed with unitary equipment, unless otherwise noted.
4. Disconnects: Factory installed nonfused disconnects or circuit breakers on each unit, unless otherwise noted.

B. Motors:

1. Refer to Section 26 20 00, Low-Voltage AC Induction Motors, for general requirements.
2. Unless otherwise stated, electric motors shall comply with the following:
   a. Voltage, Phase, Horsepower, Synchronous Speed: Refer to Equipment Schedule for motor driven equipment.
   b. Enclosure: ODP, unless specified otherwise.
   c. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
   d. Winding Thermal Protection: Manufacturer’s standard.
   e. Space Heater: Manufacturer’s standard.
   f. Multispeed Motors, Synchronous Speed, Number of Windings: Manufacturer’s standard.
   g. Efficiency: Minimum efficiency per Section 26 20 00, Low-Voltage AC Induction Motors.

2.03 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.
B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

2.04 SOURCE QUALITY CONTROL

A. Functional Test:
   1. Perform manufacturer’s standard factory motor and coil test on equipment.
   2. Test equipment actually furnished.
   3. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.
   4. Equipment with Hot Water Heating Coils: No leaks when tested underwater with 300-psig air.
   5. Equipment with Electric Resistance Heating Coils: Test with 2,000-volt dielectric test.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install in strict compliance with manufacturer’s instructions. Maintain clearances around unit as listed in manufacturer’s recommendations.

B. Electric Unit Heaters, All Types:
   1. Bottom of unit shall be a minimum of 8 feet above finish floor, unless indicated otherwise.
   2. Heater shall be permanently mounted in position indicated with a fixed power supply.
   3. Install so obstructions do not block heater air inlet or outlet.

3.02 MANUFACTURER’S SERVICES

A. Provide manufacturer’s representative at site in accordance with Section 01 43 33, Manufacturers’ Field Services, for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of Owner’s personnel for specified equipment.

END OF SECTION