CONTRACT DOCUMENTS

AND

SPECIFICATIONS

FOR

PROJECT NO. TMUA-W 24-05
A.B. JEWELL WTP RESIDUALS IMPROVEMENTS PHASE 2

ATTENDANCE AT PRE-BID CONFERENCE IS MANDATORY

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VOLUME II

SECTION 00 01 07
SEALS PAGE

SPECIFICATIONS
- DIVISION 01 – GENERAL REQUIREMENTS
  - Excluding 01 57 13, 01 88 15
- DIVISION 02 – EXISTING CONDITIONS
- DIVISION 09 – FINISHES
- DIVISION 31 – EARTHWORK
  - 31 23 23, 31 23 23.15
- DIVISION 33 – UTILITIES
- DIVISION 40 – PROCESS INTERCONNECTIONS
  - Excluding 40 90 01, 40 99 90
- DIVISION 44 – POLLUTION AND WASTE CONTROL EQUIPMENT



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May 11, 2026

B. Luke Lenard

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SPECIFICATIONS
DIVISION 01 – GENERAL REQUIREMENTS
01 57 13
DIVISION 32 – EXTERIOR IMPROVEMENTS



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SPECIFICATIONS

DIVISION 01 – GENERAL REQUIREMENTS

01 88 15

DIVISION 03 – CONCRETE

DIVISION 04 – MASONRY

DIVISION 05 – METALS

DIVISION 07 – THERMAL AND MOISTURE PROTECTION



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SPECIFICATIONS
DIVISION 26 – ELECTRICAL



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SPECIFICATIONS
DIVISION 40 – PROCESS INTERCONNECTIONS
40 90 01, 40 99 90



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END OF SECTION

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TABLE OF CONTENTS

VOLUME 1

City of Tulsa Construction Specifications (Provided by City of Tulsa)

VOLUME 2

PART 1—SPECIFICATIONS Page

DIVISION 01—GENERAL REQUIREMENTS

01 11 00	Summary of Work	1- 1
01 29 00	Payment Procedures	1- 9
01 31 13	Project Coordination	1- 9
01 31 19	Project Meetings	1- 3
01 32 00	Construction Progress Documentation	1- 8
01 33 00	Submittal Procedures	1- 10
	Supplement:	
	Transmittal of Contractor's Submittal	1- 1
01 42 13	Abbreviations and Acronyms	1- 5
01 43 33	Manufacturers' Field Services	1- 4
	Supplement:	
	Manufacturer's Certificate of Proper Installation	1- 1
01 45 16.13	Contractor Quality Control	1- 10
01 45 33	Special Inspection, Observation, and Testing	1- 7
	Supplements:	
	Contractor's Statement of Responsibility	1- 2
	Fabricator's Certificate of Compliance	1- 1
	Statement of Special Inspections	1- 65
01 50 00	Temporary Facilities and Controls	1- 14
01 57 13	Temporary Erosion and Sediment Control	1- 30
01 61 00	Common Product Requirements	1- 8
	Supplement:	
	Manufacturer's Certificate of Compliance	1- 1
01 77 00	Closeout Procedures	1- 4
01 78 23	Operation and Maintenance Data	1- 8
	Supplements:	
	Maintenance Summary Form	1- 2
	Lucity Asset Data Collection Template	1- 7
01 88 15	Anchorage and Bracing	1- 8
01 91 14	Equipment Testing and Facility Startup	1- 3
	Supplement:	
	Equipment Testing Form	1- 1

DIVISION 02—EXISTING CONDITIONS

02 41 00	Demolition	1- 7

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Pages

DIVISION 03—CONCRETE

03 01 32 Repair of Vertical and Overhead Concrete Surfaces 1- 17
03 01 33 Repair of Horizontal Concrete Surfaces 1- 16
03 10 00 Concrete Forming and Accessories 1- 8
03 21 00 Steel Reinforcement 1- 7
03 30 00 Cast-in-Place Concrete 1- 23
Supplement:
Concrete Mix Design CMD-1 ..... 1- 3
03 39 00 Concrete Curing 1- 6
03 62 00 Grouting 1- 11
Supplement:
24-hour Evaluation of Nonshrink Grout Test Form and Grout Testing Procedures 1- 4
03 63 00 Concrete Doweling 1- 5
03 64 23 Epoxy Resin Injection Grouting 1- 14
03 64 24 Polyurethane Injection Grouting 1- 10

DIVISION 04—MASONRY

04 22 00 Concrete Unit Masonry 1- 17

DIVISION 05—METALS

05 05 19 Post-Installed Anchors 1- 10
05 50 00 Metal Fabrications 1- 24

DIVISION 06 (NOT USED)

DIVISION 07—THERMAL AND MOISTURE PROTECTION

07 92 00 Joint Sealants 1- 9

DIVISION 08 (NOT USED)

DIVISION 09—FINISHES

09 90 00 Painting and Coating 1- 22
Supplements:
Paint System Data Sheet (PSDS) 1- 1
Paint Product Data Sheet (PPDS) 1- 1

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Pages

DIVISION 10 THROUGH DIVISION 25 (NOT USED)

DIVISION 26—ELECTRICAL

26 05 01 Electrical 1- 25

DIVISION 27 THROUGH DIVISION 30 (NOT USED)

DIVISION 31—EARTHWORK

31 23 23 Fill and Backfill 1- 7
31 23 23.15 Trench Backfill 1- 9

DIVISION 32—EXTERIOR IMPROVEMENTS

32 11 23 Aggregate Base Course 1- 5
32 12 16 Asphalt Paving 1- 11
32 13 13 Concrete Paving 1- 18

DIVISION 33—UTILITIES

33 05 01 Conveyance Piping—General 1- 7
33 05 01.09 Polyvinyl Chloride (PVC) Pressure Pipe and Fittings 1- 5
33 12 19 Water Utility Distribution Fire Hydrants 1- 4
33 13 00 Disinfection of Water Utility Distribution Facilities 1- 5

DIVISION 34 THROUGH DIVISION 39 (NOT USED)

DIVISION 40—PROCESS INTERCONNECTIONS

40 05 15 Piping Support Systems 1- 8
Supplement:
Table 1: Nonchemical Areas 1- 1
40 27 00 Process Piping—General 1- 14
Supplement:
Piping Schedule 1- 2
40 27 00.10 Polyvinyl Chloride (PVC) Pipe and Fittings Data Sheet 1- 2
40 27 00.13 Copper and Copper Alloy Pipe, Tubing, and Fittings Data Sheet 1- 1
40 27 00.15 Polyurethane Tubing Data Sheet 1- 1
40 27 01 Process Piping Specialties 1- 8

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Pages

40 27 02	Process Valves and Operators	1- 10
	Supplement:	
	Self-Regulated Valve Schedule	1- 1
40 80 01	Process Piping Leakage Testing	1- 3
40 90 01	Instrumentation and Control for Process Systems	1- 40
	Supplements:	
	Component Specifications	1- 4
	Instrument List	1- 1
	Loop Specification	1- 1
	IO List	1- 1
	Instrument Calibration Sheet	1- 2
	I&C Valve Adjustment Sheet	1- 4
	Performance Acceptance Test Sheet	1- 2
40 99 90	Package Control Systems	1- 17

DIVISION 41 THROUGH DIVISION 43 (NOT USED)

DIVISION 44—POLLUTION AND WASTE CONTROL EQUIPMENT

44 44 63.02	Polymer Feed System, Dry	1- 11
44 46 13.01	Belt Conveyor System	1- 10
	Supplement:	
	Induction Motor Data Sheet	1- 1
44 46 16	Belt Filter Press Dewatering Equipment	1- 12

DIVISION 45 THROUGH DIVISION 49 (NOT USED)

END OF SECTION

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PART 1

SPECIFICATIONS

SECTION 01 11 00
SUMMARY OF WORK

PART 1 GENERAL

1.01 WORK COVERED BY CONTRACT DOCUMENTS

A. The completed Work will provide the Owner with an improved residual handling system at the A.B. Jewell Water Treatment Plant. The Project includes but is not limited to:

1. Installation of a new decant pipe on the existing blend tank.
2. Refurbishment on the existing three belt filter presses.
3. Demolition and installation of two dry polymer mixing systems.
4. Demolition and installation of a new belt conveyor.
5. Resurface the residuals storage area.
6. Installation of a new lagoon waterline.
7. Install and removal of a temporary mobile dewatering unit.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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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 MEP ALLOWANCE

A. An allowance as shown in the Proposal has been provided in the Contract for various mechanical, electrical, and plumbing (MEP) work.

B. The allowance shall be used for the cost of materials, labor, installation, and overhead and profit in accordance with GC-26, for additional MEP work that is not identified in the Construction Documents and on the Drawings, and not included in the base bid lump sum.

C. The allowance shall be used only at the discretion of the Authority.

D. Contractor shall provide the Authority Representative a written request for the use of the allowance with a schedule of values and associated backup information.

E. Contractor shall proceed with work included in the allowance only after receiving a written order from the Authority Representative authorizing such work. Proceeding with work in the allowance without a written order from the Authority Representative will be at the Contractor's cost.

1.03 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: Reflect unit price quantity and price breakdown from conformed Bid Form.

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D. Lump Sum 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.
   a. Mobilization includes, at minimum, items identified in Section 01 50 00, Temporary Facilities and Controls.
   b. Include item(s) for monthly progress schedule update.

E. Break down by Division 02, Existing Conditions, through Division 44, Pollution and Waste Control Equipment, with appropriate subdivision for each specification.

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

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

H. Submit Schedule of Values by email, in a spreadsheet format compatible with latest version of Excel.

1.04 SCHEDULE OF ESTIMATED PROGRESS PAYMENTS

A. Show estimated payment requests throughout Contract Times aggregating initial Contract Price.

B. Base estimated progress payments on initially acceptable progress schedule. Adjust to reflect subsequent adjustments in progress schedule and Contract Price as reflected by modifications to the Contract Documents.

1.05 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 suitable to Engineer.

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.

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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.

1.06 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.

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F. Quantities will be based on ground profiles shown. Field surveys will not be made to confirm accuracy of elevations shown.

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

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

Item	Method of Measurement
AC	Acre—Field Measure by Engineer
CY	Cubic Yard—Field Measure by Engineer within limits specified or shown
CY-VM	Cubic Yard—Measured in Vehicle by Volume
EA	Each—Field Count by Engineer
GAL	Gallon—Field Measure by Engineer
HR	Hour
LB	Pound(s)—Weight Measure by Scale
LF	Linear Foot—Field Measure by Engineer
MFBM	Thousand Foot Board Measure—Field Measure by Engineer
SF	Square Foot
SY	Square Yard
TON	Ton—Weight Measure by Scale (2,000 pounds)

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I. 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:

Item	Measurement Parameters
Trench Safety System	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, 6 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.
Unclassified Trench Excavation	Depth of Trench: Same as Trench Safety System above.
Trench Backfill and Compaction	Depth of Trench: Same as Unclassified Trench Excavation above.
Rock Excavation	Depth: Same as for Unclassified Trench Excavation above except that depth will be measured from surface of rock to bottom of pipe base 6 inches below pipe invert.

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1.07 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 are 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 item not specifically described but required by the Drawings, Contract Documents, and Specifications shall be included in the appropriate items. The lump sum Bid items shall be broken down for the purpose of monthly process payment as outlined below. Breakdown of the lump sum items shall be provided by the apparent low Bidder within 48 hours after the Bid opening.
2. The Authority pays vendor invoices directly based upon written documentation submitted to and approved by the Authority.

B. Unit Price Pay Items:

1. Mobilization:
   a. 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 basis in the following manner:
      1) 50 percent on the first pay estimate.
      2) 35 percent on the pay estimate that shows 50 percent completion of the Work, not including allowances for stored materials.
      3) 15 percent on the final pay estimate.
2. Temporary Erosion and Sediment Control: Provide all materials, labor, equipment. and associated items necessary to provide erosion control in accordance with the Contract Documents. This item shall be paid for on a unit basis of each (EA) using a breakdown approved by the Engineer.
3. Traffic Control: Provide all materials, labor, equipment. and associated items necessary to provide traffic control. This item shall be paid for on a unit basis of each (EA) using a breakdown approved by the Engineer.
4. Demolition: Provide all materials, labor, equipment, and associated items necessary to provide demolition, hauling and disposal costs. This item shall be paid for on a unit basis of each (EA) using a breakdown approved by the Engineer.
5. Belt Filter Press – Rehabilitation: Provide all materials, labor, equipment and associated items necessary to refurbish three belt filter presses including new air compressor piping, plant wash water piping,

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removal and reinstallation of walkways and grating, and a 2-year warranty. This item shall be paid for on a unit basis of each (EA) using a breakdown approved by the Engineer.

6. Belt Filter Press – Temporary Dewatering Unit: Provide all materials, labor, equipment, and associated items necessary to provide a temporary dewatering unit including temporary piping, polymer for dewatering operation, and electrical connections. This item shall be paid for on a unit basis of each (EA) using a breakdown approved by the Engineer.
7. Conveyor: Provide all materials, labor, equipment, and associated items necessary to install Conveyor including prep work, grouting, connections, supports (including design calculations and drawings signed by a structural engineer licensed in the state of Oklahoma), and interlock with Belt Filter Press as required for a complete installation. This item shall be paid for on a unit basis of each (EA) using a breakdown approved by the Engineer.
8. Polymer System: Provide all materials, labor, equipment, and associated items necessary to for a complete installation including new polymer injectors and static mixers, level transmitters and control panels. This item shall be paid for on a unit basis of each (EA) using a breakdown approved by the Engineer.
9. Residuals Blend Tank: Provide all materials, labor, equipment, and associated items necessary for a complete installation including piping materials, fittings, supports, tank penetration, and valves. This item shall be paid for on a unit basis of each (EA) using a breakdown approved by the Engineer.
10. Lower Lagoon - Excavation: Provide all materials, labor, equipment, and associated items necessary for excavation for the lower lagoon waterline. This item shall be paid for on a cubic yard (CY) basis.
11. Lower Lagoon - Bedding: Provide all materials, labor, equipment, and associated items necessary for bedding for the lower lagoon waterline. This item shall be paid for on a cubic yard (CY) basis.
12. Lower Lagoon - Backfill: Provide all materials, labor, equipment, and associated items necessary for backfill for the lower lagoon waterline. This item shall be paid for on a cubic yard (CY) basis.
13. Lower Lagoon - Haul off, including swell: Provide all materials, labor, equipment, and associated items necessary for haul off for the lower lagoon waterline. This item shall be paid for on a cubic yard (CY) basis.
14. Lower Lagoon - Trench Safety: Provide all materials, labor, equipment, and associated items necessary for trench safety for the lower lagoon waterline. This item shall be paid for on a lump sum (LS) basis.
15. Lower Lagoon - 10-inch PVC, AWWA C900, DR14: Provide all materials, labor, equipment, piping, and associated items necessary to install 10-inch PVC waterline, including piping materials and supports. This item shall be paid for on a linear feet (LF) basis.

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16. Lower Lagoon - Restrained Joint (RJ) 10-inch PVC, AWWA C900, DR14: Provide all materials, labor, equipment, piping, and associated items necessary to install restrained 10-inch PVC waterline, including piping materials and supports. This item shall be paid for on a linear feet (LF) basis.
17. Lower Lagoon - Connection to Existing 24-inch Waterline: Provide all materials, labor, equipment and associated items necessary to make connection to the existing 24-inch waterline including any materials and supports. This item shall be paid for on an each (EA) basis.
18. Lower Lagoon - 10-Inch 45 DEG DI (RJ): Provide all materials, labor, equipment, and associated items necessary for installation of the 10-inch 45 Deg DI RJ. This item shall be paid for on an each (EA) basis.
19. Lower Lagoon - Thrust Block: Provide all materials, labor, equipment and associated items necessary to install thrust blocks. This item shall be paid for on an each (EA) basis.
20. Lower Lagoon - Water Locator Balls: Provide all materials, labor, and equipment necessary to install water locator balls. This item shall be paid for on an each (EA) basis.
21. Lower Lagoon - 10-Inch x 6-Inch DI Tee: Provide all materials, labor, equipment, and associated items necessary for installation of the 10-inch by 6-inch DI Tee. This item shall be paid for on an each (EA) basis.
22. Lower Lagoon - 6-Inch Gate Valve DI RJ: Provide all materials, labor, equipment, and associated items necessary for installation of the 6-inch gate valve RJ. This item shall be paid for on an each (EA) basis.
23. Lower Lagoon - Hydrant Assembly, Complete, In-Place: Provide all materials, labor, equipment, and associated items necessary for installation of the Hydrant Assemblies. This item shall be paid for on an each (EA) basis.
24. Lower Lagoon - Pipe Testing/Flushing/Disinfection: Provide all materials, labor, equipment, and associated items necessary for pipe testing, flushing, and disinfection of the full lower lagoon waterline, fittings, and valves. This item shall be paid for on a linear feet (LF) basis.
25. Lower Lagoon - Reseeding: Provide all materials, labor, equipment and associated items necessary for reseeding of the disturbed area of the lower lagoon waterline.

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26. Owner's Allowance:
    a. Allowance for various work not identified in the Contract Documents:
        1) Allowance 10,000 dollars.
        2) The allowance shall be used only at the discretion of the City of Tulsa. Any allowance balance remaining at the completion of the Project will be credited back to the City of Tulsa on the final Application for Payment submitted by the Contractor.
27. Construction As-Builts: This pay items includes all work necessary for the completion of the Construction As-Builts and provided to the Engineers as required by the Contract Documents and shall include an as-built survey, including location and elevation of equipment and structures. This item shall be paid for on a unit basis of each (EA) using a breakdown approved by the Engineer.

C. Alternates:

1. Alternate 01:
    a. Full Residuals Storage Area Paving: Provide all materials, labor, equipment, and associated items necessary to repave the full residuals storage area as shown on the Drawings. This item shall be paid for on a linear foot (LF) basis.
2. Alternate 02:
    a. Partial Residuals Storage Area Paving: Provide all materials, labor, equipment, and associated items necessary to partially repave the solids storage area as shown on the Drawings. This item shall be paid for on a linear foot (LF) basis.
3. Alternate 03:
    a. Instrumentation and Controls, Complete, In-Place: Provide cost for all SCADA integration including PLC programming for updates required for the belt filter press rehabilitation, automation and integration of the new conveyor, and automation and integration of the new polymer systems. This item shall be paid for on a unit basis of each (EA) using a breakdown approved by the Engineer.

1.08 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.

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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.

1.09 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.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 31 13
PROJECT COORDINATION

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Statement of Qualification (SOQ) for land surveyor or civil engineer.
2. Photographs:
   a. Digital Images: Submit one copy of digital files to Project Site or USB Drive containing images within 5 days of being taken.
   b. 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 two copies, including updated copy of project video log, within 5 days of being taken.

1.02 RELATED WORK AT SITE

A. General:

1. Other work that is either directly or indirectly related to scheduled performance of the Work under these Contract Documents, listed henceforth, is anticipated to be performed at Site by others.
2. Coordinate the Work of these Contract Documents with work of others as specified in General Conditions.
3. Include sequencing constraints specified herein as a part of Progress Schedule.

B. Applications Software Development:

1. Engineer will perform programming of applications software for Process Instrumentation and Control Subsystem (PICS). Refer to Section 40 90 01, Instrumentation and Control for Process Systems, for detailed information pertaining to Engineer programming.
   a. Coordinate testing with the Engineer, as specified for PICS.
   b. Sequencing: Include sequencing constraints specified herein as part of Progress Schedule.

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2. Allowance for interruptions to the Work because of testing by Engineer of Engineer-developed applications software:
    a. During Functional Testing and Performance Testing, Contractor shall plan for interruption of testing of the Work to allow Engineer to investigate software problems, make software configuration changes, and conduct additional testing.
    b. Allowance for Interruptions: 2 days total.
    c. When applications software testing is delayed because of altered equipment interfaces or receipt of incorrect Shop Drawing information, duration of delay will be excluded from interruption allowance, unless notified otherwise by Engineer.

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. Completion of blend tank modifications. All decant piping, tank modifications, and yard piping tie-ins are installed, tested, and placed into service to support improved residual feed conditions.
    b. Completion of belt filter press refurbishment. Refurbishment of the three existing belt filter presses is complete, including installation of new components, adjustments, and verification of proper operation.
    c. Commissioning of temporary mobile dewatering equipment. The temporary mobile dewatering unit, associated piping, power, and residuals conveyance equipment are fully installed, tested, and placed into continuous operation. The Owner confirms that the temporary system can reliably support all solids handling needs. The new or old dry polymer system may be used as polymer injection to the temporary mobile dewatering unit.

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d. Start of critical-path demolition window. With the temporary unit operational, demolition of the existing conveyor and removal of the residuals storage area surface may begin. This milestone marks the start of the most time-restricted portion of the Project, during which the facility relies entirely on temporary dewatering.
e. Completion of conveyor and residuals storage area demolition. All demolition work is complete, debris is removed, and the Site is ready for installation of the new conveyor and reconstructed residuals storage area surface.
f. Installation of new conveyor and residuals storage area surface. The new conveyor system and new residuals storage area surface are fully installed, aligned, tied in, and ready for operational testing.
g. Removal of temporary mobile dewatering equipment. After permanent systems are fully operational and accepted, the temporary mobile dewatering unit is disconnected, removed, and the area is restored.
h. Installation and integration of new dry polymer systems. New dry polymer feed systems are installed, connected, and integrated into plant controls without disrupting ongoing dewatering operations.
i. Installation of a new water line around the lower lagoons with hydrants.

1.05 WORK SEQUENCING/CONSTRAINTS

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

1. Purchase long-lead items including the new conveyor, dry polymer feed systems, and replacement components for dewatering equipment to initiate manufacturing and reduce schedule-related risks. The conveyor is anticipated to be the longest lead time item, and will drive the completion date of the Project.
2. Provide temporary mobile dewatering unit plans per Section 01 50 00, Temporary Facilities and Controls to facilitate Oklahoma Department of Environmental Quality Review and final approval.
3. Install the new decant pipe assembly, complete blend tank modifications, and connect to the yard piping. This work improves residuals feed conditions for both the existing belt filter presses and the temporary mobile dewatering unit. The blend tank modifications should be completed and in operation a minimum of 1 month prior to demolition or construction of the belt filter press refurbishments.
4. Installation of lagoon waterline. The new lagoon waterline is installed, pressure-tested, and placed into service to support temporary and permanent dewatering operations. The installation of this waterline

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enables operations to begin reprocessing residuals stored in the lagoon and helps restore lagoon capacity, which will be critical during the use of the temporary mobile press.

5. Coordinate and complete refurbishment services for the three existing belt filter presses, including replacement of specified mechanical and ancillary components and verification of proper operation. Each belt filter press is anticipated to require a maximum of 4 weeks for refurbishment. Coordinate with Plant Staff to identify in which order the belt filter presses should be refurbished.
6. Install and commission the temporary mobile dewatering system, including all piping, power, and residuals conveyance equipment. Because the equipment is exposed to weather, operation should avoid freezing conditions. Position the residuals conveyance equipment to allow Owner access for residuals removal with dump trucks; final location shall be coordinated with the Engineer and Owner. Commissioning of the mobile dewatering equipment and subsequent work on the conveyor and residuals storage area shall commence no sooner than 2 months after completion of the belt filter press rehabilitation.
7. After the temporary mobile dewatering equipment is fully commissioned and operational, demolish the existing conveyor and remove the existing residuals storage area surface. This phase is the most time-restricted portion of the Project, as the facility will rely entirely on the temporary unit for solids handling. Work must be executed during low flow season between October 1 to April 1 and completed efficiently to minimize operational risk and cost. Contractor must coordinate delivery and installation with vendor to ensure that 1-year warranty remains valid at the time of substantial warranty.
8. Install the new conveyor system and reconstruct the residuals holding area surface, including all required supports, alignments, and tie-ins.
9. After the permanent systems are fully operational, disconnect and remove the temporary mobile dewatering equipment and restore affected areas. The minimum and maximum anticipated times required for temporary mobile dewatering are 6 weeks and 10 weeks, respectively.
10. Install and integrate new dry polymer feed systems, including mechanical, electrical, and control connections. This work may occur at any point that does not risk an unplanned plant shutdown; however, performing it near the end of the Project or at the start of construction is recommended for operational continuity.
11. Install new polymer static mixers and injectors. This work may occur at any point that does not risk an unplanned plant shutdown.

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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. Construct Work in the following stages to allow for Owner's continuous occupancy and for uninterrupted operation during construction.

F. Phase A:

1. Existing plant facilities shall remain in operation except as noted below:
   a. During the demolition and replacement of all new equipment.

G. Process or Facility Shutdown:

1. The following may be shutdown at some time during the Work:
   a. One belt filter press at a time for rehabilitation work.
   b. Conveyor belt system to allow for the safe working environment for the belt filter press rehabilitations, intermittently as required and approved by Owner, but no more than 6 hours during any 24-hour period.
2. Provide 7 days advance written request for approval of need to shut down a process or facility to Owner and Engineer if shut down time is anticipated to be more than 4 hours in duration within a given day.
3. Power outages will be considered upon 48 hours written request to Owner and Engineer. Describe the reason, anticipated length of time, and areas affected by the outage. Provide temporary provisions for continuous power supply to critical facility components.

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H. Install and maintain bypass facilities and temporary connections required to keep Owner's dewatering facility operations online. Sequences other than those specified will be considered upon written request to Owner and Engineer, provided they afford equivalent continuity of operations.

I. 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.

J. 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. Upon receipt, Engineer will review, sign, and return one record copy of documentation to Contractor to be kept on file in field office.

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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.

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 48 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 1832 by 3264 pixels and 24-bit, millions of color.

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. Monthly: Take 50 photographs using digital, minimum resolution of 1832 by 3264 pixels and 24-bit, millions of color.

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 file folders or database records with Project and Owner's name, and month and year images were produced.

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1.09 REFERENCE POINTS AND SURVEYS

A. Location and elevation of benchmarks are shown on the Drawings.

B. Location and elevation of benchmarks are shown on the Drawings.

C. Contractor's Responsibilities:

1. Provide additional survey and layout required to layout the Work.
2. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
3. Maintain complete accurate log of survey work as it progresses as a Record Document.
4. On request of Engineer, submit documentation.
5. Provide competent employee(s), tools, stakes, and other equipment and materials as Engineer may require to:
   a. Check layout, survey, and measurement work performed by others.
   b. Measure quantities for payment purposes.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SALVAGE OF MATERIALS

A. Materials to be salvaged include: Owner shall have first right of refusal for salvaged materials.

B. Salvage materials for Owner's use.

1. Remove material with extreme care so as not to damage for future use.
2. Promptly remove salvaged materials from Work area.
3. Store materials where instructed by Owner onsite.

C. Meet with Engineer and Municipal City Engineer prior to starting to dismantle equipment or piping designated to be salvaged. Engineer will indicate locations where equipment is to be disconnected.

D. Provide new or repair damaged equipment or material specified or indicated to be salvaged. Clean and protect equipment from dust, dirt, natural elements, and store as directed.

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3.02 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 and Owner 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 the 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

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SECTION 01 31 19
PROJECT MEETINGS

PART 1 GENERAL

1.01 GENERAL

A. Contractor shall 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 5 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.
9. Status of as-built redline drawings.

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.

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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. Scheduled by Engineer on regular basis and as necessary to review test and inspection reports, and other matters relating to quality control of the Work and work of other Contractors.

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. In addition to any required in individual specification sections the following preinstallation meetings are required:

1. For coordination of the belt filter press refurbishments.
2. For coordination of the delivery, demolition, and installation of the temporary mobile belt filter press, conveyor, and residuals storage area paving.

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

D. Notify Engineer:7 days in advance of meeting date.

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E. 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.

F. A total of two preinstallation meetings will be required.

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

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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 60 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. Progress Schedule: Four legible copies.
   c. 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.
6. Earthwork.
7. Specified Work sequences and construction constraints.
8. Contract Milestone and Completion Dates.
9. Owner-furnished products delivery dates or ranges of dates.
10. Major structural, mechanical, equipment, electrical, architectural, and instrumentation and control Work.

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11. System startup summary.
12. Project close-out summary.
13. Demobilization 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—Critical Path Network.

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—Critical Path Network.

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

1.04 PROGRESS SCHEDULE—CRITICAL PATH NETWORK

A. General: Comprehensive computer-generated schedule using CPM, 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. Contents:

1. Schedule shall begin with the date of Notice to Proceed and conclude with the date of Final Completion.
2. Identify Work calendar basis using days as a unit of measure.

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3. Show complete interdependence and sequence of construction and Project-related activities reasonably required to complete the Work.
4. Identify the Work of separate stages and other logically grouped activities, and clearly identify critical path of activities.
5. Reflect sequences of the Work, restraints, delivery windows, review times, Contract Times, and Project Milestones set forth in the Agreement and Section 01 31 13, Project Coordination.
6. Include as applicable, at a minimum:
    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) Subcontract Work.
    e. Major equipment design, fabrication, factory testing, and delivery dates.
    f. Delivery dates for Owner-furnished products, as specified in Section 01 11 00, Summary of Work.
    g. Sitework.
    h. Concrete Work.
    i. Structural steel Work.
    j. Architectural features Work.
    k. Conveying systems Work.
    l. Equipment Work.
    m. Mechanical Work.
    n. Electrical Work.
    o. Instrumentation and control Work.
    p. Interfaces with Owner-furnished equipment.
    q. Other important Work for each major facility.
    r. Equipment and system startup and test activities.
    s. Project closeout and cleanup.
    t. Demobilization.
7. No activity duration, exclusive of those for Submittals review and product fabrication/delivery, shall be less than 1 day nor more than 60 days, unless otherwise approved.
8. Activity duration for Submittal review shall not be less than review time specified unless clearly identified and prior written acceptance has been obtained from Engineer.

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C. Network Graphical Display:

1. Plot or print on paper not greater than 30 inches by 42 inches or smaller than 22 inches by 34 inches, unless otherwise approved.
2. Title Block: Show name of Project, Owner, date submitted, revision or update number, and the name of the scheduler. Updated schedules shall indicate data date.
3. Identify horizontally across top of 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. Indicate the critical path.
6. Show, at a minimum, the controlling relationships between activities.
7. Plot activities on a time-scaled basis, with the length of each activity proportional to the current estimate of the duration.
8. Plot activities on an early start basis unless otherwise requested by Engineer.
9. Provide a legend to describe standard and special symbols used.

D. Schedule Report:

1. On 8-1/2-inch by 11-inch white paper, unless otherwise approved.
2. List information for each activity in tabular format, including at a minimum:
   a. Activity Identification Number.
   b. Activity Description.
   c. Original Duration.
   d. Remaining Duration.
   e. Early Start Date (Actual start on Updated Progress Schedules).
   f. Early Finish Date (Actual finish on Updated Progress Schedules).
   g. Late Start Date.
   h. Late Finish Date.
   i. Total Float.
3. Sort reports, in ascending order, as listed below:
   a. Activity number sequence with predecessor and successor activity.

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.

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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.
7. Report of changed logic.

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.

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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.

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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. Float:

1. Float time is a Project resource available to both parties to meet Contract Milestones and Contract Times.
2. Use of float suppression techniques such as preferential sequencing or logic, special lead/lag logic restraints, and extended activity times are prohibited, and use of float time disclosed or implied by use of alternate float-suppression techniques shall be shared to proportionate benefit of Owner and Contractor.
3. Pursuant to above float-sharing requirement, no time extensions will be granted nor delay damages paid until a delay occurs which (i) impacts Project's critical path, (ii) consumes available float or contingency time, and (iii) extends Work beyond 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.

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3. Contractor shall revise Progress Schedule prepared thereafter in accordance with Engineer's formal decision.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 33 00
SUBMITTAL PROCEDURES

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 2009 IBC Section 107.3.4.2, 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 Engineer at the following, unless specified otherwise:

1. JACOBS
   Attn: Jessica Hart
   70 North College Avenue, Suite 14P
   Fayetteville, AR 72701
2. E-mail: jessica.hart@jacobs.com.

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.

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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.
6. Submit new electronic files for each resubmittal.
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 attached as a supplement following end of this section.
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.

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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.

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1.03 ACTION SUBMITTALS

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

B. Shop Drawings:

1. One electronic copy indexed.
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 the 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 the 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.

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C. Samples:

1. Copies: Three, 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:

1. Engineer will review, comment, stamp, and distribute as noted:
   a. Approved:
      1) Contractor may incorporate product(s) or implement Work covered by submittal.
      2) Distribution: Electronic.
         a) One copy furnished Owner.
         b) One copy furnished Resident Project Representative.
         c) One copy retained in Engineer's file.
         d) Remaining copies returned to Contractor appropriately annotated.
   b. Approved as Noted:
      1) Contractor may incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
      2) Distribution: Electronic.
         a) One copy furnished Owner.
         b) One copy furnished Resident Project Representative.
         c) One copy retained in Engineer's file.
   c. Partial Approval, Resubmit as Noted:
      1) Make corrections or obtain missing portions, and resubmit.
      2) Except for portions indicated, Contractor may begin to incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.

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3) Distribution: Electronic.
   a) One copy furnished Owner.
   b) One copy furnished Resident Project Representative.
   c) One copy retained in Engineer's file.
   d) Remaining copies returned to Contractor appropriately annotated.

d. Revise and Resubmit:
   1) Contractor may not incorporate product(s) or implement Work covered by submittal.
   2) Distribution: Electronic.
      a) One copy furnished Resident Project Representative.
      b) One copy retained in Engineer's file.
      c) Remaining copies returned to Contractor appropriately annotated.

1.04 INFORMATIONAL SUBMITTALS

A. General:

1. Refer to individual specification sections for specific submittal requirements.
2. Engineer will review each submittal. If submittal meets conditions of the Contract, Engineer will forward electronic copies 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.

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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 the 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.

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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.
3. Schedule of Estimated Progress Payments: 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.

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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.

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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 a part of this specification:

1. Transmittal of Contractor's Submittal.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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TRANSMITTAL OF CONTRACTOR'S SUBMITTAL

(ATTACH TO EACH SUBMITTAL)

DATE: _____

TO: _____ _____ _____ _____ _____ **FROM**: _____ Contractor _____ _____ _____	Submittal No.: _____ ☐ New Submittal ☐ Resubmittal Project: _____ Project No.: _____ Specification Section No.: _____ **(Cover only one section with each transmittal)** Schedule Date of Submittal: _____

SUBMITTAL TYPE:	☐ Shop Drawing	☐ Sample	☐ Informational
	☐ Deferred		

The following items are hereby submitted:

Number of Copies	Description of Item Submitted (Type, Size, Model Number, Etc.)	Spec. and Para. No.	Drawing or Brochure Number	Contains Variation to Contract	
				No	Yes

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)

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SECTION 01 42 13
ABBREVIATIONS AND ACRONYMS

PART 1 GENERAL

1.01 REFERENCE TO STANDARDS AND SPECIFICATIONS OF TECHNICAL SOCIETIES

A. Reference to standards and specifications of technical societies and reporting and resolving discrepancies associated therewith shall be as provided in Article 3 of the General Conditions, and as may otherwise be required herein and in the individual specification sections.

B. Work specified by reference to published standard or specification of government agency, technical association, trade association, professional society or institute, testing agency, or other organization shall meet requirements or surpass minimum standards of quality for materials and workmanship established by designated standard or specification.

C. Where so specified, products or workmanship shall also meet or exceed additional prescriptive or performance requirements included within Contract Documents to establish a higher or more stringent standard of quality than required by referenced standard.

D. Where two or more standards are specified to establish quality, product and workmanship shall meet or exceed requirements of most stringent.

E. Where both a standard and a brand name are specified for a product in Contract Documents, proprietary product named shall meet or exceed requirements of specified reference standard.

F. Copies of standards and specifications of technical societies:

1. Copies of applicable referenced standards have not been bound in these Contract Documents.
2. Where copies of standards are needed by Contractor, obtain a copy or copies directly from publication source and maintain in an orderly manner at the Site as Work Site records, available to Contractor’s personnel, Subcontractors, Owner, and Engineer.

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1.02 ABBREVIATIONS

A. Abbreviations for trade organizations and government agencies: Following is a list of construction industry organizations and government agencies to which references may be made in the Contract Documents, with abbreviations used.

1.	AA	Aluminum Association
2.	AABC	Associated Air Balance Council
3.	AAMA	American Architectural Manufacturers Association
4.	AASHTO	American Association of State Highway and Transportation Officials
5.	ABMA	American Bearing Manufacturers' Association
6.	ACI	American Concrete Institute
7.	AEIC	Association of Edison Illuminating Companies
8.	AGA	American Gas Association
9.	AGMA	American Gear Manufacturers' Association
10.	AI	Asphalt Institute
11.	AISC	American Institute of Steel Construction
12.	AISI	American Iron and Steel Institute
13.	AITC	American Institute of Timber Construction
14.	ALS	American Lumber Standards
15.	AMCA	Air Movement and Control Association
16.	ANSI	American National Standards Institute
17.	APA	APA – The Engineered Wood Association
18.	API	American Petroleum Institute
19.	APWA	American Public Works Association
20.	AHRI	Air-Conditioning, Heating, and Refrigeration Institute
21.	ASA	Acoustical Society of America
22.	ASABE	American Society of Agricultural and Biological Engineers
23.	ASCE	American Society of Civil Engineers
24.	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
25.	ASME	American Society of Mechanical Engineers
26.	ASNT	American Society for Nondestructive Testing
27.	ASSE	American Society of Sanitary Engineering
28.	ASTM	ASTM International
29.	AWI	Architectural Woodwork Institute
30.	AWPA	American Wood Preservers' Association
31.	AWPI	American Wood Preservers' Institute
32.	AWS	American Welding Society
33.	AWWA	American Water Works Association

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34.	BHMA	Builders Hardware Manufacturers' Association
35.	CBM	Certified Ballast Manufacturer
36.	CDA	Copper Development Association
37.	CGA	Compressed Gas Association
38.	CISPI	Cast Iron Soil Pipe Institute
39.	CMAA	Crane Manufacturers' Association of America
40.	CRSI	Concrete Reinforcing Steel Institute
41.	CS	Commercial Standard
42.	CSA	Canadian Standards Association
43.	CSI	Construction Specifications Institute
44.	DIN	Deutsches Institut für Normung e.V.
45.	DIPRA	Ductile Iron Pipe Research Association
46.	EIA	Electronic Industries Alliance
47.	EJCDC	Engineers Joint Contract Documents' Committee
48.	ETL	Electrical Test Laboratories
49.	FAA	Federal Aviation Administration
50.	FCC	Federal Communications Commission
51.	FDA	Food and Drug Administration
52.	FEMA	Federal Emergency Management Agency
53.	FIPS	Federal Information Processing Standards
54.	FM	FM Global
55.	Fed. Spec.	Federal Specifications (FAA Specifications)
56.	FS	Federal Specifications and Standards (Technical Specifications)
57.	GA	Gypsum Association
58.	GANA	Glass Association of North America
59.	HI	Hydraulic Institute
60.	HMI	Hoist Manufacturers' Institute
61.	IBC	International Building Code
62.	ICBO	International Conference of Building Officials
63.	ICC	International Code Council
64.	ICEA	Insulated Cable Engineers' Association
65.	IFC	International Fire Code
66.	IEEE	Institute of Electrical and Electronics Engineers, Inc.
67.	IESNA	Illuminating Engineering Society of North America
68.	IFI	Industrial Fasteners Institute
69.	IGMA	Insulating Glass Manufacturer's Alliance
70.	IMC	International Mechanical Code
71.	INDA	Association of the Nonwoven Fabrics Industry
72.	IPC	International Plumbing Code
73.	ISA	International Society of Automation

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74.	ISO	International Organization for Standardization
75.	ITL	Independent Testing Laboratory
76.	JIC	Joint Industry Conferences of Hydraulic Manufacturers
77.	MIA	Marble Institute of America
78.	MIL	Military Specifications
79.	MMA	Monorail Manufacturers' Association
80.	MSS	Manufacturer's Standardization Society
81.	NAAMM	National Association of Architectural Metal Manufacturers
82.	NACE	NACE International
83.	NBGQA	National Building Granite Quarries Association
84.	NEBB	National Environmental Balancing Bureau
85.	NEC	National Electrical Code
86.	NECA	National Electrical Contractor's Association
87.	NEMA	National Electrical Manufacturers' Association
88.	NESC	National Electrical Safety Code
89.	NETA	InterNational Electrical Testing Association
90.	NFPA	National Fire Protection Association
91.	NHLA	National Hardwood Lumber Association
92.	NICET	National Institute for Certification in Engineering Technologies
93.	NIST	National Institute of Standards and Technology
94.	NRCA	National Roofing Contractors Association
95.	NRTL	Nationally Recognized Testing Laboratories
96.	NSF	NSF International
97.	NSPE	National Society of Professional Engineers
98.	NTMA	National Terrazzo and Mosaic Association
99.	NWWDA	National Wood Window and Door Association
100.	OSHA	Occupational Safety and Health Act (both Federal and State)
101.	PCI	Precast/Prestressed Concrete Institute
102.	PEI	Porcelain Enamel Institute
103.	PPI	Plastic Pipe Institute
104.	PS	Product Standards Section-U.S. Department of Commerce
105.	RMA	Rubber Manufacturers' Association
106.	RUS	Rural Utilities Service
107.	SAE	SAE International
108.	SDI	Steel Deck Institute
109.	SDI	Steel Door Institute
110.	SJI	Steel Joist Institute
111.	SMACNA	Sheet Metal and Air Conditioning Contractors National Association

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112.	SPI	Society of the Plastics Industry
113.	SSPC	The Society for Protective Coatings
114.	STI/SPFA	Steel Tank Institute/Steel Plate Fabricators Association
115.	SWI	Steel Window Institute
116.	TEMA	Tubular Exchanger Manufacturers' Association
117.	TCA	Tile Council of North America
118.	TIA	Telecommunications Industry Association
119.	UBC	Uniform Building Code
120.	UFC	Uniform Fire Code
121.	UL	formerly Underwriters Laboratories Inc.
122.	UMC	Uniform Mechanical Code
123.	USBR	U.S. Bureau of Reclamation
124.	WCLIB	West Coast Lumber Inspection Bureau
125.	WI	Wood Institute
126.	WWPA	Western Wood Products Association

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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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 working 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 working 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. 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.

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B. Where time is necessary in excess of that stated in these 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' 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 and 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.

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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).

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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 Section 01 78 23, Operation and Maintenance Data.
2. Complete at least 14 working days prior to beginning of facility startup.

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

3.04 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this specification:

1. Manufacturer's Certificate of Proper Installation.

END OF SECTION

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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)

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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):
   a. D3740, Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
   b. E329, Use in the Evaluation of Testing and Inspection Agencies as Used in Construction.

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;

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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.

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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.

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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.

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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.

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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 Article Quality Control 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.

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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.

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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 on the Drawings and/or these 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. 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.

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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.

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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

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SECTION 01 45 33
SPECIAL INSPECTION, OBSERVATION, AND TESTING

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 2018 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:

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
2. International Code Council (ICC):
   a. International Building Code (IBC).
   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.

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4. Special Inspector: Qualified person employed by Owner's Registered Design Professional 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 the 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 the Drawings, load-bearing walls with direct in-plane connections to roof and floors shall be considered to be shear walls.

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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 the 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.
3. Geotechnical Observation: Visual observation of selected subgrade bearing surfaces and installation of deep foundation elements by a registered design professional for general conformance to Contract Documents.
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 wind-resisting component, and seismic-resisting component listed in Statement of Special Inspections. Refer to Article Supplements located at end of section.

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2. Fabricator's Certificate of Compliance: Form shall be completed by entity responsible for shop fabrication of structural load-bearing members and assemblies. 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. None required.
3. Architectural, Plumbing, Mechanical, and Electrical Components subject to Special Inspection under IBC Section 1705.11.5, Section 1705.11.6, and Section 1705.12for 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 seismic systems and main seismic force and 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: Not required for this Project.
   g. Structural Observations to be Performed: Required frequency and distribution of Structural Observation reports by registered design professional to Contractor, building official, and Owner.

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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's Registered Design Professional In Responsible Charge 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.
4. Affect continuing rights of Owner after acceptance of completed Work.

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.

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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 on-site 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. When required by Registered Design Professional in Responsible Charge, provide access for plumbing, mechanical and electrical component inspections for those items requiring certification.

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

K. 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.

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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

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CONTRACTOR'S STATEMENT OF RESPONSIBILITY

_____
(Project)

_____
(Name of Contracting Company)

_____
(Business Address)

(_____) _____ (_____) _____
(Telephone) (Fax)

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 wind and seismic force-resisting systems, and for components including architectural, mechanical, and electrical components, as listed in Statement of Special Inspections in supplement located at the end of this section , and that:

1. 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 this Project.

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

3. 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.

4. I, (We) will provide 48-hour notification to Engineer and approved inspection agency as required for structural tests and Special Inspection for Project.

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

   Name: _____

   Qualifications: _____

   _____

   _____

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

Signed by: _____

Date: _____

Project Name: _____

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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 2018 IBC must submit Fabricator's Certificate of Compliance at the completion of fabrication.

_____
(Project)

_____
(Fabricator's Name)

_____
(Business Address)

_____
(Certification or Approval Agency)

_____
(Certification Number)

_____
(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.

_____
(Name and Title) type or print

_____
(Signature and Date)

Attach copies of fabricator's certification or building code evaluation service report and fabricator's quality control manual.

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STATEMENT OF SPECIAL INSPECTIONS

GENERAL NOTES

1. THE STATEMENT OF SPECIAL INSPECTIONS PROVIDE PROJECT COMPLIANCE WITH THE PROVISIONS OF THE 2018 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.

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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 OR OWNER'S REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE 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 WILL BE IN ACCORDANCE WITH IBC CHAPTER 17, TOGETHER WITH LOCAL AND STATE AMENDMENTS.
2. ONSITE STRUCTURAL OBSERVATION WILL BE PERFORMED FOR EACH IDENTIFIED SEISMIC FORCE- OR WIND FORCE-RESISTING SYSTEM, INCLUDING FOUNDATIONS AND CONNECTIONS. REFER TO THE GENERAL STRUCTURAL NOTES, DRAWING FOR THE BASIC SEISMIC AND WIND FORCE-RESISTING SYSTEMS FOR THE STRUCTURES INCLUDED IN THE WORK.
3. STRUCTURAL OBSERVATION WILL BE PERFORMED BY A REGISTERED PROJECT DESIGN PROFESSIONAL FOR GENERAL CONFORMANCE TO THE APPROVED CONSTRUCTION DOCUMENTS. STRUCTURAL OBSERVATION

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DOES NOT INCLUDE OR WAIVE THE RESPONSIBILITY FOR ANY REQUIRED SPECIAL INSPECTIONS OR INSPECTIONS BY THE BUILDING OFFICIAL.

4. STRUCTURAL OBSERVATION REPORTS, NOTING ANY DEFICIENCIES IN OBSERVED CONSTRUCTION, WILL BE DELIVERED TO THE CONTRACTOR, BUILDING OFFICIAL, AND OWNER FOLLOWING EACH OBSERVATION. THE CONTRACTOR WILL BE NOTIFIED ONSITE OR BY PHONE OR E-MAIL WITHIN 24 HOURS UPON FINDING DEFICIENCIES.
5. AT THE CONCLUSION OF CONSTRUCTION, A WRITTEN STATEMENT WILL BE PROVIDED TO VERIFY THAT THE STRUCTURAL OBSERVATION SITE VISITS WERE MADE AND WHETHER THERE REMAIN ANY STRUCTURAL DEFICIENCIES THAT HAVE NOT BEEN RESOLVED.
6. STRUCTURAL OBSERVATION WILL INCLUDE VISUAL OBSERVATION OF THE STRUCTURAL SYSTEM AT SIGNIFICANT CONSTRUCTION STAGES AND AT COMPLETION OF THE STRUCTURAL SYSTEM FOR EACH STRUCTURE CONTAINED IN THE WORK. THE CONTRACTOR SHALL SCHEDULE AND FACILITATE STRUCTURAL OBSERVATION, INCLUDING THE ELEMENTS DESCRIBED IN THE STRUCTURAL OBSERVATION TABLES (ATTACHED).

SPECIAL INSPECTIONS FOR WIND RESISTANCE

1. SPECIAL INSPECTIONS REQUIREMENTS FOR WIND RESISTANCE WILL BE IN ACCORDANCE WITH IBC CHAPTER 17 TOGETHER WITH LOCAL AND STATE AMENDMENTS.
2. SPECIAL INSPECTIONS REQUIREMENTS SHALL APPLY TO THE FOLLOWING:
   A. WIND FORCE-RESISTING SYSTEMS IN STRUCTURES IN WIND EXPOSURE CATEGORY B, WHERE THE 3-SECOND-GUST BASIC WIND SPEED IS 120 MILES PER HOUR OR GREATER.
   B. WIND FORCE-RESISTING SYSTEMS IN STRUCTURES IN WIND EXPOSURE CATEGORIES C OR D, WHERE THE 3-SECOND-GUST BASIC WIND SPEED IS 110 MILES PER HOUR OR GREATER.

      REFER TO GENERAL STRUCTURAL NOTES, DRAWING G-6,FOR BASIC WIND SPEED AND WIND EXPOSURE CATEGORY.
3. WIND FORCE-RESISTING SYSTEMS TO RECEIVE SPECIAL INSPECTION FOR WIND RESISTANCE SHALL INCLUDE THE COMPONENTS LISTED IN TABLE 5.
4. MAIN SYSTEMS REQUIRED TO BE COVERED UNDER PROJECT SPECIAL INSPECTION REQUIREMENTS INCLUDE THE FOLLOWING TOGETHER WITH THEIR CONNECTIONS. REFER TO SECTION 01 45 33, SPECIAL INSPECTION, OBSERVATION AND TESTING.

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SPECIAL INSPECTIONS FOR SEISMIC RESISTANCE

1. SPECIAL INSPECTIONS REQUIREMENTS FOR SEISMIC RESISTANCE WILL BE IN ACCORDANCE WITH IBC CHAPTER 17 TOGETHER WITH LOCAL AND STATE AMENDMENTS. REFER TO GENERAL STRUCTURAL NOTES, DRAWING G-6 FOR BASIC SEISMIC-FORCE-RESISTING SYSTEMS FOR EACH STRUCTURE AND DESIGNATED SEISMIC DESIGN CATEGORY.
2. SPECIAL INSPECTIONS REQUIREMENTS FOR SEISMIC RESISTANCE SHALL APPLY TO THE SYSTEMS AND COMPONENTS LISTED IN TABLE 4.
3. MAIN SYSTEMS REQUIRED TO BE COVERED UNDER PROJECT SPECIAL INSPECTION REQUIREMENTS INCLUDE THE FOLLOWING TOGETHER WITH THEIR CONNECTIONS. REFER TO SECTION 01 45 33, SPECIAL INSPECTION, OBSERVATION AND TESTING.

Statement of Special Inspections Prepared by:

_____
Type or Print Name

_____
Signature

_____
Date

Preparer's Seal

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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:

1. Federal Emergency Management Agency (FEMA).
2. National Fire Prevention Association (NFPA): 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations.
3. 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 for Dewatering Equipment:
   a. Electric power supply.
   b. Feed supply and discharge piping.
   c. Sanitary discharge.
   d. Solids holding area.
3. Temporary Construction Submittals:
   a. Access Roads: Routes.
   b. Parking area plans.
   c. Contractor’s field office, storage yard, and storage building plans, including gravel surfaced area.
   d. Fencing and protective barrier locations and details as applicable.
   e. Staging area location plan.
   f. Plan for maintenance of existing plant operations.
4. Temporary Control Submittals:
   a. Noise control plan.
   b. Dust control plan.
   c. Plan for disposal of waste materials and intended haul routes.

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5. Temporary Mobile Dewatering Unit Submittals:
    a. Equipment Specifications and Performance Guarantees.
    b. Mechanical Plans for Feed Supply & Filtrate Discharge.
    c. Location, Utility Connection and Removal Plan.
    d. Protection Plan for the Unit and City Infrastructure.
    e. Start Up, Commissioning, and Acceptance Testing Plan.

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 the Drawings. Provide lands and access to lands for temporary facilities for use by Contractor for duration of Project.

C. Progress payment for mobilization will not be approved. No more than half of Schedule of Values mobilization line item will be approved prior to installation of Engineer's Field Office.

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.

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PART 2 PRODUCTS

2.01 TEMPORARY MOBILE DEWATERING SKID

A. Dewatering Unit shall be equal to or exceeds the performance and capacity of the Andritz 2.0 SMX-8 Belt Press and auxiliary equipment as described below:

1. Belt Filter Press:
   a. Minimum 2-meter wide belt
   b. Minimum Dewatering Areas:
      1) Gravity Dewatering Zone: 91 square feet.
      2) Wedge Zone: 85 square feet.
      3) Pressure Zone 122 square feet.
   c. One set of seamed fabrics.
   d. Triple sealed split pillow block bearings.
   e. Pneumatic tracking and belt tensioning system.
   f. Rilsan or Buna-N covered rolls.
2. Auxiliary equipment may include:
   a. Sludge Grinder, 3 hp drive motor and controlled directly by skid control panel.
   b. Progressive cavity feed pump.
   c. Belt wash booster pump, 3 hp drive motor and controlled directly by skid.
   d. Compressor with a 2 hp drive motor and 125 pounds per square inch air supply at 3 SCFM and controlled directly by skid control panel.
   e. Polymer dosing system, emulsion (non-owner supplied).
      1) Velodyne liquid polymer blending system.
   f. Control and drive/starter panels.
   g. Piping and control valves.
   h. Minimum 50-foot electrical supply cable.
   i. Minimum 100-foot, 2-inch sludge supply hose.
   j. Minimum 100-foot dilution water hose for polymer system.
3. Power:
   a. 460V ac, three-phase, 60-Hz and a connection to a 160-amp circuit breaker.
   b. 120V ac utility outlets, each 15A.
4. Mechanical:
   a. 4-inch sludge feed inlet, camlock.
   b. 1.5-inch flanged clean inlet for polymer.
   c. 1-inch flanged neat polymer inlet.
   d. 3-inch wash water inlet, camlock.
   e. 4-inch by 2-inch filtrate discharge.

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5. Instrumentation, Controls and SCADA: Micro Logix PLC with touch screen.
6. Must include a minimum of 3 days of startup and training services.
7. The mobile dewatering unit shall be operated by the Plant Staff. However, the Contractor shall be fully responsible for providing, installing, maintaining, monitoring, and removing the complete temporary mobile dewatering unit required to support uninterrupted operations at the City's dewatering facility. This responsibility includes all equipment, materials, labor, utilities, controls, and ancillary components necessary to ensure continuous and effective dewatering. The Contractor acknowledges that the temporary mobile dewatering unit is critical to preventing any shutdowns or disruptions at the City's dewatering facility and agrees to assume full responsibility for its performance and reliability throughout the duration of the Work.

PART 3 EXECUTION

3.01 TEMPORARY UTILITIES

A. Power:

1. Electric power will be available at or near Site. Determine type and amount available and make arrangements for obtaining temporary electric power service, metering equipment, and pay costs for electric power used during Contract period, except for portions of the Work designated in writing by Engineer as substantially complete.
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 or building as specified in Section 01 11 00, Summary of Work.
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.

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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. Hydrant Water:
   a. 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. Contractor must obtain temporary construction meter from the City of Tulsa. Contractor is responsible for payment of water usage.
   c. Include costs to connect and transport water to construction areas in Contract Price.
2. Owner will provide a place of temporary connection for construction 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.
3. Owner will furnish construction drinking water required on Site at location shown. Furnish and install temporary piping and facilities to transport water to the Work.
4. Provide and bear costs necessary of water required for testing equipment and piping prior to Substantial Completion, unless otherwise specifically stated in Specifications for equipment, systems, or facilities to be tested.
5. Provide means to prevent water used for testing from flowing back into source pipeline.

E. Sanitary and Personnel Facilities:

1. Provide and maintain facilities for Contractor's employees, Subcontractors, and other onsite employers' employees. Service, clean, and maintain facilities and enclosures.
2. Use of Owner's existing sanitary facilities by construction personnel will not be allowed.

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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. Owner and operations shall not be cut off from vehicular traffic for a period exceeding 1-hour, unless special arrangements have been made.
3. 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.
4. 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.
5. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
6. Keep fire hydrants and water control valves free from obstruction and available for use at all times.
7. 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.
8. 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.
9. Do not impair operation of existing sewer system. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and

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other debris from entering sewers, pump stations, or other sewer structures.

10. Maintain original Site drainage wherever possible.

B. Site Security:

1. Erect a temporary security fence at locations shown on the Drawings for protection of Owner-furnished products and existing facilities. Maintain all fences 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 the Oklahoma Vehicle 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 2 days in advance of traffic approaching the Work, each displaying three flags mounted at a height of 9 feet.

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5. ROAD CONSTRUCTION AHEAD Signs: Provide four size 48 inches by 48 inches. Place in conspicuous locations, approximately 200 feet in advance of the Work, and facing approaching traffic.
6. DETOUR Signs: Provide two, right arrow or left arrow, placed as approved by Engineer.
7. RIGHT or LEFT LANE CLOSED AHEAD Signs: Provide two place in advance of lane to be closed.
8. Provide at obstructions, such as material piles and equipment.
9. 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 the 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 the 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.

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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. Move mailboxes to temporary locations accessible to postal service.
3. 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. 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.

J. 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 TEMPORARY CONTROLS

A. Air Pollution Control:

1. Minimize air pollution from construction operations.
2. Burning:
   a. Of waste materials, rubbish, or other debris will not be permitted on or adjacent to Site.
   b. Flammable debris and refuse may be burned onsite provided requirements set forth by proper fire authorities and air quality control agencies are met.

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c. Authority to burn shall not relieve Contractor from damages that may result from its operations.
d. Do not burn on easements through private property, unless specifically permitted in writing by property owner, in addition to complying with state, county, and local regulations regarding burning.

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 Ordinance: Title 27, Section 1400.
3. 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 Engineer’s and 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 Sedimentation 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.

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

3.04 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.

3.05 ACCESS ROADS

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

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. Upon completion of construction, restore ground surface disturbed by access road construction to original grade. leave access roads in condition suitable for

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future use by Owner. Replace damaged or broken culverts with new culvert pipe of same diameter and material.

3.06 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.

C. Use area designated on the Drawings for parking of Contractor's and Contractor's employees' vehicles.

3.07 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.

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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. Provide snow removal to facilitate normal vehicular traffic on public or private roads affected by construction. Perform snow removal promptly and efficiently by means of suitable equipment whenever necessary for safety, and as may be directed by proper authority.

J. Notify fire department and police department before closing street or portion thereof. Notify 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.

K. Coordinate traffic routing with that of others working in same or adjacent areas.

3.08 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.

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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

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SECTION 01 57 13
TEMPORARY EROSION AND SEDIMENT CONTROL

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 the 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 City of Tulsa Stormwater Management Criteria Manual and Drawings. In the event of a conflict, the more stringent requirement shall apply.

B. The following is a list of standards that may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): M252, Standard Specification for Corrugated Polyethylene Drainage Pipe.

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2. ASTM International (ASTM):
   a. D638, Standard Test Method for Tensile Properties of Plastics.
   b. D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
   c. D3776/D3776M, Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.
   d. D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
   e. D4397, Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
   f. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   g. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   h. D4632/D4632M, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   i. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile
   j. D6241, Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.
   k. D6459, Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Hillslopes from Rainfall-Induced Erosion.
   l. D6460, Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Earthen Channels from Stormwater-Induced Erosion.
   m. D6475, Standard Test Method for Measuring Mass Per Unit Area of Erosion Control Blankets.
   n. D7322, Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Ability to Encourage Seed Germination and Plant Growth Under Bench-Scale Conditions.
   o. D7367, Standard Test Method for Determining Water Holding Capacity of Fiber Mulches for Hydraulic Planting.
3. National Weather Service:
   a. Precipitation-Frequency of the United States by State/Territory, 2012.
   b. Precipitation Frequency Data Server, 2012.
4. North American Weed Management Association (NAWMA).
5. U.S. Department of Agriculture, Natural Resources Conservation Service: *Urban Hydrology for Small Watersheds*; 1986. Technical Release 55.

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6. U.S. Environmental Protection Agency:
   a. Developing Your Stormwater Pollution Prevention Plan: A Guide for Construction Sites, 2007. EPA-833-R-06-004.
   b. National Menu of BMPs, 2012.
7. City of Tulsa:
   a. Stormwater Management Criteria Manual (June 2019).
   b. Standard Specifications (2025).

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.
2. Design erosion and sediment controls to handle peak runoff resulting from 5-year, 24-hour storm event based on National Weather Service Precipitation Frequency Data Server (NOAA Atlas 14).
3. Size temporary stormwater conveyances based on procedures presented in U.S. Department of Agriculture, Natural Resources Conservation Service: Urban Hydrology for Small Watersheds, 1986. Technical Release 55.

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.

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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 the 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.

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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.

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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. 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.

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

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G. 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.

H. 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.

I. Install all sediment control devices including, but not limited to, construction entrance, 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.

J. 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. When groundwater is encountered in an excavation, treat and discharge as follows:
        1) When groundwater conforms to ODEQ 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.
        2) 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.
        3) 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.

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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 any waterbodies 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.

K. 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 any waterbodies, turbidity standards are achieved. Convey water to designated infiltration areas at a rate that does not produce surface runoff.

L. 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.

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M. 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.

N. If Engineer orders the Work suspended, continue to control erosion, pollution, and runoff during the shutdown.

O. 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 the 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.

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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 the Drawings.

D. Log Minimum Density: 7 lbs/cf.

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.”

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B. Meet the following criteria for Coarse Compost:

1. Gradation:

Sieve Size	Percent Passing	
	Minimum	**Maximum**
3"	100	
1"	90	100
3/4"	70	100
1/4"	40	60
Maximum particle length of 6 inches.		

2. pH: Between 6 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 percent by weight per U.S. Composting Council TMECC 03.08-A “Classification of Inerts by Sieve Size.”
4. Minimum Organic Matter: 40 percent by dry weight basis as determined by U.S. Composting Council TMECC 05.07A “Loss-On-Ignition Organic Matter Method (LOI).”
5. Soluble salt content: less than 4 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.

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2.04 COMPOST SOCK

A. Provide socks fabricated from of 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:

Properties	ASTM Test Method	Requirements
Protecting Slopes from Rainfall-Induced Erosion	D6459: Test in one soil type. Soil tested shall be sandy loam as defined by the NRCS Soil Texture Triangle.	Maximum C factor of 0.15 using Revised Universal Soil Loss Equation (RUSLE)
Dry Weight per Unit Area	D6475	0.36 lb/sq. yd. minimum
Performance in Protecting Earthen Channels from Stormwater-Induced Erosion	D6460: Test in one soil type. Soil tested shall be loam as defined by the NRCS Soil Texture Triangle.	1 lb/sq. ft. minimum
Seed Germination Enhancement	D7322	200 percent minimum
Netting, if present, shall be biodegradable with a life span not to exceed 1-year.		

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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 described in Table 1 through Table 3.

Table 1
Geotextile for Permanent Erosion Control

Geotextile Property	ASTM Test Method	Geotextile Property Requirements					
		Permanent Erosion Control				Ditch Lining	
		Moderate Survivability		High Survivability			
		Woven	Nonwoven	Woven	Nonwoven	Woven	Nonwoven
AOS	D4751	See Table 2		See Table 2		U.S. No. 30 max.	
Water Permittivity	D4491	See Table 2		See Table 2		0.02 sec^{-1} min.	
Grab Tensile Strength, in machine and x-machine direction	D4632/ D4632M	250 lb min.	160 1b min.	315 lb min.	200 lb min.	250 lb min.	160 lb min.
Grab Failure Strain, in machine and x-machine direction	D4632/ D4632M	15% -50%	≥50%	15% -50%	≥50%	<50%	≥50%
Seam Breaking Strength	D4632/ D4632M	220 lb min.	140 lb min.	270 lb min.	180 lb min.	220 lb min.	140 lb min.

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Table 1
Geotextile for Permanent Erosion Control

Geotextile Property	ASTM Test Method	Geotextile Property Requirements					
		Permanent Erosion Control				Ditch Lining	
		Moderate Survivability		High Survivability			
		Woven	Nonwoven	Woven	Nonwoven	Woven	Nonwoven
Puncture Resistance	D6241	495 lb min.	310 lb min.	620 lb min.	430 lb min.	495 lb min.	310 lb min.
Tear Strength, in machine and x-machine direction	D4533	80 lb min.	50 lb min.	112 lb min.	79 lb min.	80 lb min.	50 lb min.
Ultraviolet (UV) Radiation Stability	D4355	70% strength retained min., after 500 hours in xenon arc device					

Table 2
Filtration Properties for Geotextile for Permanent Erosion Control

Geotextile Property	ASTM Test Method	Geotextile Property Requirements		
		Class A	Class B	Class C
AOS	D4751	U.S. No. 40 max.	U.S. No. 60 max.	U.S. No. 70 max.
Water Permittivity	D4491	0.7 sec^{-1} min.	0.4 sec^{-1} min.	0.2 sec^{-1} min.

Table 3
Geotextile for Temporary Silt Fence

Geotextile Property	ASTM Test Method	Geotextile Property Requirements	
		Unsupported Between Posts	Supported Between Posts with Wire or Polymeric Mesh
AOS	D4751	U.S. No. 30 max. for silt wovens, U.S. No. 50 for all other geotextile types, U.S. No. 100 min.	
Water Permittivity	D4491	0.2 sec^{-1} min.	
Grab Tensile Strength, in machine and x-machine direction	D4632/ D4632M	180 lb min. in machine direction, 100 lb min. in x-machine direction	100 lb min.
Grab Failure Strain, in machine and x-machine direction	D4632/ D4632M	30% max. at 180 lb or more	

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Table 3 Geotextile for Temporary Silt Fence			
		Geotextile Property Requirements	
Geotextile Property	ASTM Test Method	Unsupported Between Posts	Supported Between Posts with Wire or Polymeric Mesh
Ultraviolet (UV) Radiation Stability	D4355	70% strength retained min., after 500 hours in xenon arc device	

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 INLET PROTECTION

A. As specified under Article Geotextile.

2.10 MULCH

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

Table 4 Short-Term Mulch Test Requirements		
Properties	Test Method	Requirements
Performance in Protecting Slopes from Rainfall-Induced Erosion.	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.	C Factor = 0.15 maximum using Revised Universal Soil Loss Equation (RUSLE)

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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 5
Moderate-Term Mulch Test Requirements

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

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 6
Long-Term Mulch Test Requirements

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

2.11 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.

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2.12 PLASTIC COVERING

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

2.13 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.

2.14 SEDIMENT CONTROL BARRIERS

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

2.15 SEEDING

A. Conform to Standard Specifications, Division 3, Part 325 – Sodding and Seeding.

2.16 SILT (SEDIMENT) FENCE

A. Geotextile: As specified in Article Geotextile.

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

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

2.17 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.

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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.

2.18 STRAW 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:
   a. Certified Weed Free Straw using North American Weed Management Association (NAWMA) standards.
   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.

2.19 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.

2.20 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.

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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 7
HECP Requirements

Properties	Test Method	Requirements
Acute Toxicity	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).	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.
Solvents	EPA 8260B	Benzene: < 0.03 mg/kg Methylene chloride: < 0.02 mg/kg Naphthalene: < 5 mg/kg Tetrachloreoethylene: < 0.05 mg/kg Toluene: < 7 mg/kg Trichloroethylene: < 0.03 mg/kg Xylenes: < 9 mg/kg

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Table 7
HECP Requirements

Properties	Test Method	Requirements
Heavy Metals	EPA 6020A Total Metals	Antimony: < 4 mg/kg Arsenic: < 6 mg/kg Barium: < 80 mg/kg Boron: < 100 mg/kg Cadmium: < 2 mg/kg Chromium: < 2 mg/kg Copper: < 5 mg/kg Lead: < 5 mg/kg Mercury: < 2 mg/kg Nickel: < 2 mg/kg Selenium: < 10 mg/kg Strontium: < 30 mg/kg Zinc: < 5 mg/kg
Water Holding Capacity	ASTM D7367	900 percent minimum
Organic Matter Content	ASTM D2974	90 percent minimum
Moisture Content	ASTM D2974	15 percent
Seed Germination Enhancement	ASTM D7322	Long-Term: 420 percent minimum Moderate-Term: 400 percent minimum Short-Term: 200 percent minimum

2.21 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.

2.22 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.

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2.23 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.

2.24 TIRE 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.

2.25 WATTLES

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.

2.26 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.

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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 the 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 the 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.

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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 the 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.

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.

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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 the Drawings.

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

L. Inlet Protection: Install inlet protection below or above, or as a prefabricated cover at each inlet grate, as shown on the 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.

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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 hydroseeder.
5. 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 tolon 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 Standard Specifications, Division 3, Part 325 – Sodding and Seeding.

S. Silt (Sediment) Fence:

1. Silt fence shall be installed in accordance with the 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).

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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 the 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 the 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 the 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.

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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 the 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 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 the Drawings.

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3.02 ADDITIONAL REQUIREMENTS

A. Natural Buffer or Equivalent: Comply with the requirements for natural buffers and equivalent sediment load reduction measures as defined in the City of Tulsa Stormwater Management Criteria Manual, Section 3 – Erosion and Sediment Control.

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 14 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.

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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 Standard Specifications, Division 3, Part 325 – Sodding and Seeding); 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.

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3.04 EMERGENCY MATERIALS

A. Provide, stockpile, and protect emergency erosion and sediment control materials on the Project Site in accordance with the requirements set forth in the City of Tulsa Stormwater Management Criteria Manual (June 2019), Section 3 – Erosion and Sediment Control. Emergency materials shall be maintained in sufficient quantities to address unexpected weather or erosion conditions and replenished as necessary. Remove all unused emergency materials from the Project Site at completion of the Project.

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

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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 2018 International Building Code (IBC) by International Code Council.

1. Project-specific structural and other design loads are provided on the General Structural Note Sheets on the Drawings.

1.03 ENVIRONMENTAL REQUIREMENTS

A. Altitude: Provide materials and equipment suitable for installation and operation under rated conditions at 600 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 10 degrees F to 130 degrees F.

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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 to Site.
5. Notify Owner 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.

E. Factory Test Results: Reviewed and accepted by Engineer before product shipment as required in individual specification sections.

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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.

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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.

H. Hazardous Materials: Prevent contamination of personnel, storage area, and Site. Meet requirements of product specification, codes, and manufacturer's instructions.

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.

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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 gray finish as approved by Owner.

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.

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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 these 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.

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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.

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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 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 a part of this specification:

1. Manufacturer's Certificate of Compliance.

END OF SECTION

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MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER: _____

PROJECT NAME: _____

PROJECT NO: _____

PRODUCT, MATERIAL, OR SERVICE SUBMITTED: _____

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)

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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 the 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.

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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. The Drawings will be full size.
2. Label or stamp each record document with title, "RECORD DOCUMENTS," in neat large printed letters.

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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 the 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 the Drawings.
        2) Red when showing information added to the 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.

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5. Dimensions on Schematic Layouts: Show on the 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 these 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 and Engineer.
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

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SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

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

B. 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.

C. Preliminary Data: Initial and subsequent submissions for Engineer's review.

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 equipment or system field functional testing. Submit Compilation Formatted and Electronic Media Formatted data 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.

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1.04 DATA FORMAT

A. Prepare preliminary and final data in the form of a printed instructional manual and 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 equipment number and Specification section.
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.
7. Paper: 20-pound minimum, white for typed pages.
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.

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C. Data Compilation Format:

1. Compile all Engineer-accepted preliminary O&M data into a hard-copy, hard-bound set.
2. Each set shall consist of the following:
   a. Binder: Commercial quality, permanent, three-ring or three-post binders with durable plastic cover.
   b. Cover: Identify each volume with typed or printed title "OPERATION AND MAINTENANCE DATA, VOLUME NO.__ OF __" and list:
      1) Project title.
      2) Contractor's name, address, and telephone number.
      3) If entire volume covers equipment or system provided by one Supplier, include the following:
         a) Identity of general subject matter covered in manual.
         b) Identity of equipment number and specification section.
   c. Provide each volume with title page and typed table of contents with consecutive page numbers. Place contents of entire set, identified by volume number, in each binder.
   d. Table of contents neatly typewritten, arranged in a systematic order:
      1) Include list of each product, indexed to content of each volume.
      2) Designate system or equipment for which it is intended.
      3) Identify each product by product name and other identifying number or symbols set forth in Contract Documents.
   e. Section Dividers:
      1) Heavy, 80-pound cover weight, tabbed with numbered plastic index tabs.
      2) Fly-Leaf:
         a) For each, separate product, or each piece of operating equipment, with typed description of product and major component parts of equipment.
         b) List with Each Product:
            (1) Name, address, and telephone number of Subcontractor, Supplier, installer, and maintenance contractor, as appropriate.
            (2) Provide local source of supply for parts and replacement.
         c) Identity of separate structure as applicable.
   f. Assemble and bind material, as much as possible, in same order as specified in the Contract Documents.

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D. 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 one electronic copy of a detailed outline of proposed organization and contents of Final Data prior to preparation of Preliminary Data.
2. Preliminary Data:
   a. Submit one electronic copy for Engineer's review.
   b. If data meets conditions of the Contract:
      1) The electronic copy will be forwarded to Resident Project Representative.
      2) 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 one electronic copy revised in accordance with Engineer's comments.
3. Final Data: Submit two 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. Product data shall reflect the final approved information from the equipment submittal.
   b. Include only those sheets that are pertinent to specific product.
   c. Clearly annotate each sheet to:
      1) Identify specific product or part installed.
      2) Identify data applicable to installation.
      3) Delete references to inapplicable information.

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d. Function, normal operating characteristics, and limiting conditions.
e. Performance curves, engineering data, nameplate data, and tests.
f. Complete nomenclature and commercial number of replaceable parts.
g. 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.
h. Spare parts ordering instructions.
i. 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. Drawings shall reflect the final approved information from the equipment submittal.
   b. 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 the 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.

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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.
7. Lucity Database Asset Management Spreadsheet: Contractor shall complete the Lucity Database Asset Management spreadsheet, attached at the end of this section, for each piece of equipment valued at more than $1,000. Contractor shall complete all columns in the spreadsheet that are identified as the responsibility of the Contractor. An electronic version of the spreadsheet will be provided by Owner after Contract is awarded.

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.

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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.
   b. Guide to troubleshooting.
   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 subunits.
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.

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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 OPERATIONS AND MAINTENANCE AND WARRANTY PERIOD

A. The warranty period for all new equipment shall not commence until all the following have been successfully completed, submitted, and approved by the Owner:

1. Successful startup, functional testing, and acceptance.
2. Performance testing and acceptance of all required data.
3. All required sampling, laboratory testing, and acceptance of results.
4. Submission and approval of Operations and Maintenance (O&M) Manuals.
5. Submission of spare parts and maintenance lists.
6. Completion and acceptance of required training.
7. Submission and approval of complete Lucity asset data.

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1.09 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this specification:

1. Maintenance Summary Form.
2. Lucity Asset Data Collection Template.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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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

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
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.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

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8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobil	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

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Project Information -Engineer

Completed by the City of Tulsa Staff

Field	***Details***
Project Title	
Project Number	
Account Number	
Design Engineer (1)	
Design Engineer (2)	
Design Engineer (3)	
Advertise Date	
Business Case No.	
Capital Project No.	

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Asset Inventory - Engineer

BID ITEM ID	ASSET ID (or NEW)	ASSET NAME (becomes the EQUIPMENT ID TEXT value)	ASSET DESCRIPTION (give enough detail so that City staff will know what function it performs)	REPLACES (which asset/equipment ID?)

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Hierarchy - COT

ASSET ID	EQUIPMENT_ID	EQUIPMENT ID TEXT	OPERATING STATUS	EQUIPMENT TYPE	LOCATION	AREA	LEVEL	WO CATERGORY	UTILITY	SECTION	FACILITY	PROCESS	SUBPROCESS	SYSTEM	PARENT	CHILD

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Asset Record - Nameplate

BID ITEM ID	EQUIPMENT ID	ASSET NAME (EQUIPMENT ID TEXT)	MANUFACTURER	MODEL	SERIAL NUMBER	SCADA ID	VENDOR	PURCHASE DATE	PURCHASE AMOUNT	PROJECT NO.	PURCHASE ORDER	ACCOUNT	FIXED ASSET ID	Path to O&M Manual	Path to Record Drawing

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Warranty

BID ITEM ID	ASSET ID (EQUIPMENT ID)	ASSET NAME (EQUIPMENT ID TEXT)	INSTALLED DATE	INSTALLED BY	WARRANTY NUMBER	WARRANTY TYPE	WARRANTY STATUS	WARRANTY OPEN DATE	WARRANTY EXPIRATION DATA	ADDITIONAL COST	EXTENDED WARRANTY	REVIEW DATE	Description	Manuf Code	Manufacturer Name	Manuf Name	Manuf Street 1	Manuf Street 2	Manuf Street 3	Manuf City	Manuf State	Manuf Zip	Manuf Country	Manuf Phone #	Manuf Fax #	Manuf Mobile #	Manuf E-Mail	Manuf Website

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Inspection Record

EQUIPMENT ID	EQUIPMENT ID TEXT	DATE INSPECTED	INSPECTED BY	CURRENT HOURMETER	PHYSICAL CONDITION	RELIABILITY/ MAINTAINABILITY	OBSOLESSCENSE	OPERATIONAL PERFORMANCE	SAFETY AND SECURITY	FINANCIAL EFFICIENCY

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Risk Assessment - COF

EQUIPMENT ID	EQUIPMENT ID TEXT	COF ASSESSMENT DATE	COF SCORE	REGULATORY COMPLIANCE	SAFETY	PERFORMANCE	FINANCIAL IMPACT

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SECTION 01 88 15
ANCHORAGE AND BRACING

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 2018 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. American Institute of Steel Construction (AISC) 360, Specification for Structural Steel Buildings.
2. American Society of Civil Engineers (ASCE): ASCE 7, Minimum Design Loads for Buildings and Other Structures.
3. International Code Council (ICC): International Building Code (IBC).

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 Oklahoma.

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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 20 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 have center of mass located more than 4 feet above adjacent finished floor.
10. Design seismic anchorage and bracing for Designated Seismic Systems regardless of weight or mounting height.
    a. Component Important Factor:
        1) Ip equals 1.0, unless noted otherwise.
        2) Ip shall be taken as 1.5 if any of the following conditions apply:
            a) Component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems and egress stairways.

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b) Component contains hazardous materials.
c) Component is in or attached to Risk Category IV structure and is needed for continued operation of facility or its failure could impair continued operation of facility.

11. 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, and Section 05 05 19, Post-Installed Anchors, for anchors with designated capacities for vibratory loading per manufacturer's ICC-ES report.
4. Seismic:
   a. In accordance with 2018 IBC, Section 1613, and Chapter 13 of ASCE 7.
   b. Design anchorage and bracing for design criteria listed on General Structural Notes on the Drawings.
   c. Design forces for anchors in concrete or masonry shall be in accordance with ASCE 7, Section 13.4.2, or IBC Section 1905.1.9 as applicable for Project Seismic Design Category.

C. Seismic Design Requirements:

1. Nonstructural Components: Design as nonbuilding structures for components with weights greater than or equal to 25 percent of effective seismic weight of overall structure.

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2. Analyze local region of body of nonstructural component for load transfer of anchorage attachment if component Ip equals 1.5.
3. The following are exempt from requirements for provision of seismic anchorages and bracing, in addition to those items specifically exempted in ASCE 7, Part 13.5 for architectural components and Part 13.6 for electrical and mechanical equipment:
    a. Furniture, except storage cabinets and bookshelves over 6 feet tall.
    b. Temporary or movable equipment.
4. Provide support drawings and calculations for electrical distribution components if any of the following conditions apply:
    a. Ip is equal to 1.5 and conduit diameter is greater than 2.5-inch trade size.
    b. Ip is equal to 1.5 and the total weight of bus duct, cable tray, or conduit supported by trapeze assemblies exceeds 10 pounds per foot.
    c. Supports are cantilevered up from floor.
    d. Supports include bracing to limit deflection and are constructed as rigid welded frames.
    e. Attachments utilize spot welds, plug welds, or minimum size welds as defined by AISC.
5. 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.
6. Existing components, systems, and equipment in their final condition that are modified by Project requirements and are not exempted by above paragraph require the same anchorage and bracing drawing and calculation submittals as new equipment. Field verify existing conditions.
7. Other seismic design and detailing information identified in ASCE 7, Chapter 13, is required to be provided for new and modified or noted 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.

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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. List of existing architectural, mechanical, and electrical equipment or components to be modified in Project requiring Contractor-designed anchorage and bracing in final retrofitted condition.
e. Drawings for seismic attachment assemblies include connection hardware, braces, and anchors (or anchor bolts) for modified, nonexempt existing components, equipment, and systems where a combination of new and existing systems or components' final condition would require anchorage or bracing under this specification for new equipment.
f. 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.

C. Deferred Submittals:

1. Submitted seismic anchorage drawings and calculations for Designated Seismic Systems are identified as IBC deferred submittals and will be submitted to and must be accepted by AHJ prior to installation of component, equipment, or distribution system.
2. Submit deferred Action Submittals such as Shop Drawings with supporting deferred informational submittals such as calculations no less than 4 weeks in advance of installation of component, equipment or distribution system to be anchored to structure.

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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 in Supplement located at the end of Section 01 45 33, Special Inspection, Observation, and Testing, 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 the 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.

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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-deformability 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.

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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

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SECTION 01 91 14
EQUIPMENT TESTING AND FACILITY STARTUP

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.

1.02 SUBMITTALS

A. Informational Submittals:

1. Facility Startup Plan.
2. Functional test results.

1.03 FUNCTIONAL TEST PLAN

A. Develop a written plan to include the following:

1. Step-by-step instructions for startup of each piece of equipment.

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 equipment startup.
2. Representative(s) shall be present during startup meetings and shall be available at all times during testing and startup.

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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 equipment and facility with support of Contractor and the manufacturer's representative.

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: Provide written test report for each item of equipment to be tested, to include the minimum information:
    a. Owner/Project Name.
    b. Equipment or item tested.
    c. Date and time of test.
    d. Type of test performed (Functional or Performance).
    e. Test method.
    f. Test conditions.
    g. Test results.
    h. Signature spaces for Contractor and Engineer as witness.
5. Cleaning and Checking: Prior to beginning functional testing:
    a. Calibrate testing equipment in accordance with manufacturer's instructions.
    b. Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
    c. Lubricate equipment in accordance with manufacturer's instructions.
    d. Turn rotating equipment by hand when possible to confirm that equipment is not bound.

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e. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
f. Check power supply to electric-powered equipment for correct voltage.
g. Adjust clearances and torque.
h. Test piping for leaks.

6. Ready-to-test determination will be by Engineer 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.
   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.
3. Prepare Equipment Test Report summarizing test method and results.
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.

3.03 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this specification:

1. Equipment Testing Form.

END OF SECTION

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EQUIPMENT TESTING FORM

OWNER:_____ **PROJECT:**_____

Equipment Description: (Include description and equipment number of all equipment and devices):

Equipment Testing Procedure (Describe prFocedure for startup and testing, including valves to be opened/closed, etc.):

Startup Requirements (Water, air, power, chemicals, etc.):_____

Test Results:_____

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SECTION 02 41 00
DEMOLITION

PART 1 GENERAL

1.01 REFERENCES

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

1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): Guideline K, Containers for Recovered Non-flammable Fluorocarbon Refrigerants.
2. American National Standards Institute (ANSI): A10.6, Safety Requirements for Demolition Operations.
3. Environmental Protection Agency (EPA), U.S. Code of Federal Regulations (CFR), Title 40:
   a. Part 61—National Emission Standards for Hazardous Air Pollutants.
   b. Part 82—Protection of Stratospheric Ozone.
   c. Part 273—Standards for Universal Waste Management.
4. Occupational Safety and Health Administration (OSHA), U.S. Code of Federal Regulations (CFR) Title 29 Part 1926—Occupational Safety and Health Regulations for Construction.

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 equipment, pipes, manholes tanks, conduit, and 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 the Drawings.

E. Renovation: Altering a facility or one or more facility components in any way.

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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.

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.

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 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.

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.

1.07 USE OF EXPLOSIVES

A. Use of explosives is not permitted.

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PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXISTING FEATURES TO BE DEMOLISHED OR RENOVATED

A. 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 the Drawings, notify Engineer prior to further work in that area.
4. Remove meters and related equipment and deliver to a location as determined by the Owner.
5. Provide a permanent leak-proof closure for water and gas lines.

B. Paving and Slabs:

1. Sawcut and remove concrete and asphaltic concrete paving and slabs including aggregate base as indicated to a depth of 12 inches below existing adjacent grade.
2. Provide neat sawcuts at limits of pavement removal as indicated.

C. Masonry: Sawcut and remove masonry so as to prevent damage to surfaces to remain and to facilitate the installation of new Work. Where new masonry adjoins existing, the new Work shall abut or tie into the existing construction as indicated.

D. Patching: Comply with Section 03 01 32, Repair of Vertical and Overhead Concrete Surfaces.

E. Process Mechanical:

1. Clean polymer containment area and remove all dried polymer from concrete, tanks and piping.
2. Repair and reconnect damaged overflow piping in polymer containment area.

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F. 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 where indicated.
5. Inaccessibly Concealed: Cut off and abandon in place.
6. Exposed or Concealed Above Accessible Ceilings: Remove.
7. Raceways and Cabling Scheduled for Future Use: Cap/seal and tag.
8. Relocating Equipment: Extend existing wiring or run new wiring from the source.
9. Where the existing raceway is concealed, the outlet box shall be cleaned, and a blank cover plate installed.
10. Where the concealed raceway is uncovered remove raceway (or extended to new location if appropriate).
11. Provide updates to panelboard circuit directory cards.

3.02 PROTECTION

A. Dust Debris Control: Prevent the spread of dust and debris to occupied portions of the building 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.

B. Traffic Control Signs: Where pedestrian and driver safety is endangered in the area of removal Work, use traffic barricades with flashing lights.

C. Existing Work:

1. Survey the site and examine the Drawings and Specifications to determine the extent of the Work before beginning any demolition or renovation.

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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.

D. 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.

E. 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.

F. 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.

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5. Protect structural grating in areas such as the polymer hopper skid area.

G. 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 23.15B, Trench Backfill.

3.06 TITLE TO MATERIALS

A. All items designated to be removed shall become the property of Contractor.

3.07 DISPOSITION OF MATERIAL

A. Do not remove equipment and materials without approval of Contractor's Demolition/Renovation Plan by Engineer.

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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. Equipment and material designated to be reused shall be cleaned, serviced and checked for proper operability before being put back into service.

D. Engineer will determine condition of equipment and materials prior to removal.

3.09 SPECIALIZED SALVAGE

A. Historical Items: Remove in a manner to prevent damage.

3.10 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

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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.
   b. A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
   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).
   g. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch or [50-mm] Cube Specimens).
   h. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   i. C293/C293M, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading.
   j. C348, Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
   k. C496/C496M, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
   l. C531, Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   m. C596, Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
   n. C666/C666M, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.

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o. C882/C882M, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
p. C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
q. C1583/C1583M, Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method).
r. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
s. D4259, Standard Practice for Abrading Concrete.
t. E699, Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.

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: Surface defect such as honeycomb, rock pockets, indentations and surface voids greater than 3/16-inch deep, surface voids greater than 3/4-inch diameter, cracks in liquid containment structures and belowgrade habitable spaces 0.005-inch wide and wider, cracks in other structures 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 which include but are not limited to fins, form pop-outs, and other projections, and at exposed concrete which includes texture irregularities, stains, and other color variations that cannot be removed by cleaning.

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.

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E. New Concrete: Concrete less than 60 days old forming structures constructed as part of the Work.

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: Product data sheets for each material supplied.

B. Informational Submittals:

1. Repair Mortar System: Manufacturer's preparation and installation instructions.
2. Mesh manufacturer's installation instructions and allowable load criteria.
3. Written description of equipment proposed for concrete removal and surface preparation.
4. 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.
5. Statements of Qualification: Repair mortar system applicator.
6. Field and laboratory test reports.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Repair Mortar System Applicator:
   a. For Repair System A – Shotcrete Mortar, trained and experienced applicator recognized or certified by repair mortar system manufacturer.
   b. For Repair System B – Low-Pressure Spray Mortar, in lieu of recognition or certification, demonstrate application of repair mortar manufacturer's system and obtain Certification of Proper Installation, in accordance with Article Manufacturer's Services.

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2. Repair Mortar System Manufacturer's Representative: Knowledgeable and experienced on technical data and application requirements for specified products.

B. Demonstration Mockup for Repair System A – Shotcrete Mortar and Repair, System B – Low-Pressure Spray Mortar Repair System:

1. For each noted type of repair mortar system to be used, prepare one demonstration mockup in each vertical and overhead orientation of at least 10 feet by 10 feet with average thickness, and containing reinforcement, representative of area being repaired on Project. Alternatively, a repair area in each vertical and overhead orientation that is representative of areas to be repaired in terms of size, thickness, and reinforcement, may be used for demonstration in lieu of mockups; subject to acceptance by Engineer.
2. Repair Mortar System Manufacturer's Demonstration:
    a. Schedule time for manufacturer's demonstration of repair system proposed for Project.
    b. Prepare mortar to specified consistency for testing and placement.
    c. Cure portions of each type of surface to be repaired using proposed curing procedure and materials, including overhead and vertical applications.
    d. Prepare surface area in advance of demonstration and obtain manufacturer's acceptance of preparation for each type of application.
    e. Demonstrate the following:
        1) Mixing and application equipment capabilities and procedures, including flow of material from nozzle or sprayer.
        2) Nozzle operator and person in charge of low-pressure sprayer, capabilities and ability to follow prescribed application procedures and properly operate equipment and apply surface repair materials.
    f. Compression Strength Test: Take core samples from demonstration placement and deliver to independent testing laboratory for testing at 7 days and 28 days.
    g. Tensile Bond Test: Test in situ or take a core of demonstration placement and test as specified herein below for tensile bond at 7 days as specified in Paragraph Direct Tension Bond Test.

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C. Where Required by Engineer:

1. Demonstration Mockup for Repair System C – Polymer Modified Repair Mortar System:
   a. Prepare one demonstration mockup in each vertical and overhead orientation of average size and thickness, and containing reinforcement, representative of area being repaired on Project. Alternatively, a repair area in each vertical and overhead orientation that is representative of areas to be repaired in terms of size, thickness, and reinforcement, may be used for demonstration in lieu of mockups; subject to acceptance by Engineer.
   b. Repair Mortar System Manufacturer's Demonstration:
      1) Schedule time for manufacturer's demonstration of repair system proposed for Project.
      2) Prepare mortar to specified consistency, for testing and placement.
      3) Cure portions of each type of surface to be repaired using proposed curing procedure and materials, including overhead and vertical applications.
      4) Prepare surface area in advance of demonstration and obtain manufacturer's acceptance of preparation for each type of application.
      5) Demonstrate mixing and application procedures.
      6) Compression Strength Test: Take core samples from demonstration placement and deliver to independent testing laboratory for testing at 7 days and 28 days.
      7) Tensile Bond Test: Test in situ or take a core of demonstration placement and test for tensile bond at 7 days as specified in Paragraph Direct Tension Bond Test.

D. Pre-repair 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.

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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 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 pounds per square inch minimum.
   b. 28 Days: 7,000 pounds per square inch minimum.
2. Flexural Strength (Modulus of Rupture), ASTM C78/C78M or ASTM C348 (Modified) at 28 Days: 1,100 pounds per square inch minimum.
3. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 400 pounds per square inch minimum.

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4. Chloride Ion Permeability Based on Charge Passed, ASTM C1202: 800 coulombs maximum.
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, Eucoshot with Tuf-Strand SF added per manufacturer's recommendations.

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:

1. Compressive Strength, ASTM C109/C109M at 28 Days: 6,000 pounds per square inch minimum.
2. Flexural Strength, ASTM C348 at 28 Days: 1,100 pounds per square inch minimum.
3. Slant Shear Bond Strength, ASTM C882/C882M Test Method Modified with No Bonding Agent, at 28 Days: 3,000 pounds per square inch minimum.
4. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 600 pounds per square inch 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.
9. Free of chlorides and other chemicals causing corrosion.

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.

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2.03 REPAIR SYSTEM C – POLYMER-MODIFIED REPAIR MORTAR

A. Polymer-modified, one- component or two-component, cementitious based, chloride resistant, flowable, gray in color, working time of 20 minutes minimum, surface renovation mortar.

B. Cured Mortar Properties:

1. Compressive Strength, ASTM C109/C109M at 28 Days: 7,000 pounds per square inch minimum.
2. Flexural Strength, ASTM C348 at 28 Days: 1,200 pounds per square inch minimum.
3. Slant Shear Bond Strength, ASTM C882/C882M Test Method Modified with No Bonding Agent at 28 Days: 2,000 pounds per square inch minimum.
4. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 500 pounds per square inch 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.

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B. Mesh Reinforcement: Welded wire fabric flat sheets with spacing of wires and wire size in accordance with ASTM A185/A185M, wire 75 ksi minimum tensile strength per ASTM A82/A82M, and repair mortar system manufacturer's recommendations.

C. Tie Wire: 16-gauge, galvanized.

D. Mesh Anchors:

1. Manufacturers and Products:
   a. Powers Fastening, Inc., Brewster, NY; Tie Wire Version of Power-Stud.
   b. Hilti Fastener Systems, Tulsa, OK; Kwik Bolt II HHDCA, 1/4-inch ceiling hanger.

2.06 CEMENTITIOUS BONDING AGENT AND REINFORCEMENT COATING

A. Cementitious adhesive, specifically formulated for bonding plastic portland cement concrete or mortar to hardened portland cement concrete.

1. Mixed Bonding Agent Properties:
   a. Pot Life: 75 minutes to 105 minutes.
   b. Contact Time: 24 hours.
   c. Color: Concrete gray.
2. Cured Cementitious Adhesive Properties:
   a. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 500 pounds per square inch minimum.
   b. Flexural Strength, ASTM C348: 1,000 pounds per square inch minimum.
   c. Slant Shear Bond Strength, ASTM C882/C882M at 14 Days:
      1) 2-Hour Open Time: 2,500 pounds per square inch minimum.
      2) 24-Hour Open Time: 2,000 pounds per square inch minimum.
3. Bonding agent shall not produce a vapor barrier.
4. Compatible with and from same manufacturer as the repair system used.

B. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco P 124.
2. Sika Corp., Lyndhurst, NJ; Sika Armatec 110 EpoCem.
3. Euclid Chemical Co., Cleveland, OH: Dural Prep AC.

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2.07 EVAPORATION RETARDANT

A. As specified in Section 03 39 00, Concrete Curing.

2.08 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 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 pounds per square inch minimum high-pressure water 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. For existing structures, extent of concrete removal as shown on the Drawings.
4. 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.

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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.

3.03 REINFORCEMENT INSTALLATION

A. Provide steel reinforcement when existing reinforcement is not exposed, and when mortar application is more than 3 inches deep, unless otherwise shown on the Drawings.

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B. Replace deteriorated steel reinforcement with new steel reinforcement equivalent in cross-sectional area to original steel reinforcement. Refer to details on the Drawings.

C. Install mesh anchors in accordance with mesh manufacturer's instructions.

D. Fasten steel reinforcement to mesh anchors with tie wire to prevent from moving during placement of repair mortar.

E. Lap reinforcement mesh a minimum of one mesh spacing and securely fasten mesh to mesh anchors, or to reinforcement fastened to mesh anchors, with tie wire at intervals no more than 12 inches to prevent movement during application of repair mortar.

F. Coat exposed new and existing steel reinforcement and reinforcement mesh with cementitious reinforcement coating at same time as substrate concrete is coated, as specified below, per repair mortar and cementitious reinforcement coating manufacturers' printed instructions.

3.04 PROTECTION

A. If cementitious coating or bonding agent is used, protect adjacent surfaces from over application. Promptly remove bonding agent applied beyond repair area.

B. 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.

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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. Slice off excess material with a wire screed approximately 5 minutes to 10 minutes after initial set.

J. Apply finish to exposed shotcrete mortar surface to match existing surface. Apply full strength evaporation retardant.

K. Rebound Removal: Continuously throughout shotcrete mortar application, remove rebound, sand, and miscellaneous debris, and dispose offsite at an approved disposal facility.

L. 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.

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D. Work mortar firmly and quickly into repair area.

E. Finish repair mortar to match adjacent concrete surface.

F. Provide evaporation retardant at full strength.

G. 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 smooth even surface 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 water curing after repair mortar system application and when curing will not cause erosion of mortar.

D. Continuously water 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.

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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. Alternatively, take core samples in accordance with ASTM C42/C42M from applied mortar material for testing at 7 days and 28 days.
3. Provide a 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.

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3. Laboratory Bond Testing:
   a. Core two 2-1/2-inch or 3-inch-diameter core drilled samples per ASTM C42/C42M for each 2,000 square feet of repair work for direct tension bond testing. Where total area repaired is less than 2,000 square feet, core two 2-1/2-inch or 3-inch diameter samples for direct tension bond testing. Record locations of core drilled samples extracted from each type of applied repair mortar.
   b. Cut core samples through cured mortar repair and into base concrete to total depth equal to at least 2.5 times repair mortar thickness. Avoid core drilling through structural element.
   c. Saw cut core samples after removal to trim base concrete thickness to same thickness as mortar so bond line is at center of prepared core sample.
   d. Bond core samples to steel plates at each end using epoxy bonding agent.
   e. Perform tension bond testing using calibrated independent test laboratory equipment and eyebolts or threaded connectors tapped and threaded into baseplate in order that tension load is concentric with center of core sample.
   f. Bond Strength of Repair Mortar to Substrate Concrete: 300 pounds per square inch minimum in direct tension without failure or movement.

D. Testing laboratory retained by Contractor 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. Alternatively, take core samples in accordance with ASTM C42/C42M from applied mortar material 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 pounds per square inch minimum in direct tension without failure or movement.

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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 MANUFACTURER'S SERVICES

A. Provide repair mortar system manufacturer's representative at Site to review acceptability of surface preparation, mixing and installation assistance, training of repair mortar system applicators, inspection, and Certification of Proper Installation.

3.12 CLEANING

A. Remove overshot shotcrete, Repair System A, low-pressure spray, Repair System B 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

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SECTION 03 01 33
REPAIR OF HORIZONTAL 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 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.
   b. A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
   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).
   g. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
   h. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   i. C348, Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
   j. C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.
   k. C496/C496M, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
   l. C666/C666M, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
   m. C779/C779M, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
   n. C882/C882M, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.

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o. C928/C928M, Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs.
p. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
q. C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
r. C1583/C1583M, Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method).
s. D638, Standard Test Method for Tensile Properties of Plastics.
t. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
u. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
v. D4259, Standard Practice for Abrading Concrete.
w. E699, Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.

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: Surface defect such as honeycomb, rock pockets, indentations, and surface voids greater than 3/16-inch deep, surface voids greater than 3/4-inch diameter, cracks in liquid containment structures and belowgrade habitable spaces 0.005-inch wide and wider, cracks in other structures 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 which include but are not limited to fins, form pop-outs, and other projections, and at exposed concrete which includes texture irregularities, stains, and other color variations that cannot be removed by cleaning.

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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: Concrete less than 60 days old forming structures constructed as part of the Work.

1.03 SUBMITTALS

A. Action Submittals: Product data sheets for each material supplied.

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, or receive traffic.
   c. Mortar Manufacturer's Certificate of Proper Installation.
   d. Confirmation epoxy resin bonding agents conform to ASTM C882/C882M.
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. Independent Testing Laboratory: Meet criteria stated in ASTM E699.

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C. Pre-repair 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. 1—MAGNESIUM PHOSPHATE REPAIR MORTAR

A. One- or two-component, magnesium-ammonium-phosphate concrete mortar.

B. Compressive Strength, ASTM C109/C109M modified:

1. 1-Hour: 2,000 pounds per square inch minimum.
2. 3 Hours: 5,000 pounds per square inch minimum.
3. 1-Day: 6,000 pounds per square inch minimum.
4. 28 Days: 7,500 pounds per square inch minimum.

C. Flexural Strength, ASTM C78/C78M Modified (3-inch by 4-inch by 16-inch prism) at 1-Day: 550 pounds per square inch minimum.

D. Modulus of Elasticity, ASTM C469 at 7 Days: 4.18 by 10^6 pounds per square inch minimum.

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E. Freeze-thaw Resistance and Resistance to Deicing Chemicals, ASTM C666/C666M, Procedure A, at 300 Cycles: 80 percent RDM minimum.

F. Sulfate Resistance, ASTM C1012/C1012M, Length Change after 52 Weeks: 0.09 percent maximum.

G. Application Temperature Range: 20 degrees F to 85 degrees F for normal weather applications 85 degrees F to 100 degrees F for hot weather applications.

H. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building System, Shakopee, MN; MasterEmaco T 545 T 545HT.
2. Euclid Chemical Co., Cleveland, OH; Eucospeed MP, Eucospeed MP Hot Weather.

2.02 REPAIR MORTAR SYSTEM NO. 2—HIGH EARLY STRENGTH REPAIR MORTAR

A. One- or two-component, fast-setting, high early strength repair mortar.

B. Compressive Strength, ASTM C109/C109M:

1. 2 Hours: 1,500 pounds per square inch minimum.
2. 1-Day: 4,500 pounds per square inch minimum.
3. 7 Days: 8,000 pounds per square inch minimum.
4. 28 Days: 9,000 pounds per square inch minimum.

C. Flexural Strength, ASTM C348:

1. 1-Day: 850 pounds per square inch minimum.
2. 7 Days: 1,000 pounds per square inch minimum.
3. 28 Days: 1,100 pounds per square inch minimum.

D. Modulus of Elasticity, ASTM C469:

1. 1-Day: 3.8 by 10^6 pounds per square inch minimum.
2. 28 Days: 4.5 by 10^6 pounds per square inch minimum.

E. Slant Shear Bond Strength, ASTM C882/C882M (Modified):

1. 1-Day: 2,500 pounds per square inch minimum.
2. 7 Days: 2,900 pounds per square inch minimum.
3. 28 Days: 3,100 pounds per square inch minimum.

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F. Splitting Tensile Strength, ASTM C496/C496M:

1. 1-Day: 850 pounds per square inch minimum.
2. 7 Days: 1,200 pounds per square inch minimum.
3. 28 Days: 1,300 pounds per square inch minimum.

G. Freeze-thaw Resistance, ASTM C666/C666M, Procedure A, at 300 Cycles: 98 percent RDM.

H. Chloride Ion Permeability Based on Charge Passed, ASTM C1202 or AASHTO T277, 28 Days: 960 coulombs maximum.

I. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco T 415.
2. Euclid Chemical Co., Cleveland, OH; VersaSpeed.

2.03 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 pounds per square inch minimum.
2. 7 Days: 6,000 pounds per square inch minimum.
3. 28 Days: 8,000 pounds per square inch minimum.

C. Flexural Strength, ASTM C348 at 28 Days: 770 pounds per square inch minimum.

D. Modulus of Elasticity, ASTM C469 at 28 Days: 5.9 by 10^6 pounds per square inch minimum.

E. Slant Shear Bond Strength, ASTM C882/C882M Modified:

1. 7 Days: 2,150 pounds per square inch minimum.
2. 28 Days: 3, 000 pounds per square inch 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.

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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.

2.04 REPAIR MORTAR SYSTEM NO. 4—METALLIC AGGREGATE REPAIR MORTAR

A. One- or two-component cement-based, flowable, metallic-aggregate repair mortar system:

B. Compressive Strength, ASTM C109/C109M:

1. 1-Day: 5,000 pounds per square inch minimum.
2. 7 Days: 8,800 pounds per square inch minimum.
3. 28 Days: 12,000 pounds per square inch minimum.

C. Abrasion Resistance, ASTM C779/C779M, Procedure A: Eight times more wear resistance than plain concrete, 0.017 inch maximum.

D. Density: 215-pound per cubic foot.

E. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; Master T 300.
2. Euclid Chemical Co. (The), Cleveland, OH; Super Euco-Top.

2.05 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 pounds per square inch minimum.
2. 7 Days: 5,000 pounds per square inch minimum.
3. 28 Days: 7,000 pounds per square inch minimum.

C. Flexural Strength, ASTM C348 at 28 Days: 1,500 pounds per square inch minimum.

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D. Slant Shear Bond Strength, ASTM C882/C882M Modified at 28 Days: 2,000 pounds per square inch minimum.

E. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 600 pounds per square inch 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:

1. 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.
3. Sika Corp., Lyndhurst, NJ; SikaTop 122 PLUS.

2.06 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.

2.07 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. Mesh Reinforcement: Welded wire fabric flat sheets with spacing of wires and wire size in accordance with ASTM A185/A185M, wire 75 ksi minimum tensile strength per ASTM A82/A82M, and repair mortar system manufacturer’s recommendations.

C. Tie Wire: 16-gauge, galvanized.

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D. Mesh Anchors:

1. Manufacturers and Products:
   a. Powers Fastening, Inc., Brewster, NY; Tie Wire Version of Power-Stud.
   b. Hilti Fastener Systems, Tulsa, OK; Kwik Bolt II HHDCA, 1/4-inch ceiling hanger.

2.08 CEMENTITIOUS BONDING AGENT AND REINFORCEMENT COATING

A. Cementitious adhesive, specifically formulated for bonding plastic portland cement concrete or mortar to hardened portland cement concrete.

1. Mixed Bonding Agent Properties:
   a. Pot Life: 75 minutes to 105 minutes.
   b. Contact Time: 24 hours.
   c. Color: Concrete gray.
2. Cured Cementitious Adhesive Properties:
   a. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 600 pounds per square inch minimum.
   b. Flexural Strength, ASTM C348: 1,000 pounds per square inch minimum.
   c. Slant Shear Bond Strength, ASTM C882/C882M:
      1) 2-Hour Open Time: 2,500 pounds per square inch minimum.
      2) 24-Hour Open Time: 2,000 pounds per square inch minimum.
3. Bonding agent shall not produce a vapor barrier.
4. Compatible with, and from same manufacturer as the, repair mortar system used.

B. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco P 124.
2. Sika Corp., Lyndhurst, NJ; Sika Armatec 110 EpoCem.
3. Euclid Chemical Co., Cleveland, OH; Dural Prep AC.

2.09 EPOXY BONDING AGENT

A. Two-component, moisture insensitive, 100 percent solids epoxy resin.

B. Tensile Strength, ASTM D638, at 14 Days: 4,400 pounds per square inch minimum.

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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 pounds per square inch minimum.

E. Bond Strength, ASTM C882/C882M, at 14 Days: 1,800 pounds per square inch minimum.

F. Pot Life, at 73 Degrees F to 77 Degrees F: 75 minutes minimum.

G. Manufacturer and Products: BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco ADH 326 when ambient temperature is 73 degrees F or higher.

2.10 EVAPORATION RETARDANT

A. As specified in Section 03 39 00, Concrete Curing.

2.11 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 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 pounds per square inch minimum high-pressure 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. For existing structures, extent of concrete removal as shown on the Drawings.

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4. 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.

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J. Preparation of Substrate Concrete Surface in Areas to Receive Repair Mortar System No. 1, No. 2, No. 3, and No. 5: 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. Preparation of Substrate Concrete Surface in Areas to Receive Repair Mortar System No. 4 Repair Mortar: Dry, in accordance with material manufacturer's printed instructions.

L. 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.

M. 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.

N. Collect and dispose of spent water and concrete debris from removal operations offsite in manner and location acceptable to Owner.

3.03 REINFORCEMENT INSTALLATION

A. Provide steel reinforcement when existing steel reinforcement is not exposed and when mortar application is more than 4 inches deep, unless otherwise shown on the Drawings.

B. Replace deteriorated steel reinforcement with new steel reinforcement equivalent in cross-sectional area to original steel reinforcement. Refer to details on the Drawings.

C. Install mesh anchors in accordance with mesh manufacturer's instructions.

D. Fasten steel reinforcement to chairs or mesh anchors with tie wire to prevent from moving during placement of repair mortar.

E. Lap reinforcement mesh a minimum of one mesh spacing and securely fasten mesh to mesh anchors, or to steel reinforcement fastened to mesh anchors, with tie wire at intervals no more than 12 inches to prevent movement during application of repair mortar.

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F. Coat exposed new and existing steel reinforcement with cementitious reinforcement coating at the same time as substrate concrete is coated, as specified below, per repair mortar and cementitious reinforcement coating manufacturers' printed instructions.

3.04 PROTECTION

A. If cementitious coating or bonding agent is used, protect adjacent surfaces from over application. Promptly remove bonding agent applied beyond repair area.

B. 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 No. 1, No. 2, No. 3, and No. 5:

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. Repair Mortar System No. 4:

1. Remove free water from prepared area.
2. Apply bonding agent to prepared surface in accordance with manufacturer's instructions. Do not apply more bonding agent than can be covered with mortar before bonding agent cures, past tacky to the touch.
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.

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C. 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 FINISHING

A. Spray full strength evaporation retardant on fresh concrete to prevent rapid drying during hot and windy weather.

3.07 CURING

A. Repair Mortar System No. 1:

1. No curing is required.
2. Protect from rain immediately after placing.
3. Liquid-membrane curing compounds or plastic sheeting may be used in accordance with repair mortar manufacturer's instructions to protect the surface from precipitation.
4. Never wet cure.

B. Repair Mortar System No. 2, No. 3, No. 4, or No. 5: Apply curing compound in accordance with Section 03 39 00, Concrete Curing.

3.08 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.

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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.
3. Laboratory Bond Testing:
   a. Core two 2-1/2-inch or 3-inch diameter core drilled samples per ASTM C42/C42M for each 2,000 square feet of repair work for direct tension bond testing. Where total area repaired is less than 2,000 square feet, core two 2-1/2-inch or 3-inch diameter samples for direct tension bond testing. Record locations of core drilled samples extracted from each type of applied repair mortar.
   b. Cut core samples through cured mortar repair and into base concrete to total depth equal to at least 2.5 times repair mortar thickness.
   c. Saw cut core samples after removal to trim base concrete thickness to same thickness as mortar so bond line is at center of prepared core sample.
   d. Bond core samples to steel plates at each end using epoxy bonding agent.
   e. Perform tension bond testing using calibrated independent test laboratory equipment and eyebolts or threaded connectors tapped and threaded into baseplate in order that tension load is concentric with the center of the core sample.
   f. Bond Strength of Repair Mortar to Substrate Concrete: 300 pounds per square inch minimum in direct tension without failure or movement.

D. Testing laboratory retained by Contractor 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. Alternatively, take core samples in accordance with ASTM C42/C42M from applied mortar material for testing at 7 days, and 28 days.
   c. Record location where repair mortar is being applied at time production samples are obtained.

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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 pounds per square inch 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.

3.09 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.

3.10 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

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SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES

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.
   b. 301, Specifications for Structural Concrete. 318, Building Code Requirements for Structural Concrete.
2. NSF International (NSF): 61, Drinking Water System Components - Health Effects.

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 301 and ACI 318 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 301. 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.

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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.
   b. Layout of panel joints, form liners, and tie hole pattern.
2. Product Data:
   a. Form release agent.
   b. Form ties.
   c. Products to be used for sealing tie holes.
   d. Manufacturer’s data for form liners.
3. Samples:
   a. One each as follows:
      1) Form ties.
      2) Form liners.

B. Informational Submittals:

1. Statement of qualifications for formwork designer.
2. Statement of qualifications for form liner designer.
3. Statement of qualifications for form liner installer.

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.
2. Form liner designer shall have previous experience with design and installation of comparable form liners.
3. Form liner installer shall be approved by form liner manufacturer.

B. Mockup Panel: Construct as specified in Section 03 30 00, Cast-in-Place Concrete, for each form liner type.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect form liners from damage during delivery, storage, and handling.

B. Store form liners in accordance with manufacturer’s written instructions.

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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. Use plywood forms when using form liners. Plywood may be of lower finish grade when used in conjunction with form liners.
2. Where steel forms or form liners 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. Form Liners:

1. Material: Elastomeric, FRP, ABS, or, PVC.
2. Manufacturing Tolerance: Overall dimensions within 0.125-inch at time of manufacture.
3. Controlled Permeability Form Liner:
    a. Consists of filter fabric bonded to backing grid with documented ability to improve concrete surface.
    b. Properties:
        1) Maximum Pore Size: Less than 0.050 mm.
        2) Water Retention Capacity: 1.30 liters per square meter without drainage, minimum.
        3) Absorbency: 0.1-liter per square meter, maximum.
        4) Compression: Less than 10 percent under a pressure of 200 kPa.
        5) Tensile Strength at 5 Percent Elongation: 8 kN/square meter, minimum.
    c. Manufacturer and Product: Dupont; Zemdrain MD.

D. Sandblasted Surface Forms: Medium-density overlay plywood for flat concrete surfaces to be sandblasted.

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E. Painted Surface Forms: High-density overlay plywood for flat concrete surfaces to be painted.

F. 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 or form liners.
   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: Stainless 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 water stop 0.103-inch thick and 0.625-inch diameter tightly and continuously welded to tie.

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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 water stop 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.
3. Elastic Vinyl Plug for Through-Bolt Tie Holes:
   a. Design and size of plug to allow insertion with tool to enable plug to elongate and return to original length and diameter upon removal; forms watertight seal.
   b. Manufacturers and Products:
      1) Dayton Superior, Miamisburg, OH; A58 Sure Plug.
      2) Greenstreak Group, Inc., St Louis, MO; X-Plug.

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.

D. Form Liner Forms:

1. Prepare forms as recommended by manufacturer.
2. Provide liners in full sheets and locate seams as shown on approved Shop Drawings.
3. Anchor liners to formwork as recommended by liner manufacturer.
4. Clean form liner after each use and use only form release agents approved by form liner manufacturer.

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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. Forms Supporting Form Liners:

1. Construct to structurally withstand deflection, movement, leakage, high hydraulic pressures resulting from rapid filling and heavy-high frequency vibration.
2. Lay out form joints and ties in uniform pattern, unless otherwise shown.

E. Form Liner Installation:

1. Protect form liners from extended exposure to sunlight and from high surface temperatures during installation.
2. Handle, cut, and install form liners in accordance with form liner manufacturer's instructions and recommendations.
3. Place form liners with level and square, unless otherwise noted and in accordance with specified patterns and joints.
4. Maintain required concrete cover between form liner and steel reinforcement.

F. 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.

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G. 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.

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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. Forms with Form Liners: Remove formwork in accordance with form liner manufacturer's recommendations. Use consistent form liner removal timing to avoid variations in concrete color. Avoid damaging formed profiles.

D. Form Ties: Remove conical inserts or through bolts and plug holes as specified in Section 03 30 00, Cast-in-Place Concrete.

3.04 MANUFACTURER'S SERVICES

A. Provide form liner manufacturer's representative at Site for installation assistance, and inspection.

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: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

END OF SECTION

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SECTION 03 21 00
STEEL REINFORCEMENT

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Unless otherwise specified, Work shall conform to requirements of ACI 301-20, Specifications for Concrete Construction.

B. Unless otherwise specified, requirements of this section shall comply with requirements for corresponding term in ACI 301.

C. Scope: In accordance with 3.1.1 *Scope* of ACI 301.

1.02 REFERENCES

A. Unless otherwise noted, see 1.4 *Referenced standards* of ACI 301 for referenced standards.

B. Additional references include the following:

1. American Concrete Institute (ACI): 301-20, Specifications for Structural Concrete.
2. International Code Council (ICC): Evaluation Services Report.

1.03 SUBMITTALS

A. Unless specified otherwise, in accordance with 3.1.2 *Submittals* of ACI 301.

B. Action Submittals:

1. Unless otherwise specified, comply with the following before fabrication and execution of Work:
   a. Placing Drawings: In accordance with 3.1.2.1(b) of ACI 301.
   b. Splices: In accordance with 3.1.2.1(c) of ACI 301.
   c. Column Dowels: In accordance with 3.1.2.1(e) of ACI 301.
   d. Field Bending or Straightening: In accordance with 3.1.2.1(f) of ACI 301.
   e. Field Cutting of Reinforcing Bars: In accordance with 3.1.2.1(h) of ACI 301.

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C. Informational Submittals:

1. Reinforcement: In accordance with 3.1.2.1(a) of ACI 301.
2. Mechanical Splicing Systems:
   a. Data in accordance with 3.1.2.1(d) of ACI 301 and the following:
      1) Current ICC Evaluation Services Report or equivalent code agency report listing findings to include acceptance, special inspection requirements, and restrictions.
      2) Manufacturer's written instructions for storage, handling, and installation.
3. Test results of field testing.

1.04 MATERIAL STORAGE AND HANDLING

A. In accordance with 3.1.3 *Material storage and handling* of ACI 301.

PART 2 PRODUCTS

2.01 MATERIALS

A. Unless otherwise specified, in accordance with 3.2.1 *Materials* of ACI 301 and the following:

1. Steel Reinforcing Bars:
   a. Unless otherwise specified, in accordance with 3.2.1.1 of ACI 301 and shall conform to ASTM A615/A615M, Grade 60
      1) Unless otherwise specified in Contract Documents, steel reinforcing bars shall be deformed.
2. Welded Wire Reinforcement:
   a. In accordance with 3.2.1.6. of ACI 301 and the following:
      1) Unless otherwise specified, welded wire reinforcement shall be provided in flat sheets.
         a) If welded wire reinforcement is specified to be bent, provide in bent sheets.
      2) Minimum Yield Strength: 75 ksi.
      3) Plain Welded Wire Reinforcement: In accordance with 3.2.1.6(a) of ACI 301.
3. Reinforcement Supports and Spacers:
   a. In accordance with 3.2.1.8 of ACI 301 and the following:
      1) Plastic Protected Wire Bar Supports: In compliance with ANSI/CRSI – RB 4.1 Class 1 Reinforcement Supports, except provide Class 1A with epoxy-coated or dual-coated reinforcing steel.

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2) Stainless Steel Protected Wire Bar Supports: In compliance with ANSI/CRSI – RB 4.1 Class 2B Reinforcement Supports, except the non-stainless steel portion of the supports shall not extend closer than 3/4 inch from the surface of the concrete.
3) Bar supports and spacers with no special requirements for corrosion resistance: In compliance with ANSI/CRSI – RB 4.1 Class 3 Reinforcement Supports.
4) Precast Cementitious Bar Supports and Spacers:
   a) In compliance with ANSI/CRSI – RB 4.1 Cementitious (Precast) Reinforcement Supports and the following:
      (1) Precast cementitious bar supports shall have equal or greater strength than the surrounding concrete.
      (2) Precast cementitious bar supports shall have water absorption and porosity equal to or less than water absorption and porosity of concrete being placed.
      (3) Precast cementitious bar supports shall be 4 square inches minimum, in plan.
      (4) Precast concrete shall contain a minimum of two tie embedded tie wires.

4. Tie Wire:
   a. Unless Otherwise Specified: Black, soft-annealed 16-gauge wire.
   b. Epoxy-Coated or Dual Coated Reinforcement: Tie wires coated with epoxy or other polymer.
   c. Stainless Steel Reinforcement: Stainless steel or plastic-coated tie wires.
5. Mechanical Splices:
   a. In accordance with 3.2.1.9 of ACI 301 and following:
      1) Capable of developing reinforcing in tension or compression.
      2) Specific product within system/series shall be certified to comply with ACI 318 Type 1.
      3) Shall be configured such that concrete cover over coupler complies with specified minimum cover for steel reinforcement and maintains position of reinforcement within specified placement tolerances.
      4) Manufacturers and Products:
         a) nVent Erico, Solon, OH; Erico CADWELD.
         b) nVent LENTON, Solon, OH; Mechanical Splice System.

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c) Dayton Superior Corporation, Miamisburg, OH; 100 Series through 400 Series.

2.02 FABRICATION

A. Unless otherwise specified, fabrication shall be in accordance with 3.2.2 *Fabrication* of ACI 301.

B. Bending:

1. In accordance with 3.2.2.1 of ACI 301 and the following:
   a. Minimum inside bend diameters are specified in other Contract Documents.
   b. Minimum finished bend diameters for reinforcing bars that are galvanized before fabricating shall be equal to or greater than those specified in Table 2 of ASTM A767/A767M.
   c. Minimum inside bend diameters for welded wire reinforcement used as stirrups or ties shall not be less than four times the nominal diameter of the wire for deformed wires larger than D6, and two times the nominal wire diameters for all other wires. Bends with inside diameter of less than 8-wire diameters shall not be less than 4-wire diameters from nearest weld intersection.

C. Welding:

1. Steel reinforcement shall not be welded except for the following welded assemblies produced under factory conditions:
   a. Welded wire reinforcement.
   b. Bar mats.
   c. Deformed bar anchors.
2. Proceed with Work only after welding Action Submittals have been approved and Informational Submittals have been accepted.

PART 3 EXECUTION

3.01 PREPARATION

A. In accordance with 3.3.1 *Preparation* of ACI 301.

3.02 PLACING

A. Tolerances:

1. Reinforcing Bars: In accordance with 3.3.2.1 of ACI 301.
2. Welded Wire Reinforcement: Shall be equal to that of reinforcing bars.

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B. Reinforcement Relocation: In accordance with 3.3.2.2 of ACI 301.

C. Concrete Cover: In accordance with requirements specified elsewhere in Contract Documents.

D. Tying Reinforcing Bars:

1. Unless otherwise specified, reinforcing bars shall be tied as required to maintain position of reinforcing bars within specified tolerances, after concrete has been placed.
2. Tie every other intersection on mats of reinforcing steel made up of No. 3, No. 4, No. 5, and No. 6 bars.

E. Reinforcement Around Openings: Unless otherwise specified, provide one half the equivalent area of reinforcing bars interrupted by opening and penetration, on each side, above, and below openings and penetrations. Extend reinforcing bars lap length beyond opening at each end, which shall be calculated based on the minimum net spacing between typical and additional reinforcement.

1. Minimum concrete cover around and above headed shear stud shall equal specified minimum concrete cover of reinforcement.

F. Reinforcement Supports and Spacers:

1. Install reinforcement in accordance with 3.3.2.4 of ACI 301 and the following:
    a. Bar supports and spacers 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, and location of reinforcement remains within tolerance throughout work.
    b. Bar supports and spacers in contact with waterproofing barrier or vapor barrier, shall not damage barrier system.
    c. Place reinforcement supported from ground or mud mat on precast cementitious reinforcement supports.
    d. Bar Supports and Spacers in Contact with Forms: Unless otherwise specified, bar supports shall be plastic protected wire bar supports, stainless steel protected wire bar supports, or precast concrete bar supports.
        1) Unless otherwise specified, use Class 1 bar supports.
            a) Use Class 1A to support epoxy-coated and dual-coated reinforcing steel.

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2) Use stainless steel protected wire bar supports or precast concrete bar supports at formed surfaces that will be exposed to view in finished construction regardless of whether surface is specified to receive paint or coating.
3) Use stainless steel protected wire bar supports or precast concrete bar supports at formed surfaces that will receive abrasive blasting, hydro-blasting, or grinding.

G. Welded wire reinforcement shall be supported in accordance with 3.3.2.5 of ACI 301 and as required for the welded wire reinforcement to be within specified tolerance after concrete has been placed.

H. Dowels: In accordance with 3.3.2.6 of ACI 301.

I. Lap Splices, Mechanical Splices, and Development of Reinforcement:

1. In accordance with 3.3.2.7 of ACI 301 and the following:
   a. Lap Splice Lengths and Development Lengths of Reinforcing Bars: Refer to other Contract Documents for additional information and requirements.
   b. Stagger splices in adjacent bars where indicated.
   c. Mechanical Splices:
      1) Provide mechanical splices where shown on the Drawings.
      2) Install assembly in accordance with manufacturer's written instructions and in accordance with ICC Evaluation Services Report or equivalent code agency report.

J. Field Bending or Straightening:

1. Unless otherwise specified, steel reinforcement shall not be field bent or straightened.
2. Where field bending and straightening is specified in the Contract Documents, field bending and straightening may be performed only once per reinforcing bar and shall be in accordance with 3.3.2.8 of ACI 301.
3. Unless otherwise specified, bend diameters shall comply with 3.3.2.8(c) of ACI 301.

K. Field cutting reinforcement: In accordance with 3.3.2.9 of ACI 301.

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L. Reinforcement through Movement Joints:

1. In accordance with 3.3.2.10 of ACI 301 and the following:
   a. Movement joints include expansion joints and contraction joints.
   b. Smooth dowels may continue through movement joints when unbonded on one side of joint.

M. Where reinforcement does not extend through a joint, terminate reinforcement 2 inches from face of joint.

3.03 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 the supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. The 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

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SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 GENERAL

A. Unless otherwise specified, Work must be in accordance with ACI 301, Specifications for Structural Concrete.

1.02 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 Materials.
   b. 301, Specifications for Concrete Construction.
   c. 305.1, Specification for Hot Weather Concreting.
   d. 306.1, Standard Specification for Cold Weather Concreting.
   e. CP-1, Technical Workbook for Concrete Field Testing Technician – Grade I.
2. ASTM International (ASTM):
   a. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   b. C33/C33M, Standard Specification for Concrete Aggregates.
   c. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   d. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   e. C143/C143M, Standard Test Method for Slump of Hydraulic-Cement Concrete.
   f. C138/C138M, Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
   g. C150/C150M, Standard Specification for Portland Cement.
   h. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   i. C231/C231M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
   j. C260/C260M, Standard Specification for Air-Entraining Admixtures for Concrete.
   k. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
   l. C595/C595M, Standard Specification for Blended Hydraulic Cements.

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m. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
n. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
o. C979/C979M, Standard Specification for Pigments for Integrally Colored Concrete.
p. C989/C989M, Standard Specification for Slag Cement for Use in Concrete and Mortars.
q. C1017/C1017M, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
r. C1064/C1064M, Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
s. C1074, Standard Practice for Estimating Concrete Strength by the Maturity Method.
t. C1077, Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.
u. C1218/C1218M, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
v. C1240, Standard Specification for Silica Fume Used in Cementitious Mixtures.
w. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
x. C1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
y. C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
z. ASTM C1581/C1581M, Standard Test Method for Determining Age at Cracking and Induced Tensile Stress Characteristics of Mortar and Concrete under Restrained Shrinkage.
aa. C1582/C1582M, Standard Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete.
bb. C1583/C1583M, Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method).
cc. C1602/C1602M, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
dd. C1610/C1610M, Standard Test Method for Static Segregation of Self-Consolidating Concrete Using Column Technique.
ee. C1611/C1611M, Standard Test Method for Slump Flow of Self-Consolidating Concrete.

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ff. C1621/C1621M, Standard Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring.
gg. D4580, Standard Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding.
hh. D4791, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
ii. E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
jj. E1155, Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers.

3. International Concrete Repair Institute (ICRI): PC1-10, Concrete Surface Profile Chip Set.
4. National Ready Mixed Concrete Association (NRMCA).

1.03 DEFINITIONS

A. Cold Weather: When ambient temperature is below 40 degrees F or is approaching 40 degrees F and falling.

B. Defective Area:

1. 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 belowgrade habitable spaces that are 0.005-inch wide and wider, and cracks in other structures with visible leakage or 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.
2. At exposed concrete, defective areas also include texture irregularities, stains, and other color variations that cannot be removed by cleaning.
3. Cold joints.

C. 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. Surfaces must be considered exposed concrete, even if covered by paint, sealers, or similar applications.

D. Flat and Elongated Particles of Aggregates: Those particles having a ratio of length to thickness greater than a 5 to 1.

E. Hot Weather: As defined in ACI 305.1.

F. New Concrete: Less than 60 days old.

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1.04 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, for the following:
      1) Portland cement.
      2) Blended cement.
      3) Fly ash.
      4) Slag cement.
      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) Aggregates:
         a) Deleterious substances in fine aggregate per ASTM C33/C33M, Table 2.
         b) Deleterious substances in coarse aggregate per ASTM C33/C33M, Table 4.
      4) Water-Soluble Chloride-Ion Content in Hardened Concrete:
         a) One of the following:
            (1) Test report in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.
            (2) Calculation of water-soluble chloride content based on certified chloride content of each constituent material and proportion of constituent material in concrete mixture.
      5) Shrinkage Test Results: In accordance with ASTM C157/C157M as modified herein.
      6) Resistance to Alkali Silica Reaction: Supporting information for one of the options for mitigating alkali silica reaction listed in Article Concrete Mix Design. Include documentation of test results per applicable standards.

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2. Product Data:
   a. Admixtures: Manufacturer's catalog cut sheets and product data sheets for each admixture used in proposed mix designs.
   b. Specified ancillary materials.
3. Detailed plan for curing and protection of concrete placed and cured in cold weather. Details must 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 must 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. Concrete repair techniques.

B. Informational Submittals:

1. Preinstallation conference minutes.
2. Manufacturer's application instructions for bonding agent and bond breaker.
3. Manufacturer's Certificate of Compliance to specified standards:
   a. Bonding agent.
   b. Repair materials.

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4. Statement of Qualification:
    a. Batch Plant: Certification as specified herein.
    b. Mix designer.
    c. Installer.
    d. Testing agency.
5. Field test reports.
6. 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 is permitted to be added at Site.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Batch Plant: National Ready Mixed Concrete Association (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 Department of Transportation (DOT)-certified mix designer in jurisdiction of the Work. Requirement may be waived if Mix Designer is a professional engineer registered in the state where the Project is located.
3. Flatwork Finisher: Unless otherwise permitted, at least one person on finishing crew must be certified as an ACI Flatwork Finisher, or equivalent.
4. 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 must 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 must be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor must be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

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B. Preinstallation Conference:

1. Required Meeting Attendees:
   a. The Contractor, including pumping, placing, and finishing, and curing subcontractors.
   b. Ready-mix producer.
   c. Admixture representative.
   d. Steel reinforcement installer.
   e. Testing and sampling personnel.
   f. The Owner and/or the Owner's designee.
2. Schedule and conduct Preinstallation Conference prior to incorporation of respective products into Project. Notify the Owner of location and time.
3. Agenda must 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. Steel reinforcement details.
   g. Protection procedures for weather conditions.
   h. Other specified requirements requiring coordination.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise specified, Work must be in accordance with ACI 301.

2.02 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, excluding Type IS (greater than 70), conforming to ASTM C595/C595M.
      2) Portland cement used in blended hydraulic cement, conform to requirements of ASTM C150/C150M.
   c. Furnish from one source.

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2. Supplementary Cementitious Materials (SCM):
    a. Fly Ash (Pozzolan):
        1) Class F fly ash in accordance with ASTM C618, except as modified herein:
            a) When air-entrainment is specified, fly ash shall comply with uniformity requirements of Table 3 of ASTM C618.
    b. Slag Cement: In accordance with ASTM C989/C989M, Grade 100.

B. Aggregates: Unless otherwise permitted, furnish from one quarry location for each aggregate type used in a mix design.

1. Aggregates:
    a. In accordance with ACI 301, except as modified herein.
    b. Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
    c. Aggregates that are susceptible to alkali-carbonate reactions shall not be used.
    d. Resistance to Alkali Silica Reaction: See Article Concrete Mix Design.
2. Fine Aggregates:
    a. In accordance with ACI 301, except as modified herein.
    b. In the event manufactured sand is included in mix design, material must be from same source as coarse aggregate.
    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 3 percent mass of total sample.
        2) Limit coal and lignite to 1 percent.
3. Coarse Aggregate:
    a. Crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles as determined by ASTM D4791.
    b. Class designation in accordance with ASTM C33/C33M, Table 4: 4S unless otherwise specified.
    c. Limit deleterious substances in accordance with ASTM C33/C33M, Table 4 for specified class designation.

C. Admixtures:

1. Characteristics:
    a. Compatible with other constituents in mix.
    b. Contain at most, only trace amount chlorides in solution.

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c. Furnish type of admixture as recommended by manufacturer for anticipated temperature ranges.
d. Do not use calcium chloride admixtures.

2. Air-entraining Admixture: ASTM C260/C260M.
3. Water-reducing Admixture: ASTM C494/C494M, Type A or Type D.
   a. Manufacturers and Products:
      1) Master Builders Solutions US, Shakopee, MN; MasterPozzolith Series or MasterPolyheed Series.
      2) Euclid Chemical Co., Cleveland, OH; Eucon Series.
      3) GCP Applied Technologies, Cambridge, MA; Mira Series.
4. Retarding Admixture: ASTM C494/C494M, Type B.
5. Accelerating Admixture: ASTM C494/C494M, Type C.
6. Do not use calcium chloride as an admixture.
7. High Range Water-reducing Admixture: ASTM C494/C494M, Type F or Type G.
   a. Manufacturers and Products:
      1) Master Builders Solutions US, Shakopee, MN; MasterGlenium Series or MasterRheobuild 1000.
      2) Euclid Chemical Co., Cleveland, OH; Eucon Series or Plastol Series.
      3) GCP Applied Technologies, Cambridge, MA; ADVA Series.
8. Viscosity Modifying Admixture (VMA): ASTM C494/C494M, Type S.
   a. Manufacturers and Products:
      1) Master Builders Solutions US, Shakopee, MN; MasterMatrix VMA Series.
      2) Euclid Chemical Co., Cleveland, OH; Visctrol.
      3) GCP Applied Technologies, Cambridge, MA; V-MAR Series.

D. Water and Ice: Mixing water for concrete and water used to make ice must be potable water unless alternative sources of water are permitted.

1. Water from alternative sources must comply with requirements of ASTM C1602/C1602M, and concentration of chemicals in combined mixing water must be less than:
   a. Chloride Content: 1,000 ppm.
   b. Sulfate Content as SO_4: 3,000 ppm.
   c. Alkalis as (Na_2O + 0.658 K_2O): 600 ppm.
   d. Total Solids by Mass: Less than 50,000 ppm.

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2.03 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.

2.04 CONCRETE MIX DESIGN

A. General:

1. See supplement at end of this section for mix design requirements for each class of concrete used on Project.
2. Unless otherwise specified, prepare design mixtures for each type and strength of concrete, in accordance with requirements of ACI 301.
3. Unless specified otherwise, selection of constituent materials and products in mix design are optional.
4. Use water-reducing admixture or water-reducing admixture and high-range water-reducing admixture for the following:
   a. Concrete mixtures that will be pumped.
   b. Concrete mixtures with a water-cementitious materials ratio below 0.50.
   c. Concrete mixtures used in elements of a liquid-containment structure.
   d. Concrete mixtures used in columns, piers, pilasters, and walls.
   e. When needed to achieve fresh properties that facilitate handling, placing, and consolidating of concrete mixtures, and to achieve specified hardened properties.
   f. When anticipated high temperatures, low humidity, or other adverse placement conditions can adversely affect fresh properties of concrete.
5. Unless otherwise specified, desired fresh properties of concrete must be determined by Contractor and coordinated with concrete producer. Fresh properties of concrete must remain stable to satisfaction of Contractor, for duration of placement and consolidation, and must remain in conformance with requirements of Contract Documents.
6. Concrete producer is encouraged to employ environmentally sustainable concrete mix design technologies such as supplementary cementitious materials and aggregate packing.

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B. Proportions:

1. Concrete mixtures must meet specified aesthetic, durability, and strength requirements.
2. Where fly ash is included in mix, minimum fly ash content shall be 15 percent of weight of total cementitious materials.
3. Where silica fume is included in mix, minimum silica fume content shall be 5 percent of weight of total cementitious materials.

C. Resistance to Alkali-Silica Reaction:

1. Unless otherwise specified, or unless members are designated as being dry in service and not in contact with ground, or assigned to Exposure Class W0, use one of the three following options for qualifying concrete mixtures to reduce potential of alkali-silica reaction.
   a. For each aggregate used in concrete, expansion result determined in accordance with ASTM C1293 must not exceed 0.04 percent at 1-year.
   b. For each aggregate used in concrete, expansion result of aggregate and cementitious materials combination determined in accordance with ASTM C1567 must not exceed 0.10 percent at age of 16 days. Submit supporting data for each aggregate showing expansion in excess of 0.10 percent at 16 days when tested in accordance with ASTM C1260.
   c. Alkali content in concrete (LBA), excluding that from supplementary cementitious materials and the pozzolans and slags in blended cements, must not exceed 4 lb/yd^3 for aggregates with expansions more than or equal to 0.04 percent and less than 0.12 percent or 3 lb/yd^3 for aggregates with expansions greater than or equal to 0.12 percent and less than 0.24 percent. Reactivity must be determined by testing in accordance with ASTM C1293. Alkali content must be calculated as follows:
      1) LBA = (cement content, lb/yd^3) × (equivalent alkali content of portland cement in percent/100 percent).
2. Option 1.c. shall not be used with natural pozzolan or fly ash that has a CaO content greater than 18 percent, or for aggregate with expansion at 1 year greater than or equal to 0.24 percent when tested in accordance with ASTM C1293.
3. Fly ash with an alkali content greater than 4.0 percent shall not be used in Option 1.b. or Option 1.c.

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D. Concrete Shrinkage Limits:

1. If shrinkage limits are specified, design mix for the following shrinkage limits and test in accordance with ASTM C157/C157M, with the following modifications:
   a. Prisms shall have 4-inch square cross section.
   b. Prisms must be moist cured for 7 days prior to 28-day drying period.
   c. Comparator reading at end of 7-day moist cure must be used as initial length in length change calculation.
   d. Reported results must be average of three prisms.
   e. If shrinkage of a specimen departs from average of that test age by more than 0.004 percent, disregard results obtained from that specimen.
2. Results at end of 28-day drying period shall not exceed 0.040 percent.

E. Slump:

1. Unless otherwise specified, select a target slump at point of delivery for concrete mixtures used for Work. Selected target slump shall not exceed 9 inches.
2. Concrete shall not show visible signs of segregation.
3. Target slump indicated on submittal shall be used as basis for acceptance during the Project.
4. Determine slump by ASTM C143/C143M.
5. Slump tolerances shall be in accordance with ACI 117.

F. Size of Coarse Aggregate:

1. Unless otherwise specified, nominal maximum size of coarse aggregate shall not exceed:
   a. Three-fourths of minimum clear spacing between reinforcement.
   b. One-fifth of narrowest dimension between sides of forms.
   c. One-third of thickness of slabs or toppings.

2.05 CONCRETE MIXING

A. General: Unless otherwise specified, in accordance with ACI 301.

B. Temperature Limits: Maintain concrete temperature below 95degrees 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.

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2.06 SOURCE QUALITY CONTROL

A. Source Quality Control Inspection: Engineer must 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 GENERAL

A. Unless otherwise specified, in accordance with ACI 301.

3.02 PREPARATION

A. Preparation: In accordance with ACI 301.

B. Inspection: Notify Engineer and Special Inspector at least 1 full working day in advance before starting to place concrete.

3.03 CONCRETE BONDING

A. Construction Joints at Existing Concrete:

1. Thoroughly clean and mechanically roughen existing concrete surfaces to a roughness profile range between CSP 7 to CSP 9 when verified by comparison to PC1-10.
2. Saturate surface with water for 24 hours prior to placing new concrete.

3.04 PLACEMENT OF CONCRETE

A. Unless otherwise specified, in accordance with ACI 301.

B. Retempering: Not permitted for concrete where cement has partially hydrated.

C. Pumping of Concrete: 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.

D. Joints in Footings and Slabs with Waterstops (Excluding Hydrophilic and Injection-Type): Verify space beneath plastic waterstop completely fills with concrete and is consolidated along entire length of waterstop.

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E. Maximum Size of Concrete Placements:

1. Locate expansion, control, and contraction joints where shown on the Drawings.
2. Construction Joints:
   a. Locate additional construction joints as follows:
      1) Provide vertical construction joints in walls and slabs at maximum spacing of 40 feet, unless shown or approved otherwise.
      2) When vertical expansion, contraction, or control joint spacing does not exceed 60 feet, intermediate construction joints are not required.
3. Should placement sequence result in cold joint located below finished water surface, install waterstop in joint.

3.05 CURING

A. In accordance with Section 03 39 00, Concrete Curing, unless otherwise specified.

3.06 REPAIRING CONCRETE

A. General:

1. Repair defective areas of concrete.
2. Unless otherwise specified, cracks which meet definition of defective area must be repaired by injecting epoxy resin as specified in Section 03 64 23, Epoxy Injection Grouting.
3. Moving cracks deemed as nonstructural by Owner must be repaired by injecting polyurethane resin as specified in Section 03 64 24, Polyurethane Injection Grouting.
4. 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 Owner.
5. Obtain quantities of repair material and manufacturer’s detailed instructions for use to provide repair with finish to match adjacent surface or apply enough repair material adjacent to repair to blend finish appearance.
6. Repair of concrete must provide structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to Owner.

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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. If required, color of tie-hole patch must match adjacent concrete.
   a. Clean and dampen tie holes before applying mortar. Do not use separate bonding agent.
   b. Fill with site-mixed portland cement repair mortar in accordance with ACI 301.
   c. 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 and in accordance with manufacturer's written instructions.

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 the Drawings.

3.07 FORMED SURFACE FINISHES

A. Concrete Walls Finishes:

1. Trowel and round off top exposed edges of walls with 1/4-inch radius steel edging tool.

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2. Type W-1 (Ordinary Wall Finish):
   a. Patch tie holes.
   b. Remove projections.
   c. Repair defective areas to provide smooth uniform appearance.
   d. Inject cracks.
3. Type W-2 (Smooth Wall Finish):
   a. Patch tie holes.
   b. Remove projections.
   c. Repair defective areas to provide smooth uniform appearance.
   d. Inject cracks.

B. Concrete Beam and Column Finishes:

1. Type B-1: Match wall Type W-1.
2. Type B-2: Match wall Type W-2.
3. Type B-3:
   a. Repair rock pockets.
   b. Fill air voids.
4. Type C-1: Match wall Type W-1.
5. Type C-2: Match wall Type W-2.
6. Type C-3: Fill air pockets.

3.08 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 enough 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.

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5. Provide light steel-troweled finish (two trowelings) at air-entrained slabs. Provide hard steel-troweled finish (ringing sound from the trowel) for non-air 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 spots 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-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.

E. Type S-6 (Sidewalk Finish):

1. Slope walks down 1/8 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.

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F. 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.

3.09 CONCRETE SLAB TOLERANCES

A. General: Concrete slab tolerances are in accordance with ACI 117 tolerances for random traffic floor surface finishes, for cast-in-place concrete buildings.

B. Slab Tolerances:

1. Slab Elevation and Thickness:
   a. Finish Slab Elevation: Slope slabs to floor drains and gutter. Slabs must adequately drain regardless of tolerances.
   b. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from thickness shown.

3.10 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 the 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.

3.11 FIELD QUALITY CONTROL

A. General:

1. Unless otherwise specified, concrete field-testing services will be in accordance with ACI 301 and Section 01 45 33, Special Inspection, Observation, and Testing.
2. Unless otherwise specified, refer to ACI 301 and Section 01 45 33, Special Inspection, Observation, and Testing for additional information regarding requirements related to concrete field quality assurance.
3. Unless otherwise specified, concrete field-testing services will be provided by Owner.

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4. Provide electrical and water services to area of Site for safe storage and curing of concrete test specimens prior to transport of test specimens to testing lab.
5. Concrete testing agency will provide storage facility for proper curing of concrete test specimens onsite prior to transport of test specimens to testing lab.
6. Unless otherwise specified, concrete will be sampled for making test specimens, from point of delivery.
7. For additional information regarding requirements of the Contractor related to concrete field quality assurance, refer to Section 01 45 33, Special Inspection, Observation, and Testing.
8. Unless otherwise specified, sampled concrete used to mold strength test specimens (ASTM C31/C31M) will be tested for slump (ASTM C143/C143M) or slump flow (ASTM C1611/C1611M), air content (ASTM C231/C231M), temperature (ASTM C1064/C1064M), and density (ASTM C138/C138M).
9. Measured Air Content at Point of Delivery:
    a. When measured air content at point of delivery is greater than specified limit, a 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.
    b. 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.
    c. Concrete that has failed to meet requirements of Contract Documents must be rejected.
10. If concrete is pumped, concrete will be sampled for air content testing at point of delivery and at point of placement.
11. Test specimens must be stored and cured in accordance with ASTM C31/C31M and tested in accordance with ASTM C39/C39M.
12. Frequency of testing may be changed at discretion of Special Inspector or Owner.
13. Evaluation and acceptance will be in accordance with ACI 301 and the Contract Documents.

B. Concrete Strength Test:

1. Unless otherwise specified, specimens will be made and tested as follows:
    a. One standard test specimen at age of 7 days for information.

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b. Minimum of two standard test specimens at age of 28 days for acceptance.
c. A minimum of one spare standard test specimen per sample.

2. Spare cylinder will be tested as directed by Owner.

C. Tolerances:

1. Concrete tolerances must comply with the more stringent of equipment manufacturers' tolerances and specified tolerances.
2. Formed Surfaces:
   a. Formed surface finishes must comply with specified requirements.
   b. Tolerances of formed surfaces must comply with specified requirements and with ACI 117 for cast-in-place concrete buildings.
3. Unformed Surfaces:
   a. Surface finishes must comply with specified requirements.
   b. Unless otherwise specified, tolerances for unformed surface must conform to requirements of ACI 117 for cast in place concrete buildings.
   c. Concrete slab tolerances must comply with specified requirements and with ACI 117 random traffic floor surface finish tolerances, unless otherwise specified.
   d. Slab Elevation:
      1) Slabs must slope to drains.
      2) Top of concrete elevations must comply with specified requirements and ACI 117 for cast-in-place concrete buildings.
   e. Slab thickness tolerance must comply with specified requirements and ACI 117 for cast in place concrete buildings.

3.12 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. Observe how concrete mixes are performing.
   b. Be present during first placement of each type of concrete mix.
   c. Assist with concrete mix design, performance, placement, weather problems, and problems as may occur with concrete mix throughout Project, including instructions for redosing.
   d. Establish control limits on concrete mix designs.

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e. 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.

3.13 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 because of other construction work.

B. Repair areas damaged by construction, using specified repair materials and approved repair methods.

3.14 SCHEDULE OF CONCRETE FINISHES

A. Form Tolerances: As specified in Section 03 10 00, Concrete Forming and Accessories.

B. Unless otherwise specified, provide concrete finishes and tolerances as scheduled:

Area	Type of Finish	Required Tolerances
Exterior Wall Surfaces		
Abovegrade/exposed (above point 6" below finish grade)	W-2	W-B
Abovegrade/covered with brick veneer or other finish material	W-1	W-A
Backfilled/waterproofed (below point 6" below finish grade)	W-1	W-A
Backfilled/not waterproofed (below point 6" below final grade)	W-1	W-A
Walls to receive cementitious coatings	W-4	W-B

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Area	Type of Finish	Required Tolerances
Interior Wall Surfaces		
Open top hydraulic structures not painted or coated	W-2	W-A
Covered hydraulic structures not painted or coated	W-1	W-A
Hydraulic structures painted or coated	W-5	W-A
Buildings, pipe galleries, and other dry areas not painted or coated	W-2	W-A
Buildings, pipe galleries, and other dry areas painted or coated	W-5	W-A
Exterior Slabs		
Roof slab/exposed	S-5	S-B
Roof slab/covered with roofing material	S-1	S-A
Top of wall	S-5	S-B
Top of footing	S-2	S-A
Clarifier slabs	S-7	S-A
Slabs in hydraulic structures unless otherwise specified	S-1	S-A
Stairs and landings	S-5	S-B
Sidewalks	S-6	S-B
Exterior slabs unless otherwise specified	S-5	S-A
Interior Slabs		
Buildings, pipe galleries, and other dry areas	S-1	S-B
Slabs to receive mortar setting bed for tile	S-2	S-A
Slabs to receive resilient flooring or carpet	S-1	S-A
Hydraulic channels	S-1	S-A
Underside of elevated slabs	S-3	S-A

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Area	Type of Finish	Required Tolerances
Beams and Columns		
Beams/coated	B-3	B-A
Beams/not coated	B-2	B-A
Columns/coated	C-3	C-A
Columns/not coated	C-2	C-A

3.15 SUPPLEMENT

A. Requirements of concrete mix designs (CMD) following "End of Section," is a part of this specification and supplement requirements of Part 1 through Part 3 of this section:

1. Concrete Mix Design—CMD-1.

END OF SECTION

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Concrete Mix Design
CMD-1

A. Mix Locations: Typical, unless otherwise specified.

B. Exposure Categories and Classifications: F3S1W2C2 as defined in ACI 318-19.

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) must be 5,000 pounds per square inch at 28 days.
3. Concrete mix must be designed to conform to shrinkage limits.
4. Air-entraining admixtures are prohibited in concrete mixtures and total air content must not be greater than 3 percent, for the following:
   a. Slabs to receive a hard-troweled finish.
   b. Slabs to receive a dry shake floor hardener.
   c. Slabs to receive a topping placed monolithically as a two-course floor on top of plastic concrete.
5. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in. ‡	**Air Content (%)***
3/8	7.5
1/2	7.0
3/4	6.0
1	6.0
1-1/2	5.5

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Nominal Maximum Aggregate Size in. ‡	Air Content (%)*
2	5.0
3	4.5

‡ 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.

6. Limit supplementary cementitious materials as follows:

Limits on Cementitious Materials for Concrete Assigned to Exposure Class F3‡*	
Supplementary Cementitious Materials	**Maximum Percent of Total Cementitious Materials by Mass**
Fly ash or natural pozzolans conforming to ASTM C618	25
Slag cement conforming to ASTM C989	50
Silica fume conforming to ASTM C1240	10
Total of fly ash or natural pozzolans and silica fume	35
Total of fly ash or natural pozzolans, slag cement, and silica fume	50

‡Supplementary cementitious materials, including fly ash and natural pozzolans, slag cement, and silica fume, used in the manufacture of ASTM C595/C595M and ASTM C1157/C1157M blended cements shall be included in assessing compliance with these limits.

*Individual limits shall apply regardless of the number of cementitious materials in a concrete mixture.

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7. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II or Type V; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II or Type V in accordance with the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
   c. ASTM C595/C595M Types excluding Type IS (greater than 70), conforming to ASTM C595/C595M and having (MS) designation.
   d. ASTM C1157/C1157M having (MS) designation.
8. Limit water-soluble, chloride ion content in hardened concrete, percent by mass of cementitious materials to 0.15
   a. Limits are stated in terms of water-soluble chloride ions (Cl^-) in percent by mass of cementitious materials.

D. Refer to Part 1 through Part 3 of this section for additional requirements.

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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):
   a. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   b. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
3. NSF International: 61, Drinking Water System Components – Health Effects.

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.

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PART 2 PRODUCTS

2.01 MATERIALS

A. Curing Compound:

1. Water-based, high-solids content, nonyellowing, curing compound meeting requirements of ASTM C1315, Type I and Type II, 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., Cleveland, OH; Eucobar.

C. Penetrating Water Repellent Sealer: Water based, ready to use, single component, silane/siloxane, penetrating, clear water repellant 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.

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D. Clear Liquid Densifier:

1. Colorless, aqueous solution of magnesium fluorosilicate.
2. Each gallon of solution shall contain a minimum of 2 pounds of fluorosilicate compound.
3. Manufacturers and Products:
   a. BASF Construction Chemicals, Shakopee, MN; MasterKure HD 300WB.
   b. Euclid Chemical Co., Cleveland, OH; Surfhard.

E. Retardant for Exposed Aggregate Finish on Slabs:

1. Manufacturers and Products:
   a. Sika Chemical Corp., Lyndhurst, NJ; Rugasol.
   b. Conrad Sovig Co., San Francisco, CA; Conreveal Top Surface.
   c. Burke Co., San Mateo, CA; Burke True Etch Surface Retarder.
   d. Euclid Chemical Co., Cleveland, OH; Surface Retarder S.

F. Retardant for Exposed Aggregate Finish on Formed Surface:

1. Manufacturers and Products:
   a. L. M. Scofield Co., Los Angeles, CA; Lithotex Top Surface Retarder.
   b. Conrad Sovig Co., San Francisco, CA; Control Set.
   c. Burke Co., San Mateo, CA; Burke True Etch Surface Retarder.
   d. Euclid Chemical Co., Cleveland, OH; Surface Retarder F.

G. 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 ACI 308.1.
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.

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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.

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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 to floor slabs.

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 CLEAR LIQUID DENSIFIER APPLICATION

A. Apply to floor slabs.

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. Apply liquid densifier evenly, using three coats, allowing 24 hours between coats.

1. First coat 1/3 strength, second coat 1/2 strength, and third coat 2/3 strength, mix with water.
2. Apply each coat so as to remain wet on surface for 15 minutes.
3. Apply approved liquid densifier in accordance with manufacturer's instructions.
4. After final coat is completed and dry, remove surplus liquid densifier from surface by scrubbing and mopping with water.

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3.06 RETARDANT FOR EXPOSED AGGREGATE SURFACES

A. Apply to floor slabs.

B. Apply in accordance with manufacturer's product instructions.

3.07 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

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SECTION 03 62 00
GROUTING

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. C230, Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
   b. C307, Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.
   c. C531, Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   d. C579, Standard Test Methods for Compressive Grout Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   e. C882, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.
   f. C939, Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
   g. C940, Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.
   h. C1107/C1107M, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
   i. C1181, Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.
   j. D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

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.
3. Forming method for fluid grout placements.
4. Curing method for grout.

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B. Informational Submittals:

1. Manufacturer's Written Instructions: 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 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.

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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:

Application	Temperature Range	Max. Placing Time	
	40 deg F to 100 deg F	20 Min.	Greater Than 20 Min.
Blockouts for gate guides	I or II		II
Precast joints	I or II		II
Column baseplates single-story	I or II		II
Machine bases 25 hp or less	II	II	II
Bases for precast wall sections	II	II	II
Baseplates for columns over one story	II	II	II
Baseplates for legs of tanks, pipe supports, nonvibratory equipment	II	II	II
Welded steel tanks	II	II	II
Precast base joints higher than one story	II	II	II
Form Tie-Through bolt openings	II	II	II
Machine bases 26 hp and up	III or Epoxy Grout	III or Epoxy Grout	III or Epoxy Grout
Baseplates and/or soleplates with vibration, thermal movement, etc.	III or Epoxy Grout	III or Epoxy Grout	III or Epoxy Grout

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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 pounds per square inch at 3 days, 5,000 pounds per square inch at 7 days, and 7,000 pounds per square inch at 28 days.
6. Manufacturers and Products:
   a. Master Builders Solutions, Shakopee, MN; MasterFlow 100.
   b. Euclid Chemical Co., Cleveland, OH; NS Grout.
   c. Dayton Superior Corp., Miamisburg, OH; 1107 Advantage Grout.
   d. US MIX Co., Denver, CO; US SPEC GP 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. One hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout, 3,500 pounds per square inch at 1-day, 4,500 pounds per square inch at 3 days, and 7,500 pounds per square inch at 28 days.
7. Maintain fluid consistency when mixed in 1-yard to 9-yard loads in ready-mix truck.
8. Manufacturers and Products:
   a. Master Builders Solutions, Shakopee, MN; MasterFlow 928.
   b. Five Star Products Inc., Fairfield, CT; Five Star Fluid Grout 100.
   c. Euclid Chemical Co., Cleveland, OH; Hi Flow Grout.

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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. One hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout, 4,000 pounds per square inch at 1-day, 5,000 pounds per square inch at 3 days, and 9,000 pounds per square inch at 28 days.
7. Maintain fluid consistency when mixed in 1-yard to 9-yard loads in ready-mix truck.
8. Manufacturer and Product:
   a. Master Builders Solutions, Shakopee, MN; MasterFlow 885.
   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 pounds per square inch at 75 degrees F at 7 days, 11,000 pounds per square inch at post cure.

F. Maximum creep resistance in accordance with ASTM C1181 at 600 pounds per square inch, 140 degrees F; 6.0 by 10^{-3} in/in.

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G. Minimum bond strength in accordance with ASTM C882, 2,000 pounds per square inch.

H. Minimum tensile strength in accordance with ASTM C307, 2,000 pounds per square inch.

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:

1. Master Builders Solutions, Shakopee MN; MasterFlow 648.
2. Euclid Chemical Co., Cleveland, OH; E^3-Series.
3. Dayton Superior Corp., Miamisburg, OH; Pro-Poxy 2000 Normal Set.
4. Five Star Products Inc., Fairfield, CT; DP Epoxy Grout.

PART 3 EXECUTION

3.01 GENERAL

A. Unless otherwise specified, prepare and condition concrete substrate in accordance with grout manufacturer’s training instructions.

B. Mix, place, and cure grout in accordance with grout manufacturer’s representative’s training instructions.

C. 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.

D. Form Tie-Through Bolt Holes: Provide nonshrink grout, Category II, fill space with dry pack dense grout hammered in with steel tool and hammer.

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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.

E. 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 corners of grout pad.

I. Install expansion joints for epoxy grout placement in accordance with manufacturer's written instructions.

3.03 WELDED STEEL TANKS

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 paint, oil, grease, loose rust, and other foreign material that will be in contact with grout.

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C. Set tank base in position and support using shims as needed.

D. Moisture condition existing concrete surfaces that will be in contact with grout.

1. Moisture condition surfaces of concrete substrate that will be covered by grout, plus 3 inches beyond edges of grout.
2. Saturate existing concrete substrate with water as required by grout manufacturer.
3. Surface of concrete substrate shall be damp but free of standing water at time of placement of grout.

E. Form with watertight forms at least 2 inches higher than bottom of plate.

F. Fill space between bottom of tank base and concrete substrate in accordance with manufacturer's representative's training instructions.

G. Cure grout in accordance with grout manufacturer's written instructions.

3.04 FIELD QUALITY CONTROL

A. General:

1. Performed by Project representative's inspection staff.
2. Perform the following quality control inspections. 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 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.

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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.

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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. 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. 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 II and 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 II and 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. Mix and demonstrate patching through-bolt holes and blockouts for gate guides, and similar items.

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7. Transport test cubes to independent test laboratory and obtain test reports.
8. Training by manufacturer's representative does not relieve Contractor of overall responsibility for this portion of the work.
9. 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 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 a part of this specification:

1. 24-hour Evaluation of Nonshrink Grout Test Form and Grout Testing Procedures.

END OF SECTION

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SUPPLEMENT 1

_____
(Test Lab Name)

_____
(Address)

_____
(Phone No.)

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?	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.

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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-second 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.

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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 an 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 pounds per square inch for grouts claiming fluid placement capabilities.

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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

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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 an 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 pounds per square inch for grouts claiming fluid placement capabilities.

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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

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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:

1. American National Standards Institute (ANSI).
2. ASTM International (ASTM):
   a. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
   b. E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
3. International Code Council (ICC):
   a. 2018 International Building Code (IBC).
   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. Manufacturer’s written letter of certification identifying installer’s qualifications to install products.
3. ICC Evaluation Services Report: Specific to proposed doweling system manufacturer.

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1.04 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: At least three similar projects with same products within last 3 years.
2. 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:

1. Approved by an ICC Evaluation Services Report for conformance to 2018 IBC requirements for doweling of steel reinforcing bars in cracked concrete.
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. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
7. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; HIT-RE 500 V3 (ESR-3814) or HIT HY 200 (ESR 3187) Adhesive Anchors.
   b. Powers Fasteners, Brewster, NY; Power PURE110+ Epoxy Adhesive Anchor System (ESR-3298).

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c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-XP Epoxy Adhesive Anchors (ESR-2508).

B. Mixing Nozzles:

1. Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.
2. Nonremovable internal static mixer required to ensure proper blending of components.

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 the 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 or other obstruction is likely, slant drill to address edge distance or to clear obstruction. If drill must be slanted more than indicated in the manufacturer’s installation instructions to clear obstruction, notify Engineer for direction on how to proceed.

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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 10 percent of installed dowels, with a minimum of two tension tests. 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.

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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

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SECTION 03 64 23
EPOXY RESIN INJECTION GROUTING

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. C882, Standard Specification for Test Method for Bond Strength of Epoxy Resin System Used with Concrete by Slant Shear.
   b. D570, Standard Test Method for Water Absorption of Plastics.
   c. D638, Standard Test Method for Tensile Properties of Plastics.
   d. D648, Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edgewise Position.
   e. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
   f. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
2. National Sanitation Foundation (NSF):
   a. Standard 60, Standard for Drinking Water Treatment and Chemicals – Health Effects.
   b. Standard 61, Standard for Drinking Water System Components – Health Effects.

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.

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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. Health and Safety Plans for confined space entry. Test results of epoxy resin bond tests.
7. Epoxy resin two component ratio and injection pressure test records for concrete crack repair work.

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1.04 QUALITY ASSURANCE

A. Qualifications for Injection Staffs:

1. Manufacturer's Site Representative:
   a. Capable of instructing successful methods of epoxy injection process for concrete structure.
   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:

1. Fill cracks and joints with minimum resin depth penetration no less than 90 percent of:
   a. Full thickness of concrete section for cracks or joints.
   b. Depth between waterstop and inside 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 pounds per square inch minimum bond strength per ASTM C882 test requirements with no failure of either concrete or epoxy resin.

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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.
   c. ANSI Hazard Classification.
   d. ANSI recommended precautions for handling.
   e. Mix ratio by volume for components.

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 Concresive 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 (No. 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 or other voids in concrete structures for bonding or grouting.

B. Uncured Resin Properties:

1. When mixed in ratio specified on resin container label:

	Test Method	Wide Cracks or Joints	Narrow Cracks or Joints
Pot Life (60-gram mass) @ 77, plus or minus 4 deg F	As specified in Article Source Quality Control	13 to 25 minutes	15 to 30 minutes

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	Test Method	Wide Cracks or Joints	Narrow Cracks or Joints
Pot Life (60-gram mass) @ 100, plus or minus 4 deg F	As specified in Article Source Quality Control	3 to 10 minutes	10 to 20 minutes
Viscosity @ 40, plus or minus 3 deg F	Brookfield RVT Spindle No. 4 @ 20 rpm	4,400 cps	600 cps
Viscosity @ 75 to 77 deg F	Brookfield RVT Spindle No. 2 @ 20 rpm	375 to 350 cps	175 to 140 cps

C. Epoxy Resin Properties: When cured for 7 days at 77 degree F, plus or minus 3 degrees F and conditioned at test temperature 12 hours prior to test, unless otherwise specified.

	Test Method	Wide Cracks or Joints	Narrow Cracks or Joints
Ultimate Tensile Strength, psi	ASTM D368	8,000 min.	5,000 min.
Tensile Elongation @ Break, percent	ASTM D638	4.2 max.	3.0 max.
Flexural Strength, psi	ASTM D790	10,000 min.	10,000 min.
Flexural Modulus, psi	ASTM D790	5.5×10^5 min.	4.5×10^5 min.
Compressive Yield Strength, psi	ASTM D695*	15,000 min.	12,000 min.
Compressive Modulus, psi	ASTM D695*	4.0×10^5 min.	4.0×10^5 min.
Heat Deflection Temperature	ASTM D648*	130 deg F min.	140 deg F min.
Cured 3 days @ 40 deg F – Wet Concrete		3,500 psi min.	3,500 psi min.
Cured 1 day @ 77 deg F – Dry Concrete		5,000 psi min.	5,000 psi min.
Cured 3 days @ 77 deg plus or minus 3 deg F		5,000 psi min.	5,000 psi min.
*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.			

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2.03 SURFACE SEAL

A. Sufficient strength and adhesion for holding injection fittings firmly in place and to resist pressures preventing leakage during injection.

B. Capable of removal after injection resin has cured.

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. Scrape 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. Unless permitted otherwise, structurally repair cracks or joints listed below:

1. Cracks considered to be defective as defined in Section 03 30 00, Cast-in-Place Concrete.
2. All vertical cracks or joints near corners or intersections.
3. All horizontal cracks or joints at wall bases.

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4. All cracks or joints in walls of circular tanks.
5. All cracks or joints caused by voids or honeycombs.
6. All horizontal joints with leaks and dampness.
7. All cracks or joints caused by construction overloading.
8. All vertical or diagonal cracks or joints caused by drying shrinkage within a distance equal to the height of wall from the face of corners or intersecting walls. Inject 90 days after placement, unless approved otherwise by the Project Structural Engineer.
9. All horizontal cracks or joints caused by drying shrinkage within a distance equal to one-quarter on the wall height above or below elevated slabs. Inject 90 days after placement, unless approved otherwise by the Project Structural Engineer.
10. All cracks or joints as a result of thermal shrinkage where the concrete member being injected has been allowed to dry after placement for a minimum of 90 days.
11. All other cracks or joints as a result of drying shrinkage to be repaired 90 days or more after placement.

B. Do not proceed with injection work until submittals have been reviewed and approved by Engineer.

C. 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, Section 03 01 33, Repair of Horizontal Concrete Surfaces, for concrete surface repair system.

D. Width of cracks may vary along length and through thickness of concrete section.

E. 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.

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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 pounds per square inch.

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 by low pressure water cleaning using a pressure of 1,000 pounds per square inch to 3,000 pounds per square inch.

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.

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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 interior 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 to 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.

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C. Acid Flushing of Cracks and 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, at a pressure of 1,000 pounds per square inch, or resin injection pressure, whichever is greater, 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 or 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.

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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 pounds per square inch 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 pounds per square inch discharge pressure and repeat procedure for 0 pounds per square inch 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.

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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 pounds per square inch.
4. Stop pumps and observe pressure; do not allow pressure gauge to drop below 150 pounds per square inch 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 stop 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.

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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.

D. Core Sample Tests:

1. Only where required by Engineer.
2. Initial Cores:
   a. 4-inch diameter for full crack depth along cracks or joints or to waterstop in joints taken from Engineer selected locations.
   b. Take three cores in first 100 linear feet of crack repaired and one core sample for each 500 linear feet thereafter.
   c. Label each core with core number, location, and date when core was obtained.
3. Provide suitable containers for storage, curing, and transportation of test specimens.
4. Methods of Testing Cores:
   a. Penetration: Visual examination.
   b. Bond Strength/Compression Test: Concrete failure prior to resin failure.
5. Test Requirements:
   a. Penetration: Per performance requirements.
   b. Bond Strength (Compression Test): Per performance requirements.
6. Evaluation and Acceptance of Tests:
   a. If initial cores pass tests as specified, epoxy resin injection work at area represented by cores will be accepted.
   b. If initial cores fail either by lack of penetration or bond strength, crack or joint repair Work shall not proceed further until areas represented by cores are reinjected or repaired and retested for acceptance.
   c. Obtain verifying core samples, number, and location as selected by Engineer, after rework of areas represented by failed initial cores is complete.

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7. Core Hole Repair:
   a. Correct work as result of testing upon notification from Engineer.
   b. Refill initial and verifying core holes with a suitable repair mortar, per Section 03 01 32, Repair of Vertical and Overhead Concrete Surfaces, or Section 03 01 33, Repair of Horizontal Concrete Surfaces, tamped and rodded in-place to completely fill for full depth of core hole.
   c. Finish surface to blend with adjacent concrete.

END OF SECTION

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SECTION 03 64 24
POLYURETHANE INJECTION GROUTING

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. D638, Standard Test Method for Tensile Properties of Plastics.
   b. D1622, Standard Test Method for Apparent Density of Rigid Cellular Plastics.
   c. D1623, Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
   d. D3574, Standard Test Method for Flexible Cellular Material Slab, Bonded, and Molded Urethane Foams.
2. National Sanitation Foundation (NSF):
   a. Standard 60, Standard for Drinking Water Treatment and Chemicals—Health Effects.
   b. Standard 61, Standard for Drinking Water System Components—Health Effects.

1.02 DEFINITIONS

A. Crack: Complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.

B. Injection: Method of bonding together; method of addressing or eliminating leakage through cracks or joints by installing polymer under pressure to fill the void in crack or joint.

C. Joint: Planned and formed discontinuity in concrete structure at junction of adjacent and sequential concrete placements, and may contain embedded waterstops.

D. Leak or Leakage: Crack or joint exhibiting moisture, sign of efflorescence, intermittent wet to touch, or continuous flow of liquid.

E. Narrow Cracks: Width equal to or less than 0.015-inch.

F. Wide Crack: Wider than 0.015-inch.

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1.03 SUBMITTALS

A. Action Submittals:

1. Physical and chemical properties for polyurethane injection resin.
2. Technical data for metering, mixing, and injection equipment.
3. Submit:
    a. Marked up drawings showing locations of proposed polyurethane injection work, including the following:
        1) Exact locations for injection.
        2) Depth of penetration or crack.
        3) Width of crack measured every 4 feet minimum.
        4) Length of penetration or crack.
    b. Proposed materials.
    c. Injection procedure, including the following:
        1) Preparation of penetration for polyurethane.
        2) Fittings for installation for injection.
        3) Temperature of installation.
        4) Measurement and monitoring of injection pressure.
        5) Surface cleaning and repair.
4. Sample bottle.

B. Informational Submittals:

1. Manufacturer’s recommended surface preparation procedures and application instructions for polyurethane resin injection.
2. Manufacturer’s Certificate of Compliance in accordance with Section 01 61 00, Common Product Requirements. Certified test results for each batch of polyurethane.
3. Statements of Qualification for Polyurethane Resin Injection:
    a. Manufacturer’s Site representative.
    b. Injection applicator.
    c. Injection pump operating technician.
4. Health and Safety Plans for confine space entry.
5. Sample of polyurethane resin mix ratio and injection pressure test records for concrete crack and joint injection work.
6. Installation instructions for repairing core holes with repair mortar.
7. Polyurethane resins injection pressure test records for concrete crack and joint injection work.

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1.04 QUALITY ASSURANCE

A. Qualifications for Injection Staff:

1. Manufacturer's Site Representative:
   a. Capable of instructing successful methods of polyurethane injection process for concrete structures.
   b. Understands and is capable of explaining technical aspects of correct material selection and use.
   c. Experienced in the operation, maintenance, and troubleshooting of application equipment.
2. Injection crew and job foreman shall provide written and verifiable evidence showing compliance with the following requirements:
   a. Licensed or certified by polyurethane resin manufacturer.
   b. Minimum 3 years' experience in successful polyurethane injection.

1.05 PERFORMANCE REQUIREMENTS

A. Injected polyurethane resin shall fill cracks and joints, and in no case shall depth of penetration of injection material be less than 90 percent of:

1. Full thickness of the concrete section for cracks.
2. Depth between the waterstop and the inside face of the structure for joints.

B. In cured state, injected polyurethane resin forms a dense rubber-like closed cell flexible foam compression gasket-type seal material.

C. Notwithstanding the foregoing, injected cracks or joints which exhibit leakage are considered deficient work irrespective of the depth of penetration observed in quality control core drilled samples. Reinject deficient work as required to meet the performance requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping:

1. Package adhesive material in new sealed containers and label with following information:
   a. Manufacturer's name.
   b. Product name and lot number.
   c. ANSI Hazard Classification (formerly SPI Classification).
   d. ANSI recommended precautions for handling.
   e. Mix ratio by volume for accelerator.

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B. Storage and Protection: Store polyurethane resin material containers in accordance with manufacturer's printed instructions or in the absence of such information at ambient temperatures below 110 degrees F and above 68 degrees F.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sika Corp., Lyndhurst, NJ; SikaFix HH Hydrophilic.

B. Euclid Chemical Co., Cleveland, OH; DURAL Aqua-Fil.

C. Prime Resins, Inc., Conyers, GA; Prime Flex 900 XLV.

2.02 POLYURETHANE RESIN

A. Single-component, water-activated, hydrophilic polyurethane injection resin.

B. Accelerator: Compatible with polyurethane resin from same manufacturer.

C. Elongation: Minimum 350 percent, in accordance with ASTM D3574 or ASTM D638 test method.

D. Tensile Strength: Minimum 150 pounds per square inch, in accordance with ASTM D3574 or ASTM D638 test method.

E. Shrinkage: Less than 2 percent.

2.03 SURFACE SEAL

A. Provide seal with sufficient strength and adhesion for holding injection fittings firmly in place, and to resist pressures preventing leakage during injection.

B. Capable of removal after injection resin has cured.

2.04 ACID FLUSHING SOLUTION

A. Premixed solution of food grade phosphoric acid diluted to a 5 percent plus or minus 0.5 percent of the volume of the bottle.

2.05 WATER

A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards.

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2.06 SAMPLE BOTTLE

A. 5 inches natural wide mouth HDPE bottle or 4 ounces clear PVC cylinder bottle, supplied with caps.

2.07 SOURCE QUALITY CONTROL

A. Test Requirements: Perform tests for each batch of polyurethane resins.

PART 3 EXECUTION

3.01 GENERAL

A. Use of polyurethane injection shall be limited to locations as determined by Structural Engineer.

B. Unless permitted otherwise, polyurethane inject cracks and joints listed below:

1. Cracks and joints that leak.
2. Cracks and joints exhibit dampness, efflorescence, or other evidence of leakage.

C. Do not proceed with injection work until action submittals have been reviewed and approved by the Structural Engineer of Record.

D. Perform injection work after performing surface preparation.

E. Width of the cracks shown may vary along the length and through the thickness of the concrete section.

F. Remove all excess unused polyurethane resins materials inside the structure prior to the end of the work.

3.02 EQUIPMENT

A. Portable, positive displacement type pumps with in-line metering to meter mixed components, and inject mixture into crack or joint.

B. Pumps:

1. Positive displacement type pump.
2. Equip the polyurethane injection equipment with pail heater(s) suitable for plastic pails capable of maintaining the polyurethane resin and accelerator mixture between 50 degrees F and 160 degrees F.
3. A thermometer with each pump for monitoring the temperature of the polyurethane resin.

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C. Discharge Pressure: Automatic pressure controls capable of discharging mixed polyurethane resin at pressures in accordance with polyurethane resin manufacturer's printed instructions, and able to maintain such pressure.

D. Proportioning Ratio Tolerance: Maintain polyurethane manufacturer's prescribed mix ratio within a tolerance in accordance with polyurethane resin manufacturer's printed instructions.

E. Pressure gauge capable of sensing pressure behind valve.

3.03 PREPARATION

A. Free cracks and joints from loose matter, dirt, laitance, oil, grease, salt, and other contaminants.

B. Clean cracks and joints in accordance with polyurethane resins manufacturer's printed instructions.

C. Clean surfaces adjacent to cracks and joints from dirt, dust, grease, oil, efflorescence, encrustation, 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 instructions.

D. Do not use acids and corrosives for cleaning, other than those specified herein, unless neutralized prior to injecting polyurethane resin.

E. During installation and curing of materials, if the ambient temperature is expected to drop below the manufacturer's recommended minimum temperature, provide enclosures and heat as required.

F. Provide work platforms as required.

3.04 APPLICATION

A. Injection Ports:

1. Drill holes shall be installed along cracks and joints designated for injection as required to meet the performance requirements for injection.
2. The requirements for installing drill holes for injection provided below represent acceptable minimum standards of practice.
3. Drill holes for injection at an angle between 45 degrees and 60 degrees from the surface of the concrete and perpendicular to the cracks or joints alignment, to intersect the cracks at the midpoint of the concrete section, and intersect the joints at the midpoint between the waterstop and interior concrete surface, except as noted otherwise.

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4. Locate drill holes on alternate sides of the crack or joint where possible, unless orientation of the crack or joint is known or has been verified by nondestructive testing techniques or core drilling.
5. The spacing of drill holes not to exceed the concrete thickness 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 required angle, such as using a template, during the Work especially at the commencement of drilling holes for injection and at the beginning of each subsequent shift.
7. Take measures to prevent drilling holes for injection too shallow, or too deep, and/or damaging the existing waterstop in the joints. Shallow hole injections lead to concrete spalls. Repair spalls at Contractor's expense.
8. Remove dust and debris in drill holes and on interior surface of the structure resulting from drilling operation, by flushing with water prior to installing injection packers or ports.
9. 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.

B. Acid Flushing of Cracks and Joints:

1. Flush the cracks and joints with the acid flushing solution in accordance with manufacturer's printed instructions, at high pressure, or the resin injection pressure. Apply the acid flushing solution for a sufficient duration to permit the acid flushing solution to penetrate the full depth and length of the cracks, or joints, or to the waterstop in joints.
2. Following the acid flushing, flush the cracks and joints with copious quantities of potable water in accordance with manufacturer's printed instructions, at a pressure of 1,000 pounds per square inch, or the resin injection pressure, whichever is greater, until there is no more evidence of acid flushing solution visible in the flush water.
3. Submit in-field health and safety plan for this operation. As a minimum submit:
    a. Identify the worker who is carrying out the acid flushing operations by wearing a reflective safety vest and signs indicating "Acid Flushing."
    b. Clearly identify the portion of the work area where acid flushing is being carried out by signs and isolated by placing orange pylons, or other temporary barriers, and signs indicating "Acid Flushing." As work progresses, move the pylons or barriers and signs to maintain a safe zone.

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C. Application of Surface Seal Along Cracks and Joints:

1. Apply surface seal along the length of the cracks and joints designated for injection on the top side and underside of slabs, or both sides of walls, where possible in order to contain, confine, and prevent escape of the injected polyurethane resin, in accordance with manufacturer's printed instructions.
2. Cure the surface seal in accordance with the material's manufacturer's printed instructions.

D. Mixing Polyurethane Injection Resin:

1. Add accelerator to polyurethane injection resin at the required dosage to produce cured polyurethane material meeting performance requirements, and mix thoroughly in accordance with manufacturer's printed instructions until a homogeneous mixture is obtained outside of the structure.
2. Heat polyurethane injection resin materials prior to and during mixing and injection as required and in accordance with manufacturer's printed instructions to a temperature between 85 degrees F and 130 degrees F. Injection of polyurethane resin when it is less than 85 degrees F or more than 130 degrees F is prohibited.

E. Polyurethane Injection of Cracks and Joints:

1. Inject polyurethane resins, mixed with accelerator or in a neat form, into cracks and joints in a sequential manner, and reinjection as required, to meet the performance requirements.
2. Start injection into each crack or joint at lowest elevation entry port for vertical or diagonal cracks and joints and at one end for horizontal cracks and joints in vertical structure. Continue injection at first port until pure uncontaminated resin begins to flow out of next port. Plug first port and start injection at second port until polyurethane resin flows from next port. Inject crack or joint in a sequential manner until the full length of the crack or joint has been injected. At no time inject more than 6 feet length of vertical crack or joint before verifying that the first 12 inches of injected crack or joint is set and cured.

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3. Prior to commencing the injection work along a crack or joint in horizontal structure when packers with zerk couplings are used, remove the zerk couplings from the injection packers or ports except for the two packers located where the injection work will commence. Commence injection work in the first two packers. Once clean resin is vented from the third injection packer, cease injection at the first packer, and install the zerk coupling and commence injection at the third packer. Repeat the process for the fourth and subsequent packers until the full length of the crack or joint has been injected.

F. Finishing:

1. Cure polyurethane resins after crack or joints has been completely filled without draining or runback of polyurethane resin material from crack or joints.
2. Remove surface seal and injection packers or ports from along the crack or joints.
3. Finish surface flush and to match surrounding concrete.
4. Indentations or protrusions caused by placement of entry ports drill holes, or damage from removal of surface seal, is not acceptable.
5. Grind off protrusions, and patch indentations and holes from packers and ports with a suitable patch material to the satisfaction of the Engineer.
6. Remove surplus surface seal material on splatters and injection material runs and spills from concrete surfaces.

3.05 FIELD QUALITY CONTROL

A. Injection Pressure Test:

1. Disconnect mixing head of injection equipment and connect polyurethane component delivery line 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 pounds per square inch.
4. Stop pumps and observe pressure; do not allow pressure gauge to drop below 150 pounds per square inch 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 has stopped for more than 45 minutes.

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6. Check tolerance to verify equipment capable of meeting specified ratio tolerance.

B. Bottled Samples:

1. During the injection operation, provide at least one sample of the mixed polyurethane injection resins per shift per injection pump in a sample bottle.
2. Half fill each sample bottle, containing a small amount of water (5 percent by volume) with polyurethane injection resin material from the pump discharge hose. Swirl or lightly shake sample to thoroughly mix resin with the water. When foaming rises near the top of the bottle, install the cap to contain the expanding resin material.
3. Label each bottled sample with Contractor's name, date and time sample was taken, and location in structure where sample was taken. Maintain a log of bottle samples.
4. Place filled sample bottle upright in a box or pail and allow sample to cure.
5. After sample cured, cut bottled sample open and visually inspect contents to verify that polyurethane injection resins material has completely reacted and cured.
6. Evaluation and Assessment of Test:
    a. If a bottled sample(s) indicates a problem with the polyurethane injection resins, such as polyurethane resin not cured; take verifying core sample immediately from the cracks or joints, where the material was used.
    b. If the above-referenced bottle sample(s) and core sample(s) indicate a problem with the polyurethane injection resins, have a Technical Representative of the polyurethane injection resins 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 the Technical Representative of the polyurethane injection resins manufacturer.

C. Visual Inspection:

1. Confirm injection of polyurethane has stopped the leaking material.
2. Confirm installation of material is in accordance with manufacturers' requirements.
3. Confirm installation of material is not damaging concrete.

END OF SECTION

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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.
   b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   c. C33, Standard Specification for Concrete Aggregates.
   d. C90, Standard Specification for Loadbearing Concrete Masonry Units.
   e. C140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   f. C144, Standard Specification for Aggregate for Masonry Mortar.
   g. C150, Standard Specification for Portland Cement.
   h. C207, Standard Specification for Hydrated Lime for Masonry Purposes.
   i. C270, Standard Specification for Mortar for Unit Masonry.
   j. C404, Standard Specification for Aggregates for Masonry Grout.
   k. C476, Standard Specification for Grout for Masonry.
   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.
   o. C989, Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
   p. C1314, Standard Test Method for Compressive Strength of Masonry Prisms.
   q. C1403, Standard Test Method for Rate of Water Absorption of Masonry Mortars.
   r. C1611/C1611M, Standard Test Method for Slump Flow of Self-Consolidating Concrete.
   s. E514/E514M, Standard Test Method for Water Penetration and Leakage through Masonry.

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2. International Code Council (ICC):
   a. International Building Code (IBC).
   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 repellant masonry sealer.
   d. Grout mix design.
   e. Prebagged mortar properties and data sheets.
   f. Grout sand gradation in accordance with ASTM C404.
3. Samples:
   a. Sample:
      1) One of each type of masonry unit to be used on Project from the proposed manufacturer.
      2) One of each, textured, glazed, and sound absorbing units for selection of color and texture for each batch of manufacturer.
   b. Mortar colors for color selection.

B. Informational Submittals:

1. Method and Location of Placing Grout: High lift or low lift.
2. Mix design test results.

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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.
9. Method and materials for removal of efflorescence.
10. Field test results to qualify materials.
    a. Grout tests in accordance with ASTM C1019.
    b. Prism tests per ASTM C1314.

1.03 QUALITY ASSURANCE

A. Mockups:

1. Lay up Sample panel for each type of masonry at Site.
2. Dimensions: Minimum 4 feet high by 4 feet long.
3. Use approved materials and procedures.
4. Leave intact after approval until acceptance of permanent masonry work and then remove at the end of the Project.
5. Approved panels shall serve as basis of color, texture, bond, quality of finished joints, surface applied finishes, and for acceptance of permanent construction.
6. Demonstrate ability to keep insulation and grout isolated and in certain cells during any sequence of placement, and to demonstrate materials will be restricted to cells and bond beams intended to receive grout.
7. Construction shall show areas required to receive mortar, including webs on each side of each grouted cell to prevent grout from entering adjacent cells or courses.
8. Where bond beams are to be used, demonstrate proper placement of grout to bond beam level, and proper placement of bond beam prior to placement of grout above bond beam level.

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9. Demonstrate proper use of running bond and stacked bond.
10. Compliance Requirements: For masonry finish and appearance, dimension tolerances, tolerances of construction, joint tolerances, and wall plumb tolerances, comply with the requirements and criteria of NCMA, ASTM C90, and TMS 602.1.

B. 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.
   f. Project Architect for coating system and appearance.
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'c) of Masonry: 2,000 pounds per square inch.

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2.02 CONCRETE MASONRY UNITS (CMU)

A. ASTM C90: Mediumweight.

1. Net Area Compressive Strength: 2,800 pounds per square inch minimum, in accordance with TMS 602, Table 2.
    a. Water Repellent Admixture:
        1) Structural concrete masonry units in weather exposed exterior wall shall be manufactured with integral liquid polymeric admixture to provide resistance to water penetration.
        2) Manufacturers and Products:
            a) W.R. Grace & Co.; Dry-Block Block Admixture.
            b) BASF Construction Chemicals; Rheopel Plus.
2. Nominal Size: 16 inches long by 8inches high by thickness shown on the Drawings.
3. Color of Units: Natural.
4. Surface Texture on Exposed Surfaces: Smooth, as shown on the Drawings.
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.

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2.03 MORTAR MATERIALS

A. Portland Cement-Lime Mortar:

1. ASTM C270.
2. Cement: ASTM C150, Type II portland cement.
3. Lime: ASTM C207, Type S hydrated.
4. Aggregates:
    a. Non-reactive in accordance with ASTM C33, Appendix X1.
    b. Mortar: ASTM C144, sand.

B. Mortar Cement Mortar: ASTM C1329.

C. Water: Fresh, clean, and potable.

D. Water Repellent Admixture:

1. ASTM C1403.
2. Mortar for structural concrete masonry units in weather exposed exterior walls shall include an integral liquid polymeric admixture to provide resistance to water penetration.
3. Manufacturer and Product: BASF Construction Chemicals; Rheopel Plus Mortar Admixture.

E. Manufacturers and Products:

1. W.R. Grace; DRY-BLOCK.
2. Harris Specialty Chemicals.
3. Axim Italcementi Group; Intrapel.
4. BASF Chemical Co.; Rheopel Admixture.

F. 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 selected by Architect.

2.04 GROUT MATERIALS

A. Cement: ASTM C150, Type II portland cement.

B. Fly Ash: 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.

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D. Lime: ASTM C207, Type S hydrated.

E. Aggregates:

1. ASTM C404, fine and coarse.
2. Non-reactive 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:

1. Dayton Superior/Dur-O-WalDayton, OH; DA 2001 Control Joint Regular Rubber.
2. Hohmann and Barnard, Inc, Hauppauge, NY; #RS-Standard.

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 pounds per square inch.

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C. Mixing:

1. Machine mix in approved mixers in accordance with ASTM C270. Time addition of approved admixtures in accordance with manufacturer's instructions. Procedure used for adding it to mix shall provide good dispersion.
2. Follow manufacturer's instructions for mortar color admixture.
3. Follow manufacturer's instructions for water repellent admixture.
4. Review compatibility with other mortar admixture.

2.08 GROUT MIXES

A. Compressive Strength Property: Minimum 2,000 pounds per square inch 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.
2. Transit-Mixed Grout: Meet requirements of ASTM C476.
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.

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C. Manufacturers and Products:

1. W. R. Grace & Co.; Infiniseal DB Sealer.
2. BASF Construction Chemicals; Enviroseal PBT.

PART 3 EXECUTION

3.01 GENERAL

A. Meet requirements of 2018 IBC, Chapter 21 and 2016 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 onsite.
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.

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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. Toothing 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 the Drawings.
3. Stack Bond: Provide only where specifically indicated on the Drawings. Lay up walls in straight, uniform courses with vertical joints aligned and plumb.
4. Glazed Concrete Masonry Units:
   a. Single-faced units may be installed through wall where walls or partitions are shown to have glazed masonry unit finish on one side only.
   b. Use facing for dimensional and plane reference in installation.

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c. Where glazed masonry unit finish is indicated on both sides of a wall or partition, install coved bases of two-unit construction or two-faced units through the wall.
d. Install coved bases flush with finished surfaces above, except as otherwise specified.

5. 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, Article Laying Masonry Units.
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.
4. Remove mortar containing water repellent admixture from face of masonry before it sets.

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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.

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3. For high lift grouting, hold in position at maximum intervals of 4 feet OC with 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 the 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.

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C. Grout beams over openings in one continuous operation.

D. Maintain vertical alignment in accordance with TMS 602.

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. Solid grout all walls.
   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 TMS 602.

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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 on the Drawings. 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 independent testing agency, retained by Contractor and approved by Engineer.

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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 prism testing 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.

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 TMS.
3. Water Repellent Performance Test: Masonry using concrete masonry units and mortar with integral water repellent additives, and water repellent masonry sealer, shall achieve a Class E rating when evaluated in accordance with ASTM E514, with the test extended to 72 hours.

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.

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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

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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.
2. American Iron and Steel Institute (AISI): Stainless Steel Type 316.
3. American National Standards Institute (ANSI).
4. ASTM International (ASTM):
   a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   c. A194/A194M, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   d. E488/E488M, Standard Test Methods for Strength of Anchors in Concrete Elements.
   e. F436/F436M, Standard Specification for Hardened Steel Washers.
   f. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   g. F594, Standard Specification for Stainless Steel Nuts.
   h. F1554, Standard Specification for Anchor Bolts, Steel, 36-ksi, 55-ksi, and 105-ksi Yield Strength.
5. International Association of Plumbing and Mechanical Officials Uniform ES (IAPMO-UES): Evaluation Reports for Concrete and Masonry Anchors.

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6. International Code Council Evaluation Service (ICC-ES):
   a. Evaluation Reports for Concrete and Masonry Anchors.
   b. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
   c. 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.

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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.
   c. Adhesive Anchor Installer Certification.
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.
2. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

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 because of metal banding and rough handling.

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PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Stainless Steel:	
Threaded Rods	F593, AISI Type 316, Condition CW
Nuts*	F594, AISI Type 316, Condition CW
Carbon Steel:	
Threaded Rods	F1554, Grade 36
Flat and Beveled Washers (Hardened)	F436/F436M
Nuts*	A194/A194M, Grade 2H
Galvanized Steel:	
All	A153/A153M
*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 ACI 355.2.
4. Adhesive Anchors: Comply with the requirements of ICC-ES AC308 or ACI 355.4.

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B. Torque-Controlled Expansion Anchors (Wedge Anchors):

1. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; KWIK Bolt-TZ2 Expansion Anchor Safe Set System with hollow drill bit and vacuum and SI-AT-A22 tool with adaptive torque for applicable sizes (ESR-4266).
   b. DeWalt/Powers Fasteners, Brewster, NY; Power-Stud +SD1, +SD2, +SD4, or +SD6 Anchors (ESR-2502 and ESR-2818).
   c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt 2 Anchors (ESR-1771 and ESR-3037).

C. Self-Tapping Concrete Screw Anchors:

1. Do not use for equipment anchorage unless specifically shown on the Drawings.
2. Manufacturers and Products:
   a. DeWalt/Powers Fasteners, Brewster, NY; Screw-Bolt+ (ESR-3889).
   b. DeWalt/Powers Fasteners, Brewster, NY; Hangermate+ Rod Hanger Screw Anchor (ESR-3889).
   c. DeWalt/Powers Fasteners, Brewster, NY; Snake+ Flush Mount Screw Anchor (ESR-2272).
   d. Hilti, Inc., Tulsa, OK; Kwik HUS, KH-EZ, KH-EZ CRC, KH-EZ SS316, KH-EZ C, KH-EZ E, KH-EZ I, and KH-EZ P Screw Anchor Safe Set System with hollow drill bit and vacuum (ESR-3027).
   e. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Titen HD Screw Anchor (ESR-2713 and IAPMO UES-493).

D. Adhesive Anchors:

1. Threaded Rod:
   a. Diameter as shown on the 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.

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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-HY 200 V3 Safe Set System with HAS threaded rod (ESR-4868), HIT-RE 500 V3 Safe Set System with HAS threaded rod (ESR-3814), or HIT-RE 500 V3 Safe Set System with Hilti Roughening Tool (HIT RT) with HAS threaded rod (ESR-3814) for diamond cored holes.
   b. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-3G Epoxy Adhesive Anchors. (ESR-4057).
   c. DeWalt/Powers Fasteners, Brewster NY; Pure 220+ Epoxy adhesive anchor system with Dust X+ System (ESR-5144).

E. Adhesive Threaded Inserts:

1. Type 316 stainless steel, internally threaded inserts.
2. Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIS-RN Insert with HIT-RE 500 V3 or HIT-HY 200 adhesive.

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.

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C. Manufacturers and Products:

1. Hilti, Inc., Tulsa, OK; HIT-HY 270 Safe Set System with Hilti hollow drill bit and vacuum (ESR-4143) for solid grouted masonry, HIT-HY 200 V3 Safe Set System with Hilti hollow drill bit and vacuum (ESR-4878) for solid grouted masonry, HIT-HY 270 Safe Set System with Hilti hollow drill bit and vacuum (ESR-4144) for unreinforced three-wythe brick.
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, Screw-Bolt+ (ESR-4042) for grout-filled masonry, AC100+ Gold with Dust X+ System for unreinforced three-wythe brick (ESR-2966 2582).

PART 3 EXECUTION

3.01 CONCRETE AND MASONRY ANCHORS

A. Begin installation only after concrete or masonry to receive anchors is a minimum of 21 days old or has attained design strength whichever requires a longer duration.

B. Locate existing reinforcing with ground penetrating radar or other method approved by the Engineer prior to drilling. Coordinate with the 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 the Drawings.

E. Use only drill type, bit type, and diameter recommended by anchor manufacturer. Use rotary hammer drill unless otherwise approved by the Engineer. Core drilling may only be used if specifically allowed by the Engineer.

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 the Engineer for direction on how to proceed.

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H. Adhesive Anchors:

1. Unless otherwise approved by the 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.
2. For hollow-unit masonry, install screen tube in accordance with manufacturer's instructions.
3. Prestressed Concrete: Do not use drilled-in anchors in prestressed or post-tensioned concrete members without the Engineer's prior approval unless specifically shown on the 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. The 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. Proof Loading:

1. To be performed where continuous inspection of anchors is required.
2. Testing will be performed by the Owner's Independent Testing Agency.
3. Proof loading of adhesive anchors to be performed only after adhesive has achieved proper cure per manufacturer's requirements.
4. Testing will be conducted on minimum of 10 percent of installed anchors, with a minimum of two tension tests.
5. Testing will be conducted in accordance with ASTM E488/E488M and as follows:
   a. Performance of a static tension test of each test anchor.
   b. Test apparatus reaction base shall not interfere with bond failure of anchor but shall preclude a pullout cone failure.

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c. Each test anchor to be tested at a proof load equal to the lesser of 80 percent of the yield strength of the anchor or 50 percent of calculated ultimate load based on adhesive bond strength or as directed by the Engineer.
d. Test load to be maintained for a minimum of 30 seconds without visible signs of movement of anchor or drop in gauge reading.

6. Failure of anchor or failure within base material will cause anchor to be rejected. For each rejected anchor, test two additional anchors. Rejected anchors shall be replaced as approved by the Engineer.

3.03 MANUFACTURER'S SERVICES

A. Adhesive and Mechanical Anchors: Conduct Site training of installation personnel for proper installation, handling, and storage of adhesive anchor system. Notify the Engineer of time and place for sessions.

3.04 FASTENER SCHEDULE

A. Unless indicated otherwise on the Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Post-Installed Anchors for Metal Components to Cast-in-Place Concrete (such as, Ladders, Handrail Posts, Electrical Panels, Platforms, and Equipment)		
Interior Dry Areas	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).	Verify product acceptability and manufacturer's requirements if anchor installation will occur in an overhead application
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel adhesive anchors	Verify product acceptability and manufacturer's requirements if anchor installation will occur in an overhead application

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Service Use and Location	Product	Remarks
2. Anchors in Grout-Filled Concrete Masonry Units		
Interior Dry Areas	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).	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel adhesive anchors	
3. Anchors in Hollow Concrete Masonry Units		
Interior Dry Areas	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).	Adhesive anchors shall be installed with screen tubes.
Exterior, Interior Wet, and Corrosive Areas	Stainless steel adhesive anchors	Adhesive anchors shall be installed with screen tubes.
4. All Others		
All service uses and locations	Stainless steel fasteners	

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

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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:

1. The Aluminum Association, Inc. (AA): The Aluminum Design Manual.
2. American Galvanizers Association (AGA):
   a. Inspection of Hot-Dip Galvanized Steel Products.
   b. Quality Assurance Manual.
3. American Iron and Steel Institute (AISI): Stainless Steel Types.
4. American Ladder Institute (ALI): A14.3, Ladders - Fixed - Safety Requirements.
5. American National Standards Institute (ANSI).
6. American Society of Safety Engineers (ASSE): A10.11, Safety Requirements for Personnel and Debris Nets.
7. American Welding Society (AWS):
   a. D1.1/D1.1M, Structural Welding Code - Steel.
   b. D1.2/D1.2M, Structural Welding Code - Aluminum.
   c. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
8. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A48/A48M, Specification for Gray Iron Castings.
   c. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   d. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
   e. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   f. A143/A143M, Standard for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
   g. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   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.

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j. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
k. A276, Standard Specification for Stainless Steel Bars and Shapes.
l. A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
m. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 pounds per square inch Tensile Strength.
n. A325, Standard Specification for Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength.
o. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
p. A384/A384M, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
q. A385/A385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
r. A489, Standard Specification for Carbon Steel Lifting Eyes.
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.
u. A563, Standard Specification for Carbon and Alloy Steel Nuts.
v. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
w. A780/A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
x. A786/A786M, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
y. A793, Standard Specification for Rolled Floor Plate, Stainless Steel.
z. A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
aa. A992/A992M, Standard Specification for Structural Steel Shapes.
bb. A1085, Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS).
cc. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
dd. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.

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ee. B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
ff. B632/B632M, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
gg. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
hh. D1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
ii. F436, Standard Specification for Hardened Steel Washers.
jj. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
kk. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
ll. F594, Standard Specification for Stainless Steel Nuts.
mm. F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
nn. F1554, Standard Specification for Anchor Bolts, Steel, 36-ksi, 55-ksi, and 105-ksi Yield Strength.

9. NSF International (NSF): 61, Drinking Water System Components—Health Effects.
10. Occupational Safety and Health Administration (OSHA):
    a. 29 CFR 1910.27, Fixed Ladders.
    b. 29 CFR 1926.105, Safety Nets.
    c. 29 CFR 1926.502, Fall Protection Systems Criteria and Practices.
11. 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. Corrosive area includes areas exposed to corrosive atmosphere such as hydrogen sulfide from wastewater.

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.

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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.
2. Pre-engineered Ladders: Letter of certification that ladder meets OSHA 29 CFR 1910.27 requirements.
3. Passivation method for stainless steel members.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

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.

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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:

Item	ASTM Reference
Steel Wide Flange Shapes	A992/992M
Other Steel Shapes and Plates	A36/A36M or A572/A572M, Grade 50 or A992/A992M for other steel shapes
Steel Pipe	A500, Grade B
Hollow Structural Sections (HSS)	A500/A500M, Grade C
Aluminum:	
Aluminum Plates	B209, Alloy 6061-T6
Aluminum Structural Shapes	B308/B308M, Alloy 6061-T6

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Item	ASTM Reference
Stainless Steel:	
Bars and Angles	A276, AISI Type 316 (316L for welded connections)
Shapes	A276, AISI Type 304 (304L for welded connections)
Steel Plate, Sheet, and Strip	A240/A240M, AISI Type 316 (316L for welded connections)
Bolts, Threaded Rods, Anchor Bolts, and Anchor Studs	F593, AISI Type 316, Group 2, Condition SH
Nuts	F594, AISI Type 316, Condition CW
Steel Bolts and Nuts:	
Carbon Steel	A307 bolts, with A563 nuts
High-Strength	A325, Type 1 bolts, with A563 nuts
Anchor Bolts and Rods	F1554, Grade 36, with weldability supplement S1.
Eyebolts	A489
Threaded Rods	A36/A36M
Flat Washers (Unhardened)	F844
Flat and Beveled Washers (Hardened)	F436
Thrust Ties for Steel Pipe:	
Threaded Rods	A193/A193M, Grade B7
Nuts	A194/A194M, Grade 2H
Plate	A283/A283M, Grade D
Welded Anchor Studs	A108, Grade C-1010 through Grade C-1020
Aluminum Bolts and Nuts	F468, Alloy 2024-T4
Cast Iron	A48/A48M, Class 35

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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 the 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 the Drawings.

1. Carbon Steel: ASTM A108, Standard Quality Grade 1010 through Grade 1020, inclusive either semikilled or killed aluminum or silicon dioxidation, 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. Stud Welding Associates, Inc., Elyria, OH.

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2.05 PIPE SLEEVES

A. As specified in Section 40 27 01, Process Piping Specialties.

B. ASTM A53/A53M, Schedule 40 steel pipe sleeves with continuously welded 3/16-inch-thick seep ring with outside diameter 3 inches greater than sleeve outside diameter. Hot-dip galvanize in accordance with ASTM A123/A123M.

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 or Type HZA Dynagrip.

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2.09 ABRASIVE NOSING FOR STAIRS

A. Unless otherwise shown on the 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.
3. Base of Nosing: Extruded aluminum alloy, 6063-T5, heat-treated.

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 and Spectra Type WP3C.
2. American Safety Tread Co., Inc., Helena, AL; Type BF-311D and Type FA-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.
3. Aluminum: ASTM B632/B632M, Alloy 6061-T6.

B. Minimum Thickness:

1. Steel: 1/4-inch, unless shown otherwise on the Drawings.
2. Aluminum: 3/8-inch, unless shown otherwise on the Drawings.

C. Surface: Raised-lug pattern or diamond tread, unless shown otherwise on the Drawings.

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D. Slip-Resistant Surface:

1. Provide where indicated on the 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 EXTRUDED FLOOR PLATE

A. Extruded Deck Plate:

1. Minimum Section Height: As shown on the Drawings.
2. Minimum Section Width: 12 inches.
3. Accessories: Dovetail interlock strips, anchor clamp fixtures, toeboard, 1-inch raised lip.
4. Manufacturer and Product: Alcoa Building Products, Inc., Sidney, OH; Standard Diamondback.

B. Extruded Tread Plate:

1. Minimum Section Height: 0.360-inch, plus serrations.
2. Section Width: 12 inches.
3. Accessories: Edgebands, tongue-and-groove attachment.
4. Manufacturer and Product: Alcoa Building Products, Inc., Sidney, OH; Standard Diamondback.

2.12 SIDEWALK DOORS

A. Load Capacity: 300 psf with maximum deflection of 1/150th of span. Provide H-20 wheel loading capacity where indicated on the Drawings.

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 the Drawings.
3. Safety Grate: Aluminum grating with 300 psf live load capacity, 5-inch by 5-inch grate openings, permanent hinging system that locks grate in 90-degree position, and opening arm with vinyl grip handle and locking device.

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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:

1. Bilco Co., New Haven, CT; J Series.
2. Nystrom Products Co., Minneapolis, MN; FG Series.
3. U.S.F. Fabrication, Hialeah, FL; T Series.
4. ITT Flygt Corporation, Trumbull, CT; FDRN Series.
5. Thompson Fabricating Co., Birmingham, AL; TE Series.
6. Halliday Products, Orlando, FL; WS Series.

2.13 FLOOR HATCHES

A. Load Capacity: 300 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.
2. Angle Frame: 1/4-inch thick extruded aluminum angle frame with concrete anchors and integral neoprene gasket strip.

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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:

1. Bilco Co., New Haven, CT; K Series.
2. Nystrom Products Co., Minneapolis, MN; FH Series.
3. U.S.F. Fabrication, Hialeah, FL; A Series.
4. ITT Flygt Corporation, Trumbull, CT; FLE Series.
5. Thompson Fabricating Co., Birmingham, AL; TI Series.
6. Halliday Products, Orlando, FL; SS Series.

2.14 HATCH SAFETY NET

A. General:

1. Conforms to ASSE A10.11 and OSHA CFR Part 1926.105.
2. Size to fit hatch opening where indicated.

B. Components and Accessories:

1. Rails and Slide Rings: Aluminum 6061-T6 extruded rails and aluminum-alloy 713.0 slide rings.
2. Corner Hooks and Eyebolts: AISI Type 316 stainless steel.
3. Netting: Polyester, 5-inch by 5-inch net openings; 5,000 pounds minimum breaking strength.
4. Bolts, Nuts, and Concrete Anchors: AISI Type 316 stainless steel.

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C. Manufacturer and Product: Safe Approach Inc., Auburn, ME; Hatch Net 121.

2.15 HINGED MANHOLE COVERS

A. Slab type rectangular manhole frame and cover with flush, waterproof lift handles, and stainless steel butt hinges.

B. ASTM A48/A48M, Class 35, cast iron, unpainted.

C. Furnish as shown in table:

Hinged Manhole Covers			
Mark	**Duty**	**Size (inches)**	**Weight (pounds)**
HMC-1	Light	24 x 36	275
HMC-2	Light	30 x 30	290
HMC-3	Light	30 x 36	335
HMC-4	Light	30 x 48	450
HMC-5	Heavy	30 x 36	525
HMC-6	Heavy	36 x 36	700

D. Manufacturers:

1. Neenah Foundry Co., Neenah, WI.
2. Flockhart Foundry Co., Newark, NJ.

2.16 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.
3. Self-closing gates at landings.

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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. ASTM A276, AISI Type 316Lstainless steel.

C. Aluminum Pre-engineered Pipe Ladder:

1. Rungs:
   a. Aluminum extrusions of Alloy 6063-T6.
   b. Nonslip grip surface, 1-inch wide flat top, and semicircular bottom with mill finish.
   c. Diamondback, finish to match rails, as manufactured by Alcoa Building Products, Inc., Sidney, OH.
2. Side Rails: ASTM B429/B429M, Alloy 6063-T6, 1-1/2 inches, Schedule 40 pipe with anodized finish, AA M32-C22-A41.
3. Ladder Attachments and Cage Assembly Fasteners: Stainless steel.
4. Welded, pop riveted, or glued construction is not acceptable.
5. Fabricate to longest length as practical but not to exceed 24 feet.
6. Furnish support attachments to side rails at 6 feet maximum spacing.
7. Manufacturer: Thompson Fabricating Co. Inc., Tarrant, AL.

D. Ladder Safety Post:

1. Telescoping tubular, spring balanced and automatically locking in raised position, with release lever for unlocking.
2. Post: Stainless steel, AISI Type 304.
3. Hardware: Stainless steel, AISI Type 316.
4. Furnish dissimilar metal protective coatings at connections.
5. Manufacturer and Product: Bilco Co., New Haven, CT; “Ladder Up” to fit ladder rungs.

2.17 SAFETY CLIMB DEVICE

A. General:

1. Conforms to ALI A14.3 and OSHA CFR Part 1910.27.
2. Belt and harness shall withstand minimum drop test of 250 pounds in 6-foot free fall.
3. Fall Prevention System Material: Aluminum 6061-T6 or Stainless steel, AISI Type 316.

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B. Components and Accessories:

1. Main Components: Sleeve or trolley, safety harness, and carrier or climbing rail.
2. Ladder rung clamps with aluminum or stainless steel, AISI Type 316, 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.

2.18 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.

2.19 FALL ARREST ANCHORS

A. General:

1. Conforms to OSHA CFR Part 1926.502.
2. Minimum Breaking Strength: 5,000 pounds.
3. Material: Stainless steel, AISI Type 304.

B. Components and Accessories:

1. Forged combination eye and base assembly with headed anchor bolt, backer platelock washer, and nut.
2. Suitable for embedment in concrete wall or slab.

C. Manufacturers and Products:

1. Thaler Metal Industries, Buffalo, NY; FARA Wall Anchor.
2. Rose Manufacturing Company, Pittsburgh, PA; Anchorage Connector.

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2.20 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 the 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.

2.21 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.

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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.

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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 raw water. 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.

2.22 SOURCE QUALITY CONTROL

A. Visually inspect all fabrication welds and correct deficiencies.

1. Steel: AWS D1.1/D1.1M, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
2. Aluminum: AWS D1.2/D1.2M.
3. Stainless Steel: AWS D1.6/D1.6M.

B. Hot-Dip Galvanizing

1. An independent testing agency , shall be retained by Contractor and approved by Engineer 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.

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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.

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 the 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.

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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 the 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.

D. Route drain pipe to exterior face of concrete or as shown on the Drawings or per manufacturer's Shop Drawings.

E. Position cover so that hinge is on side opposite ladder.

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 the 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.

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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.

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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 on the Drawings.
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 and Section 01 88 15, Anchorage and Bracing.

3.10 FASTENER SCHEDULE

A. Unless indicated otherwise on the Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Anchor Bolts Cast Into Concrete for Structural Steel, Metal Fabrications and Castings		
Interior Dry Areas	Plain uncoated steel headed anchor bolts, unless indicated otherwise	
Exterior and Interior Wet Areas	Stainless steel headed anchor bolts	
Submerged and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating	See Section 09 90 00, Painting and Coating

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Service Use and Location	Product	Remarks
2. Anchor Bolts Cast Into Concrete for Equipment Bases		
Interior Dry Areas	Stainless steel headed anchor bolts, unless otherwise specified with equipment	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating, unless otherwise specified with equipment	See Section 09 90 00, Painting and Coating
3. Post-Installed Anchors: See Section 05 05 19, Post-Installed Anchors		
4. Anchors Cast in Grout-Filled Concrete Masonry Units		
Dry Areas	Hot-dip galvanized steel headed anchor bolts or zinc-plated steel sleeve anchors	
Exterior and Interior Wet Areas	Hot-dip galvanized steel headed anchor bolts, zinc-plated or stainless steel sleeve anchors	
5. Connections for Structural Steel Framing		
Exterior and Interior Wet and Dry Areas	High-strength steel bolted connections	Use hot-dipped galvanized high-strength bolted connections for galvanized steel framing members.
6. Connections for Steel Fabrications and Wood Components		
Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections	

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Service Use and Location	Product	Remarks
7. Connections of Aluminum Components		
Submerged, Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections, unless otherwise specified with equipment	
8. All Others		
Exterior and Interior Wet and Dry Areas	Stainless steel fasteners	

B. Antiseizing Lubricant: Use on stainless steel threads.

END OF SECTION

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SECTION 07 92 00
JOINT SEALANTS

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. C661, Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
   b. C834, Standard Specification for Latex Sealants.
   c. C920, Standard Specification for Elastomeric Joint Sealants.
   d. C1193, Standard Guide for Use of Joint Sealants.

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.

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1.05 SPECIAL GUARANTEE

A. Product: Furnish manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Provide special guarantee 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 is 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 provided all other specified requirements are met.

B. Color: Unless specifically noted, match color of the principal wall material adjoining area of application.

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 Chemical Co.; DOWSIL 790.
   b. General Electric; SCS2000 Silpruf.
   c. Sika Corp.; Sikasil N Plus US.

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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. Master Builders Solutions Construction Systems US; MasterSeal SL-2.
   b. Pecora Corp.; Dynatrol II-SL.
   c. Sika 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. Master Builders Solutions Construction Systems US; MasterSeal NP-2.
   c. Sika Corp.; Sikaflex-2c NS EZ Mix.

F. Type 4—Multipart Polyurethane, Nonsag, Nonimmersible:

1. Polyurethane base, multicomponent, chemical curing; ASTM C920, Type M, Grade NS, Class 25.
2. Manufacturers and Products:
   a. Master Builders Solutions Construction Systems US; MasterSeal NP-2.
   b. Pecora Corp.; Dynatrol II.
   c. Sika Corp.; Sikaflex-2c NS EZ Mix.

G. Type 5—One-part Polyurethane, Immersible:

1. Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS or Grade P, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturers and Products for Nonsag:
   a. Sika Corp.; Sikaflex-1a.
   b. Tremco; Vulkem 116.
4. Manufacturers and Products for Self-leveling:
   a. Master Builders Solutions Construction Systems US; MasterSeal SL-1.
   b. Tremco; Vulkem 45SSL.
   c. Sika Corp.; Sikaflex-1c SL.

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H. Type 6—One-part Polyurethane, Nonimmersible:

1. Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 25.
2. Manufacturers and Products:
   a. Tremco; Dymonic 100.
   b. Master Builders Solutions Construction Systems US; MasterSeal NP-1.
   c. Sika Corp.; Sikaflex-1a.

I. Type 7—Multipart Polysulfide, Immersible:

1. Polysulfide base, two-component, chemical curing; ASTM C920, Type M, Grade P or Grade NS, Class 25.
2. Capable of being continuously immersed in water.
3. For use above grade and below grade.
4. Manufacturers and Products:
   a. W. R. Meadows; Deck-O-Seal Gun Grade, two-part.
   b. Pecora Corp.; Synthacalk GC2+.

J. Type 8—One-part Polysulfide, Nonsag, Nonimmersible:

1. Polysulfide base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 12 1/2.
2. Capable of withstanding movement up to 20 percent of joint width.
3. Manufacturer and Product: W. R. Meadows; POLY-JET LOX.

K. Type 9—One-part Acrylic Terpolymer, Nonsag, Nonimmersible:

1. Acrylic base, single-component, solvent curing; ASTM C834 nonsag.
2. Capable of withstanding movement up to 7.5 percent of joint width; Shore “A” hardness of 55 maximum.
3. Manufacturer and Product: KARNAK; 44 Klear Seal Caulk.

L. Type 10—Sanitary Sealant:

1. Silicone sealant similar to Type 1, above, formulated to resist mold growth and repeated exposure to high humidity while retaining adhesion, flexibility, and color.
2. Manufacturers and Products:
   a. Dow Chemical Co.; DOWSIL 786.
   b. General Electric; SCS1700 Sanitary.

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M. Type 11—Fire Penetration Seal:

1. Manufacturers and Products:
   a. 3M Corp.; Fire Barrier Sealant CP 25WB+ and Fire Barrier Moldable Putty Stix MP+.
   b. Specified Technologies Inc.; SpecSeal LCI Intumescent Sealant.
   c. Hilti USA; CP 604.

N. Type 12—One-part Polycarbonate, Immersible:

1. Polycarbonate base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturer and Product: Pro-Seal Products, Inc.; Pro-Seal 34.

O. Type 13—Tape Sealant:

1. Compressible polyurethane foam impregnated with polybutylene or polymer-modified asphalt.
2. Color: Black.
3. Size: 3/4-inch wide by length required by expanded thickness recommended by manufacturer for particular application.
4. Manufacturer and Product: Sika Corp., Emseal Joint Systems, Ltd.; AST Hi-Acrylic.

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. Tremco; Closed-cell Backing Rod.
2. W.R. Meadows; Cera-Rod and Kool-Rod.

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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.

2.04 PREFORMED SEALS

A. Preformed Compressible Joint Seals:

1. Widths Up to 5 Inches:
   a. BASF, Watson Bowman Acme Div.; Wabo Weatherseal II.
   b. Sika Corp., Emseal Joint Systems, Ltd.; Seismic Colorseal.
   c. LymTal International; Iso-flex Compression Seal Expansion Joint System.
2. Other Widths: Series or model recommended by seal manufacturer.

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:

Joint Size	Sealant Type
Less than 1 inches	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, or 12
Less than 2 inches	1, 2, 3, 4, or 7
Over 2 inches	Follow manufacturer’s recommendation

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3.02 PREPARATION

A. Verify that joint dimensions, and physical and environmental conditions, are acceptable to receive sealant.

B. Sealed surfaces to 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.
3. Tape sealant may be used as joint filler if approved by sealant manufacturer.

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.

F. Tape Sealant: Compress to 50 percent of expanded thickness and install in accordance with manufacturer’s instructions.

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3.04 PREFORMED SEALS

A. Prepare joint surfaces clean and dry, free from oil, rust, laitance, and other foreign material.

B. Construct joints straight and parallel to each other and at proper width and depth.

C. Apply joint sealant manufacturer's approved primer and adhesive in accordance with manufacturer's instructions.

D. Install seal in accordance with manufacturer's instructions.

3.05 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.

3.06 JOINT SEALANT SCHEDULE

A. This schedule lists the sealant types acceptable for each joint location. Use as few different sealant types as possible to meet the requirements of Project.

Joint Locations	Sealant Type(s)
Expansion/Contraction and Control Joints At:	
Concrete Walls (except water-holding and belowgrade portions of structures)	1, 3, 4, 5, 6, 12
Concrete Floor Slabs (except for water-holding Structures)	2, 5
Concrete Walls and Slabs immersed in water and/or below grade	7
Slabs Subject to Vehicle and Pedestrian Traffic	2, 5
Masonry Walls	1, 3, 4, 5, 6, 7, 12, 13
Exterior Insulation and Finish System	4
Ceramic Tile Floors	1, 2, 5, 10
Ceramic Tile Walls	1, 3, 5, 10
Precast Concrete Wall Panels	3, 4, 5, 12, 13

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Joint Locations	Sealant Type(s)
Material Joints At:	
Metal Door, Window, and Louver Frames (Exterior)	1, 5, 6, 8, 12
Metal Door, Window, and Louver Frames (Interior)	1, 5, 6, 8, 9
Wall Penetrations (Exterior)	1, 5, 6, 8, 12
Wall Penetrations (Interior)	1, 5, 6, 8
Floor Penetrations	5, 6, 7
Ceiling Penetrations	1, 3, 4, 5, 6, 7
Roof Penetrations	5
Sheet Metal Flashings	5, 13
Sheet Metal Roofing and Siding	5, 13
Precast Concrete Wall Panels	1, 3, 4, 5, 6, 7, 12, 13
Glazed Concrete Masonry Unit Joints	1
Precast/Prestressed Floor Panels (Interior)	2, 7
Precast/Prestressed Floor and Roof Panels (Exterior)	3, 7
Other Joints:	
Threshold Sealant Bed	5
Between Counter Tops and Backsplashes	10
Around Plumbing Fixtures	10
Openings Around Pipes, Conduits, and Ducts Through Fire-Rated Construction	11

B. Use sealant Type 4 for building joints and elsewhere as indicated.

C. Use sealant Type 10 for joints between counter tops and backsplashes and around plumbing fixtures where they fit against walls and floors.

D. Use sealant Type 11 to seal voids and holes around penetrations through fire-rated elements.

END OF SECTION

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SECTION 09 90 00
PAINTING AND COATING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Water Works Association (AWWA):
   a. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines—Enamel and Tape—Hot-Applied.
   b. C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
   c. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   d. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
2. Environmental Protection Agency (EPA).
3. NACE International (NACE): SP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
4. NSF International (NSF): 61, Drinking Water System Components - Health Effects.
5. Occupational Safety and Health Act (OSHA).
6. Research Council on Structural Connections (RCSC): Specification for Structural Joints using High-Strength Bolts.
7. 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 2, Hand Tool Cleaning.
   e. SP 3, Power Tool Cleaning.
   f. SP 5, White Metal Blast Cleaning.
   g. SP 6, Commercial Blast Cleaning.
   h. SP 7, Joint Surface Preparation Standard Brush-Off Blast Cleaning.
   i. SP 10, Near-White Blast Cleaning.
   j. SP 11, Power Tool Cleaning to Bare Metal.
   k. SP 16, Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.

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l. SP 13, Surface Preparation of Concrete.
m. Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.

1.02 DEFINITIONS

A. Terms used in this section:

1. Coverage: Total minimum dry film thickness in mils or square feet per gallon.
2. FRP: Fiberglass Reinforced Plastic.
3. HCl: Hydrochloric Acid.
4. MDFT: Minimum Dry Film Thickness, mils.
5. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
6. Mil: Thousandth of an inch.
7. PPDS: Paint Product Data Sheet.
8. PSDS: Paint System Data Sheet.
9. PVC: Polyvinyl Chloride.
10. SFPG: Square Feet per Gallon.
11. SFPGPC: Square Feet per Gallon per Coat.
12. 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. Detailed chemical and gradation analysis for each proposed abrasive material.

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2. Samples:
    a. Proposed Abrasive Materials: Minimum 5-pound sample for each type.
    b. Reference Panel:
        1) Surface Preparation:
            a) Prior to start of surface preparation, furnish a 4-inch by 4-inch steel panel for each grade of sandblast specified herein, prepared to specified requirements.
            b) Provide panel representative of the steel used; prevent deterioration of surface quality.
            c) Panel to be reference source for inspection upon approval by Engineer.
        2) Paint:
            a) Unless otherwise specified, before painting work is started, prepare minimum 8-inch by 10-inch sample with type of paint and application specified on similar substrate to which paint is to be applied.
            b) Furnish additional samples as required until colors, finishes, and textures are approved.
            c) Approved samples to be the quality standard for final finishes.

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. Coating for Faying Surfaces: Manufacturer's test results that show the proposed coating meets the slip resistance requirements of the AISC Specification for Structural Joints using ASTM A325 or ASTM A490 bolts.
6. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.
7. Manufacturer's written instructions and special details for applying each type of paint.

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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.

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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. Sherwin Williams.
2. Tnemec Coatings.
3. Azko Nobel (Devoe; International).
4. Carboline.
5. PPG.

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.

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3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.

B. Products:

Product	Definition
Acrylic Latex	Single-component, finish as required
Acrylic Latex (Flat)	Flat latex
Acrylic Sealer	Clear acrylic
Alkyd (Semigloss)	Semigloss alkyd
Alkyd Enamel	Optimum quality, gloss or semigloss finish as required, medium long oil
Alkyd Wood Primer	Flat alkyd
Bituminous Paint	Single-component, coal-tar pitch based
Block Filler	Primer-sealer designed for rough masonry surfaces, 100% acrylic emulsion
Coal-Tar Epoxy	Amine, polyamide, or phenolic epoxy type 70% volume solids minimum, suitable for immersion service
DTM Acrylic Primer	Surface tolerant, direct-to-metal water borne acrylic primer
DTM Acrylic Finish	Surface tolerant, direct-to-metal water borne acrylic finish coat
Elastomeric Polyurethane	100% solids, plural component, spray applied, high build, elastomeric polyurethane coating, suitable for the intended service
Epoxy Filler/Surfacer	100% solids epoxy trowel grade filler and surfacer, nonshrinking, suitable for application to concrete and masonry. Approved for potable water contact and conforming to NSF 61, where required
Epoxy Nonskid (Aggregated)	Polyamidoamine or amine converted epoxies aggregated; aggregate may be packaged separately
Epoxy Primer—Ferrous Metal	Anticorrosive, converted epoxy primer containing rust-inhibitive pigments

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Product	Definition
Epoxy Primer—Other	Epoxy primer, high-build, as recommended by coating manufacturer for specific galvanized metal, copper, or nonferrous metal alloy to be coated
Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service
TFE Lube or Grease Lube	Tetrafluoroethylene, liquid coating, or open gear grease as supplied by McMaster-Carr Supply Corporation, Elmhurst, IL
High Build Epoxy	Polyamidoamine epoxy, minimum 69% volume solids, capability of 4 to 8 MDFT per coat
Inorganic Zinc Primer	Solvent or water based, having 85% metallic zinc content in the dry film; follow manufacturer's recommendation for topcoating
Latex Primer Sealer	Waterborne vinyl acrylic primer/sealer for interior gypsum board and plaster. Capable of providing uniform seal and suitable for use with specified finish coats
NSF Epoxy	Polyamidoamine epoxy, approved for potable water contact and conforming to NSF 61
Epoxy, High Solids	Polyamidoamine epoxy, 80% volume solids, minimum, suitable for immersion service
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish
Organic Zinc Rich Primer	Epoxy or moisture cured urethane with 85-percent zinc content in the dry film, meeting the requirements of RCSC Specification for Structural Joints using High Strength Bolts, Class A or Class B, as required.
Rust-Inhibitive Primer	Single-package steel primers with anticorrosive pigment loading
Sanding Sealer	Co-polymer oil, clear, dull luster
Silicone/Silicone Acrylic	Elevated temperature silicone or silicone/acrylic based
Stain, Concrete	Acrylic, water repellant, penetrating stain
Stain, Wood	Satin luster, linseed oil, solid or transparent as required

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Product	Definition
Varnish	Nonpigmented vehicle based on a variety of resins (alkyd, phenolic, urethane) in gloss, semigloss, or flat finishes, as required
Water Base Epoxy	Two-component, polyamide epoxy emulsion, finish as required

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

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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.

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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 2, Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using nonpower hand tools.
   c. SP 3, Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using power-assisted hand tools.
   d. SP 5, White Metal Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter by blast cleaning.
   e. SP 6, Commercial 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 33 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.
   f. 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.

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g. 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.

h. SP 11, Power Tool Cleaning to Bare Metal: Removal of visible oil, grease, dirt, dust, mill scale, rust, paint, oxide, corrosion products, and other foreign matter using power-assisted hand tools capable of producing suitable surface profile. Slight residues of rust and paint may be left in lower portion of pits if original surface is pitted.

i. SP 16, Brush Blasting of Non-Ferrous Metals: A brush-off blast cleaned non-ferrous 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. Ductile Iron Pipe Supplied with Asphaltic Varnish Finish: Remove asphaltic varnish finish prior to performing specified surface preparation.
5. Hand tool clean areas that cannot be cleaned by power tool cleaning.
6. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
7. 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.

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8. 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.
9. 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.
10. 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.
2. Meet requirements of SSPC SP 13.

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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. Plastic and FRP Surface Preparation:

1. Hand sand plastic surfaces to be coated with medium grit sandpaper to provide tooth for coating system.
2. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so surface is roughened without removing excess material.

F. Existing Painted Surfaces to be Repainted Surface Preparation:

1. Detergent wash and freshwater rinse.
2. Clean loose, abraded, or damaged coatings to substrate by hand or power tool, SP 2 or SP 3.
3. Feather surrounding intact coating.
4. Apply one spot coat of specified primer to bare areas, overlapping prepared existing coating.
5. Apply one full finish coat of specified primer to entire surface.
6. If an aged, plural-component material is to be topcoated, contact coating manufacturer for additional surface preparation requirements.
7. Application of Cosmetic Coat:
    a. It is assumed that existing coatings have oxidized sufficiently to prevent lifting or peeling when overcoated with paints specified.
    b. Check compatibility by application to a small area prior to starting painting.
    c. If lifting or other problems occur, request disposition from Engineer.
8. Perform blasting as required to restore damaged surfaces. Materials, equipment, procedures shall meet requirements of SSPC.

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3.05 SURFACE CLEANING

A. 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.

B. Acid Etching:

1. After precleaning, spread the following solution by brush or plastic sprinkling can: 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.

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C. 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.

3.06 APPLICATION

A. General:

1. The intention of these Specifications is for existing and new, interior and exterior masonry, concrete, and metal, and submerged metal surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Do not paint exterior concrete surfaces, unless specifically indicated.
2. Extent of Coating (Immersion): Coatings shall be applied to internal vessel and pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals, unless otherwise specified.
3. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating until completion of curing cycle.
4. 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.
5. Sand wood lightly between coats to achieve required finish.
6. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
7. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
8. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
9. Water-Resistant Gypsum Board: Use only solvent type paints and coatings.
10. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
11. Keep paint materials sealed when not in use.
12. 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.

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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 the exposure.

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.
3. Surface Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application 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. Recoat 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, nonferrous metal, plastic, and wood 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.

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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.

3.07 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. System No. 6 Exposed Metal—Atmospheric:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Rust-Inhibitive Primer	1 coat, 2 MDFT
	Alkyd Enamel	2 coats, 4 MDFT

1. Use on the following items or areas:
   a. Exposed metal surfaces, new and existing located inside or outside of structures or exposed to weather, including metal doors and frames, vents, louvers, exterior metal ductwork, flashing, sheet metalwork and miscellaneous architectural metal trim.
   b. Apply surface preparation and primer to surfaces prior to installation. Finish coats need only be applied to surfaces exposed after completion of construction.

C. System No. 10 Galvanized Metal, Copper, and Nonferrous Metal Alloy Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation	Epoxy Primer—Other	As recommended by coating manufacturer Remaining coats as required for exposure

1. Use on the following items or areas:
   a. Galvanized surfaces requiring painting.
   b. After application of System No. 10, apply finish coats as required for exposure.

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D. System No. 11 Faying Surfaces of Slip Critical Bolted Connections:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Organic Zinc Rich Primer	1 coat, 3 MDFT

1. Use on faying surfaces of slip critical joints as specified and as shown on the Drawings.
2. Provide primer in accordance with RCSC Specification for Structural Joints using High-Strength Bolts.
3. System No. 25 Exposed FRP, PVC:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Plastic and FRP Surface Preparation	Acrylic Latex Semigloss	2 coats, 320 SFPGPC

4. Use on the following items or areas:
   a. All exposed-to-view PVC and CPVC surfaces, and FRP surfaces without integral UV-resistant gel coat.

3.08 ARCHITECTURAL PAINT 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. System No. 107 Metal Trim and Structural Steel:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Rust-Inhibitive Primer	1 coat, 2 MDFT
	Alkyd Enamel (Semigloss)	2 coats, 4 MDFT

1. Use on the following items or areas:
   a. Conveyors.
   b. Polymer System (as needed).

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C. System No. 121 Concrete, Skid-Resistant:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete Surface Preparation	Epoxy Nonskid (Aggregated)	1 coat, 160 SFPG

1. Use on the following items or areas:
   a. Residuals Storage Pad.

3.09 COLORS

A. Provide as designated herein.

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.
   b. Fire Protection Equipment and Apparatus: OSHA Red.
   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.
   e. Paint process equipment per the manufacturer’s standard finish or as indicated in the equipment specification.

D. Pipe Identification Painting:

1. Color code nonsubmerged metal piping, except electrical conduit. Paint fittings and valves the same color as pipe, except equipment isolation valves.
2. Pipe Color Coding: As shown in table below.

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E. Pipe System Color Code:[BS1.1]

Pipe System	Color
Compressed Air (CA)	None
Wash Water (WW)	Medium Blue
Polymer (PO)	Orange

3.10 FIELD QUALITY CONTROL

A. Testing Equipment:

1. Provide calibrated electronic type dry film thickness gauge to test coating thickness specified in mils.
2. Provide low-voltage wet sponge electrical holiday detector to test completed coating systems, 20 mils dry film thickness or less, except zinc primer, high-build elastomeric coatings, and galvanizing, for pinholes, holidays, and discontinuities, as manufactured by Tinker and Rasor, San Gabriel, CA, Model M-1.
3. Provide high-voltage spark tester to test completed coating systems in excess of 20 mils dry film thickness. Unit as recommended by coating manufacturer.

B. 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.

C. 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.

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D. 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.

E. 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.

3.11 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. As required to resolve field problems attributable to or associated with manufacturer's product.
3. To verify full cure of coating prior to coated surfaces being placed into immersion service.
4. As required to provide Manufacturer's Certificate of Proper Installation.

3.12 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.

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C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

3.13 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

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PAINT SYSTEM DATA SHEET (PSDS)

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.

Paint System Number (from Spec.):		
Paint System Title (from Spec.):		
Coating Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	**Product Name/Number (Proprietary)**	**Min. Coats, Coverage**

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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:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Min. Recoat Time			
Max. Recoat Time			

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.:_____

Attach additional sheets detailing manufacturer's recommended storage requirements and holiday testing procedures.

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SECTION 26 05 01
ELECTRICAL

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 Transportation Officials (AASHTO).
2. ASTM International (ASTM):
   a. A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A240/A240M, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
   c. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   d. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
3. Electronic Industries Association (EIA/TIA): 569, Commercial Building Standard for Telecommunications Pathways and Spaces.
4. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
   b. PC62.41.1, Draft Guide on the Surge Environment in Low-Voltage (1,000 V and less) AC Power Circuits.
   c. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   d. 114, IEEE Standard Test Procedure for Single-Phase Induction Motors.
5. National Electrical Contractor’s Association, Inc. (NECA): 1, Standard Practices for Good Workmanship in Electrical Contracting.
6. National Electrical Manufacturers Association (NEMA):
   a. C80.1, Rigid Steel Conduit-Zinc Coated.
   b. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   c. ICS 1, Industrial Control and Systems: General Requirements.

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d. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC.
e. ICS 2.3, Industrial Control and Systems: Instructions for the Handling, Installation, Operation and Maintenance of Motor Control Centers.
f. MG 1, Motors and Generators.
g. PB 1, Panelboards.
h. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
i. WC 55, Instrumentation Cables and Thermocouple Wire.
j. WC 70, Standard for Non-Shielded Power Cables Rated 2,000 V or Less for the Distribution of Electrical Energy.
k. WD 1, General Color Requirements for Wiring Devices.

7. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
8. UL:
   a. 1, Flexible Metal Conduit.
   b. 6, Electrical Rigid Metal Conduit—Steel.
   c. 13, Power-Limited Circuit Cables.
   d. 44, Thermoset Insulated Wires and Cables.
   e. 62, Flexible Cord and Fixture Wire.
   f. 67, Panelboards.
   g. 360, Liquid-Tight Flexible Steel Conduit.
   h. 486A, Wire Connectors and Soldering Lugs for Use with Copper Conductors.
   i. 486C, Splicing Wire Connectors.
   j. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   k. 508, Industrial Control Equipment.
   l. 510, Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
   m. 514B, Fittings for Cable and Conduit.
   n. 870, Wireways, Auxiliary Gutters, and Associated Fittings.
   o. 1059, Terminal Blocks.
   p. 1277, Electrical Power and Control Tray Cables with Optional Optical-Fibre Members.

1.02 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.

B. MCOV: Maximum Allowable Continuous Operating Voltage.

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C. MOV: Metal Oxide Varistor.

D. SASD: Silicon Avalanche Suppressor Diode.

E. SVR: Surge Voltage Rating.

1.03 SUBMITTALS

A. Action Submittals:

1. Junction and pullboxes.
2. Circuit breakers and switches.
3. Support and framing channels.
4. Nameplates and nameplate schedule.
5. Conduit, fittings, and accessories.
6. Conductors, cable, and accessories.
7. Motors: Nameplate data, detailed information on any special features.
8. Grounding materials.
9. 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. Factory test reports.
3. Field test reports.
4. Signed permits indicating Work is acceptable to regulatory authorities having jurisdiction.
5. Operation and Maintenance Data:
   a. As specified in Section 01 78 23, Operation and Maintenance Data.
   b. Provide for all equipment, as well as each device having features that can require adjustment, configuration, or maintenance.
   c. Minimum information shall include manufacturer's preprinted instruction manual, one copy of the approved submittal information for the item, tabulation of any settings, and copies of any test reports.

1.04 APPROVAL BY AUTHORITY HAVING JURISDICTION

A. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing

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laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the NEC.

B. 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 or label.

PART 2 PRODUCTS

2.01 GENERAL

A. Products shall comply with all applicable provisions of NFPA 70.

B. Like Items of Equipment: End products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's service.

C. Equipment and Devices Installed Outdoors or in Unheated Enclosures: Capable of continuous operation within ambient temperature range as specified in Section 01 61 00, Common Product Requirements.

D. Equipment Finish:

1. Manufacturer's standard finish color, except where specific color is indicated.
2. If manufacturer has no standard color, finish equipment in accordance with light gray color finish as approved by Engineer.

2.02 OUTLET AND DEVICE BOXES

A. Sheet Steel: One-piece drawn type, zinc-plated or cadmium-plated.

B. Cast Metal:

1. Box: Cast ferrous metal.
2. Cover: Gasketed, weatherproof, and cast ferrous metal with stainless steel screws.
3. Hubs: Threaded.
4. Lugs: Cast Mounting.
5. Manufacturers and Products, Nonhazardous Locations:
   a. Crouse-Hinds; Type FS or Type FD.
   b. Appleton; Type FS or Type FD.

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2.03 JUNCTION AND PULL BOXES

A. Outlet Boxes Used as Junction or Pull Box: As specified under Article Outlet and Device Boxes.

B. Conduit Bodies Used as Junction Boxes: As specified under Article Conduit and Fittings.

C. Large Sheet Steel Box:

1. NEMA 250, Type 1.
2. Box: Code-gauge, galvanized steel.
3. Cover: Full access, screw type.
4. Machine Screws: Corrosion-resistant.

D. Large Cast Metal Box:

1. NEMA 250, Type 4.
2. Box: Cast ferrous metal, electrogalvanized finished, with drilled and tapped conduit entrances and exterior mounting lugs.
3. Cover: Hinged with clamps.
4. Gasket: Neoprene.
5. Hardware and Machine Screws: ASTM A193, Type 316 stainless steel.
6. Manufacturers and Products, Surface Mounted Nonhinged Type:
   a. Crouse-Hinds; Series W.
   b. O-Z/Gedney; Series Y.
7. Manufacturer and Product, Surface Mounted, Hinged Type: O-Z/Gedney; Series YW.
8. Manufacturers and Products, Recessed Type:
   a. Crouse-Hinds; Type WJBF.
   b. O-Z/Gedney; Series YR.

2.04 CIRCUIT BREAKER, INDIVIDUAL, 0-VOL TO 600 VOLTS

A. UL 489 listed for use at location of installation.

B. Minimum Interrupt Rating: As shown.

C. Thermal-magnetic, quick-make, quick-break, indicating type showing ON/OFF and TRIPPED indicating positions of operating handle.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Locking: Provisions for padlocking handle.

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F. Enclosure: As specified under Part 3 Execution.

G. Interlock: Enclosure and switch shall interlock to prevent opening cover with breaker in the ON position.

H. Manufacturers:

1. Eaton.
2. General Electric Co.
3. Square D Co.

2.05 NONFUSED SWITCH, INDIVIDUAL, 0-VOLT TO 600 VOLTS

A. NEMA KS 1.

B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

C. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

D. Enclosure: As specified under Part 3 Execution.

E. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

F. Manufacturers:

1. Eaton.
2. General Electric Co.
3. Square D Co.

2.06 PUSHBUTTONS, INDICATING LIGHTS, AND SELECTOR SWITCHES

A. Type: Heavy-duty, oiltight. Provide contact arrangements, colors, inscriptions, and functions as shown.

B. Contact Rating: NEMA ICS 2, Type A600.

C. Unless otherwise shown, provide the following features:

1. Selector Switch Operating Lever: Standard.
2. Indicating Lights: Push-to-test, transformer-type.
3. Pushbutton Color:
   a. ON or START: Black.
   b. OFF or STOP: Red.

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4. Pushbuttons and selector switches lockable in OFF position where indicated.

D. Legend Plate:

1. Material: Aluminum.
2. Engraving: Indicating specific function, or as shown.
3. Letter Height: 7/64-inch.

E. Manufacturers and Products:

1. General Electric Co.; Type CR 104P.
2. Square D Co.; Type T.
3. Eaton; Type 10250T.

2.07 TERMINAL BLOCKS

A. Type: UL 1059. Compression screw clamp, with current bar providing direct contact with wire and yoke, with individual rail mounted terminals. Marking system shall permit use of preprinted or field-marked tags.

B. Yokes and Clamping Screws: Zinc-plated, hardened steel.

C. Rating: 600V ac.

D. Manufacturers:

1. Weidmuller, Inc.
2. Ideal.

2.08 SUPPORT AND FRAMING CHANNELS

A. Carbon Steel Framing Channel:

1. Material: Rolled, mild strip steel, 12 gauge, ASTM A1011/A1011M, Grade 33.
2. Finish: Hot-dip galvanized after fabrication.

B. Stainless Steel Framing Channel: Rolled, ASTM A167, Type 316 stainless steel, 12 gauge.

C. Manufacturers:

1. B-Line Systems, Inc.
2. Unistrut Corp.

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2.09 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment: Adhesive.

C. Color: Black, engraved to a white core, or as shown.

D. Engraving:

1. Devices and Equipment: Name or tag shown, or as required.
2. Panelboards:
   a. Designation.
   b. Service voltage.
   c. Phases.
3. Minimum Requirement: Label metering and power distribution equipment, local control panels, junction boxes, motor controls, and transformers.

E. Letter Height:

1. Pushbuttons, Selector Switches, and Other Devices: 3/16 inch.
2. Equipment and Panelboards: 1/4 inch.

2.10 CONDUIT AND FITTINGS

A. Rigid Galvanized Steel Conduit (RGS):

1. Meet requirements of NEMA C80.1 and UL 6.
2. Material: Hot-dip galvanized, with chromated protective layer.

B. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel, with an extruded PVC jacket.

C. Fittings:

1. Provide bushings, grounding bushings, conduit hubs, conduit bodies, couplings, unions, conduit sealing fittings, drain seals, drain/breather fittings, expansion fittings, and cable sealing fittings, as applicable.
2. Rigid Galvanized Steel and Intermediate Metal Conduit:
   a. Meet requirements of UL 514B.
   b. Type: Threaded, galvanized.

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3. Flexible Metal, Liquid-Tight Conduit:
   a. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
   b. Insulated throat and sealing O-rings.

2.11 CONDUIT ACCESSORIES

A. Identification Devices:

1. Raceway Tags:
   a. Material: Permanent, nonferrous metal.
   b. Shape: Round.
   c. Raceway Designation: Pressure stamped, embossed, or engraved.
   d. Tags relying on adhesives or taped-on markers not permitted.

B. Raceway Band:

1. Slip-on Type:
   a. Provide heat-shrinkable, black, medium-wall polyolefin tubing with factory-applied adhesive/sealant. Select product size based upon raceway outside diameter.
   b. Manufacturer and Product: 3M; Type IMCSN, medium wall cable sleeve.
2. Wrap-around Type:
   a. Provide 4-inch width, 20-mil thickness, nonprinted black PVC corrosion protection tape with primer.
   b. Manufacturer and Product: 3M; Type Scotchrap 51 with Scotchrap Pipe Primer.

2.12 CONDUCTORS AND CABLES

A. Conductors 600 Volts and Below:

1. Conform to applicable requirements of NEMA WC 70.
2. Conductor Type:
   a. 120-Volt and 277-Volt Lighting, 10 AWG and Smaller: Solid copper.
   b. 120-Volt Receptacle Circuits, 10 AWG and Smaller: Solid copper.
   c. All Other Circuits: Stranded copper.
3. Insulation: THHN/THWN, except for sizes No. 6 and larger, with XHHW-2 insulation.
4. Direct Burial and Aerial Conductors and Cables:
   a. Type USE/RHH/RHW insulation, UL 854 listed or Type RHW-2/USE-2.

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b. Conform to physical and minimum thickness requirements of NEMA WC 70.

5. Flexible Cords and Cables:
   a. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
   b. Conform to physical and minimum thickness requirements of NEMA WC 70.
6. Grounding Conductors: As specified in Article Grounding.

B. 600-Volt Rated Cable:

1. General:
   a. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu per hour, and NFPA 70, Article 340, or UL 13 meeting requirements of NFPA 70, Article 725.
   b. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
   c. Suitable for installation in open air, in cable trays, or conduit.
   d. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
   e. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.
2. Type 3, 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.
   a. Outer Jacket: 45 mils nominal thickness.
   b. Individual Pair Shield: 1.35 mils, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
   c. Dimension: 0.31-inch nominal outside diameter.
   d. Conductors:
      1) Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
      2) 20 AWG, seven-strand tinned copper drain wire.
      3) Insulation: 15 mils nominal PVC.
      4) Jacket: 4 mils nominal nylon.
      5) Color Code: Pair conductors black and red.
   e. Manufacturers: Okonite Co.
3. Type 30 (CAT 6+), Unshielded Twisted Pairs (UTP) Data Cable, 300V:
   a. Category 6 UTP, UL listed, and third party verified to comply with TIA/EIA 568-C Category 6 requirements.

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b. Suitable for high speed network applications including gigabit ethernet and video. Cable shall be interoperable with other standards compliant products and shall be backward compatible with Category 5 and Category 5e.
c. Provide four each individually twisted pair, 23 AWG conductors, with FEP insulation and blue PVC jacket.
d. NFPA 70 Plenum (CMP) rated; comply with flammability plenum requirements of NFPA 70 and NFPA 262.
e. Cable shall withstand a bend radius of 1 inch minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking.
f. Manufacturer and Product: Belden; 7852A.

C. Accessories:

1. Tape:
   a. General Purpose, Flame Retardant: 7 mils, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.
   b. Flame Retardant, Cold and Weather Resistant: 8.5 mils, vinyl plastic, Scotch Brand 88.
2. Identification Devices:
   a. Sleeve-type, permanent, PVC, yellow or white, with legible machine-printed black markings.
   b. Manufacturer and Products: Raychem; Type D-SCE or Type ZH-SCE.
3. Connectors and Terminations:
   a. Nylon, Self-Insulated Crimp Connectors:
      1) Manufacturers and Products:
         a) Thomas & Betts; Sta-Kon.
         b) Burndy; Insulug.
         c) ILSCO.
4. Self-Insulated, Freespring Wire Connector (Wire Nuts):
   a. Plated steel, square wire springs.
   b. UL Standard 486C.
   c. Manufacturers and Products:
      1) Thomas & Betts.
      2) Ideal; Twister.
5. Cable Lugs:
   a. In accordance with NEMA CC 1.
   b. Rated 600 volts of same material as conductor metal.
   c. Uninsulated Crimp Connectors and Terminators:
      1) Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

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2) Manufacturers and Products:
a) Thomas & Betts; Color-Keyed.
b) Burndy; Hydent.
c) ILSCO.

d. Uninsulated, Bolted, Two-Way Connectors and Terminators:
1) Manufacturers and Products:
a) Thomas & Betts; Locktite.
b) Burndy; Quiklug.
c) ILSCO.

6. Cable Ties:
a. Nylon, adjustable, self-locking, and reusable.
b. Manufacturer and Product: Thomas & Betts; TY-RAP.
7. Heat Shrinkable Insulation:
a. Thermally stabilized, crosslinked polyolefin.
b. Manufacturer and Product: Thomas & Betts; SHRINK-KON.

2.13 MOTORS

A. Three-Phase:

1. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.
2. Meet requirements of NEMA MG 1.
3. Provide motors that conform to UL 674 and have an applied UL listing mark.
4. Motors shall be specifically designed for use and conditions intended, with a NEMA design letter classification to fit application.
5. Lifting lugs on motors weighing 100 pounds or more.
6. Operating Conditions: Maximum ambient temperature not greater than 40 degrees C.
7. Horsepower Rating: As designated in motor-driven equipment specifications. Brake horsepower of the driven equipment at any operating condition shall not exceed motor nameplate horsepower rating, excluding any service factor.
8. Service Factor: 1.15 minimum at rated ambient temperature, unless otherwise shown.
9. Voltage and Frequency Rating: 460V and 208V ac, 60 Hz, unless otherwise indicated in motor-driven equipment specifications.
10. Suitable for full voltage starting.
11. Efficiency and Power Factor: Provide premium efficiency units, except for under 1 hp, multispeed, or short-time rated motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists. Provide standard power factor.

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12. Insulation Systems: Unless otherwise indicated in motor-driven equipment specifications, Class B or Class F at nameplate horsepower and designated operating conditions, except EXP motors that shall be Class B with Class B rise.
13. Enclosures:
    a. Open drip-proof, unless specified otherwise in the motor-driven equipment specification. Provide screens over air openings. Enclosures shall conform to NEMA MG 1.
    b. TEFC and TENV: Furnish with a drain hole with porous drain/weather plug.
    c. Equipment Finish: Manufacturer's standard.
14. Nameplates: In accordance with NEMA MG1.
15. Multispeed: Meet requirements for speeds, number of windings, and load torque classification indicated in the motor-driven equipment specifications.
16. Inverter Duty Motor:
    a. Motor supplied power by adjustable frequency drives shall be inverter duty-rated.
    b. Motor shall meet all applicable requirements of NEMA MG 1, Section IV, Part 30 and Part 31.
    c. Motor shall be suitable for operation over entire speed range indicated.
    d. Provide forced ventilation where speed ratio is greater than published range for motor being installed. Provide and coordinate fan power supply and motor control requirements with associated drive.

B. Single-Phase:

1. Provide induction-type unit meeting NEMA MG 1 requirements and suitable for application and mounting with the driven load. Motor shall be 115/230V ac, 60 Hz. Provide integral thermal protection and manufacturer's standard insulation system.
2. Horsepower rating: As specified under motor-driven equipment specification.
3. Single-speed: Single-winding. Speed as specified under motor-driven equipment specification.
4. Two-speed: Two-winding; speeds as specified under motor-driven equipment specification.
5. Enclosure: Open drip-proof, unless otherwise noted.

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C. Manufacturers:

1. General Electric.
2. Reliance Electric.
3. U.S. Electrical Motors.

D. Factory Testing:

1. Tests:
   a. In accordance with IEEE 112 for polyphase motors and IEEE 114 for single-phase motors.
   b. Provide routine (production) tests on all motors in accordance with NEMA MG 1. Test multispeed motors at all speeds.
   c. For premium efficiency motors, test efficiency and power factor at 50 percent, 75 percent, and 100 percent of rated horsepower:
      1) In accordance with IEEE 112, Test Method B, and NEMA MG 1, Paragraph 12.54 and Paragraph 12.57.
      2) For smaller motors, furnish a copy of a certified motor efficiency test report for identical motor.
2. Test Report Forms:
   a. Routine Tests: IEEE 112, Form A-1.
   b. Efficiency and power factor by Test Method B, IEEE 112, Form A-2, and NEMA MG 1, Paragraph (table) 12.57.

2.14 GROUNDING

A. Ground Conductors:

1. Equipment: Stranded copper with green, Type THHN/THWN insulation.

B. Connectors:

1. Compression Type:
   a. Compress-deforming type; wrought copper extrusion material.
   b. Single indentation for conductors 6 AWG and smaller.
   c. Double indentation with extended barrel for conductors 4 AWG and larger.
   d. Single barrels prefilled with oxide-inhibiting and antiseizing compound.
   e. Manufacturers:
      1) Burndy Corp.
      2) Thomas and Betts Co.
      3) ILSCO.

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2. Mechanical Type:
   a. Split-bolt, saddle, or cone screw type; copper alloy material.
   b. Manufacturers:
      1) Burndy Corp.
      2) Thomas and Betts Co.

2.15 LOW VOLTAGE MOTOR CONTROL

A. General:

1. Make adjustments as necessary to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors and motor ratings actually provided.
2. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
3. Operating Conditions:
   a. Ambient Temperature: Maximum 40 degrees C.
   b. Equipment to be fully rated without any derating for operating conditions listed above.

B. Manufacturers:

1. General Electric.
2. Eaton Electric.

PART 3 EXECUTION

3.01 GENERAL

A. Install materials and equipment in accordance with manufacturer's instructions and recommendations.

B. Work shall comply with all applicable provisions of NECA 1.

C. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

3.02 DEMOLITION

A. General Demolition:
   1. Where shown, de-energize and disconnect nonelectrical equipment for removal by others.
   2. Where shown, de-energize, disconnect, and remove electrical equipment.

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3. Remove affected circuits and raceways back to serving panelboard or control panel. Where affected circuits are consolidated with others, remove raceways back to first shared condulet or box. Where underground or embedded raceways are to be abandoned, remove raceway to 1-inch below surface of structure or 12 inches belowgrade and restore existing surface.

3.03 PROTECTION FOLLOWING INSTALLATION

A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation.

B. Cap conduit runs during construction with manufactured seals.

C. Close openings in boxes or equipment during construction.

3.04 JUNCTION AND PULL BOXES

A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.

B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

C. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.

E. Use conduit bodies as junction and pull boxes where no splices are required and their use is allowed by applicable codes.

F. Installed boxes shall be accessible.

G. Do not install on finished surfaces.

H. Install plumb and level.

I. Support boxes independently of conduit by attachment to building structure or structural member.

J. Flush Mounted:

1. Install with concealed conduit.

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2. Holes in surrounding surface shall be no larger than required to receive box.
3. Make edges of boxes flush with final surface.

K. Mounting Hardware:

1. Noncorrosive Indoor Dry Areas: Galvanized.
2. Outdoor or Noncorrosive Indoor Wet Areas: Stainless steel.
3. Corrosive Areas: Stainless steel.

L. Location/Type:

1. Indoor, Dry (Electrical and Control Rooms): NEMA 250, Type 1.
2. Indoor and Outdoor, Process Areas: NEMA 250, Type 4.

M. Install Drain/breather fittings in NEMA 250, Type 4 enclosures.

3.05 CIRCUIT BREAKERS AND SWITCHES

A. Location and Enclosure Type:

1. Indoor or Outdoor: NEMA 250, Type 4.

3.06 TERMINAL BLOCKS

A. Install for termination of control circuits entering or leaving equipment and local control panels.

3.07 SUPPORT AND FRAMING CHANNELS

A. Install where required for mounting and supporting electrical equipment and raceway systems.

B. Channel Type:

1. Interior, Wet or Dry Noncorrosive Locations: Carbon steel.
2. Outdoor, Noncorrosive Locations: Carbon steel.

C. Paint carbon steel channel cut ends prior to installation with zinc-rich primer.

3.08 NAMEPLATES

A. Provide identifying nameplate on all equipment.

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3.09 CONDUIT AND FITTINGS

A. General:

1. Crushed or deformed raceways not permitted.
2. Maintain raceway entirely free of obstructions and moisture.
3. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.
4. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.
5. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.
6. Group raceways installed in same area.
7. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.
8. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.
9. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.
10. Install watertight fittings in outdoor, underground, or wet locations.
11. Paint threads and cut ends, before assembly of fittings, galvanized conduit, PVC-coated galvanized conduit, or IMC installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.
12. Metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.
13. Do not install raceways in concrete equipment pads, foundations, or beams.
14. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.
15. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.
16. Install conduits for fiber optic cables, telephone cables, and Category 5 data cables in strict conformance with the requirements of EIA/TIA 569.

B. Conduit Application:

1. Diameter:
   a. Interior Minimum: 3/4 inch.
   b. Exterior Minimum: 3/4 inch.
2. Outdoor, Exposed: Rigid galvanized steel.
3. Indoor, Exposed: Rigid galvanized steel.

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C. Connections:

1. For motors-, wall-, or ceiling-mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other equipment where flexible connection is required to minimize vibration:
   a. General: Flexible metal, liquid-tight conduit.
   b. Wet or Corrosive Areas: Flexible metal liquid-tight.
   c. Length: 18 inches minimum, 60 inches maximum, sufficient to allow movement or adjustment of equipment.
2. Outdoor areas, process areas exposed to moisture, and areas required to be oiltight and dust-tight: Flexible metal, liquid-tight conduit.

D. Penetrations:

1. Make at right angles, unless otherwise shown.
2. Notching or penetration of structural members, including footings and beams, not permitted.
3. Fire-Rated Walls, Floors, or Ceilings: Firestop openings around penetrations to maintain fire-resistance rating.
4. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack.
5. Entering Structures:
   a. General: Seal raceway at the first box or outlet with oakum or expandable plastic compound to prevent the entrance of gases or liquids from one area to another.
   b. Concrete Roof or Membrane Waterproofed Wall or Floor: Provide watertight seal.
   c. Existing or Precast Wall (Underground): Core drill wall and install watertight entrance seal device.
   d. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
      1) Provide Schedule 40 galvanized pipe sleeve or watertight entrance seal device.
      2) Fill space between raceway and sleeve with expandable plastic compound or oakum and lead joint on each side.

E. Support:

1. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 10 feet. Do not support from piping, pipe supports, or other raceways.
2. Multiple Adjacent Raceways: Provide ceiling trapeze.

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3. Application/Type of Conduit Strap:
    a. Steel Conduit: Zinc-coated steel, pregalvanized steel, or malleable iron.
4. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:
    a. Wood: Wood screws.
    b. Hollow Masonry Units: Toggle bolts.
    c. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
    d. Steelwork: Machine screws.
    e. Location/Type of Hardware:
        1) Electrical and Control Rooms: Galvanized.
        2) Everywhere else: Stainless steel.

F. Bends:

1. Install concealed raceways with a minimum of bends in the shortest practical distance.
2. Make bends and offsets of longest practical radius. Bends in conduits and ducts being installed for fiber optic cables shall be not less than 20 times cable diameter, 15 inches minimum.
3. Install with symmetrical bends or cast metal fittings.
4. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.
5. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.
6. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run and raceways are same size.
7. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

G. Termination at Enclosures:

1. Cast Metal Enclosure: Provide manufacturer’s premolded insulating sleeve inside metallic conduit terminating in threaded hubs.
2. Nonmetallic, Cabinets, and Enclosures: Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.
3. Sheet Metal Boxes, Cabinets, and Enclosures:
    a. Rigid Galvanized Conduit:
        1) Provide one lock nut each on inside and outside of enclosure.
        2) Install grounding bushing.

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3) Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.
4) Install insulated bushing on ends of conduit where grounding is not required.
5) Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
6) Terminate conduits with threaded conduit hubs at NEMA 4 and 4X boxes and enclosures.

b. Flexible Metal Conduit: Provide two-screw type, insulated, malleable iron connectors.

4. Free-Standing Enclosures:
a. Terminate metal conduit entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.
b. Terminate PVC conduit entering bottom with bell end fittings.

H. Identification Devices:

1. Raceway Tags:
a. Identify origin and destination.
b. Install at each terminus, near midpoint, and at minimum intervals of every 50 feet of exposed raceway, whether in ceiling space or surface mounted.
c. Provide corrosion-resistant wire for attachment.

3.10 CONDUCTORS AND CABLES

A. Conductor storage, handling, and installation shall be in accordance with manufacturer’s recommendations.

B. Do not exceed manufacturer’s recommendations for maximum pulling tensions and minimum bending radii.

C. Conduit system shall be complete prior to drawing conductors. Lubricate prior to pulling into conduit. Lubrication type shall be as approved by conductor manufacturer.

D. Terminate all conductors and cables, unless otherwise shown.

E. Do not splice conductors, unless specifically indicated or approved by Engineer.

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F. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 12 inches.

G. Wiring within Equipment and Local Control Panels: Remove surplus wire, dress, bundle, and secure.

H. Power Conductor Color Coding:

1. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 inches to 2 inches wide.
2. 8 AWG and Smaller: Provide colored conductors.
3. Colors:
    a. Neutral Wire: White.
    b. Live Wires, 120/240-Volt, Single-Phase System: Black, red.
    c. Live Wires, 120/208-Volt, Three-Phase System: Black, red, or blue.
    d. Live Wires, 277/480-Volt, Three-Phase System: Brown, orange, or yellow.
    e. Ground Wire: Green.

I. Circuit Identification:

1. Circuits Appearing in Circuit Schedules: Identify power, instrumentation, and control conductor circuits, using circuit schedule designations, at each termination and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.
2. Circuits Not Appearing in Circuit Schedules: Assign circuit name based on device or equipment at load end of circuit. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.
3. Method: Identify with sleeves. Taped-on markers or tags relying on adhesives not permitted.

J. Connections and Terminations:

1. Install wire nuts only on solid conductors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control circuit conductors.
3. Tape insulate all uninsulated connections.
4. Install crimp connectors and compression lugs with tools approved by connector manufacturer.

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3.11 GROUNDING

A. Grounding shall be in compliance with NFPA 70 and as shown.

B. Shielded Instrumentation Cables:

1. Ground shield to ground bus at power supply for analog signal.
2. Expose shield minimum 1-inch at termination to field instrument and apply heat shrink tube.
3. Do not ground instrumentation cable shield at more than one point.

C. Equipment Grounding Conductors: Provide in all conduits containing power conductors and control circuits above 50 volts.

3.12 FIELD QUALITY CONTROL

A. Tests shall be performed in accordance with the requirements of Section 01 91 14, Equipment Testing and Facility Startup.

B. General:

1. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.
2. Test instrument calibration shall be in accordance with NETA ATS.
3. Perform inspection and electrical tests after equipment has been installed.
4. Perform tests with apparatus de-energized whenever feasible.
5. Inspection and electrical tests on energized equipment are to be:
   a. Scheduled with Owner prior to de-energization.
   b. Minimized to avoid extended period of interruption to the operating plant equipment.

C. Tests and inspection shall establish that:

1. Electrical equipment is operational within industry and manufacturer’s tolerances.
2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70.

D. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer’s recommendations.

E. Adjust mechanisms and moving parts for free mechanical movement.

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F. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

G. Verify nameplate data for conformance to Contract Documents.

H. Realign equipment not properly aligned and correct unlevelness.

I. Properly anchor electrical equipment found to be inadequately anchored.

J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.

K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

L. Provide proper lubrication of applicable moving parts.

M. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

N. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by Engineer, door and panel sections having damaged surfaces.
5. Replace missing or damaged hardware.

O. Provide test report(s) documenting the successful completion of specified testing. Include field test measurement data.

P. Test the following equipment and materials:

1. Conductors: Insulation resistance, No. 4 and larger only.
2. Panelboards, switches, and circuit breakers.
3. Motor controls.
4. Grounding electrodes.
5. Motors.

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Q. Controls:

1. Test control and signal wiring for proper termination and function.
2. Test local control panels and other control devices for proper terminations, configuration and settings, and functions.
3. Demonstrate control, monitoring, and indication functions in presence of Owner and Engineer.

R. Balance electrical load between phases on panelboards and mini-power centers after installation.

END OF SECTION

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SECTION 31 23 23
FILL AND BACKFILL

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. C117, Standard Test Method for Materials Finer Than 75-Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.
   b. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
   c. D75, Standard Practice for Sampling Aggregates.
   d. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 feet-lbf/ft^3 (600 kN-m/m^3)).
   e. D1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   f. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   g. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   h. D4254, Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   i. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Borrow Material: Material from required excavations or from designated borrow areas on or near Site.

B. Completed Course: A course or layer that is ready for next layer or next phase of Work.

C. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

D. Geosynthetics: Geotextiles, geogrids, or geomembranes.

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E. Imported Material: Materials obtained from sources offsite, suitable for specified use.

F. Influence Area:

1. Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:
   a. 1-foot outside outermost edge at base of foundations or slabs.
   b. 1-foot outside outermost edge at surface of roadways or shoulder.
   c. 0.5-foot outside exterior at spring line of pipes or culverts.

G. Lift: Loose (uncompacted) layer of material.

H. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

I. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.

J. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D698.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.

K. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.

L. Selected Backfill Material: Materials available onsite that Engineer determines to be suitable for specific use.

M. Standard Specifications: When referenced in this section, shall mean City of Tulsa Standard Specifications.

N. Structural Fill: Fill materials as required under structures, pavements, and other facilities.

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O. Well-Graded:

1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Tank manufacturer's recommendations for backfill around each buried tank.
2. Samples: Imported material taken at source.

B. Informational Submittals:

1. Manufacturer's data sheets for compaction equipment.
2. Certified test results from independent testing agency.

1.04 QUALITY ASSURANCE

A. Notify Engineer when:

1. Structure or tank is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
3. Fill material appears to be deviating from Specifications.

1.05 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 02 41 00, Demolition, prior to placing fill or backfill.

B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 00, Cast-in-Place Concrete. Obtain Engineer's acceptance of concrete work and attained strength prior to placing backfill.

C. Backfill around water-holding structures only after completion of satisfactory leakage tests as specified in Section 03 30 00, Cast-in-Place Concrete.

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PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Gradation Tests: As necessary to locate acceptable sources of imported material.

B. During production of imported material, test per City of Tulsa Standard Specifications Part 335 – Acceptance Sampling/Testing Requirements.

C. Samples:

1. Collected in accordance with ASTM D75: During production of imported material, provide Samples per City of Tulsa Standard Specifications Part 335 – Acceptance Sampling/Testing Requirements. Clearly mark to show source of material and intended use.

2.02 EARTHFILL

A. Excavated material from required excavations free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

2.03 GRANULAR FILL

A. 1-inch minus crushed gravel or crushed rock.

B. Free from dirt, clay balls, and organic material.

C. Well-graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 8 percent by weight passing No. 200 sieve.

2.04 WATER FOR MOISTURE CONDITIONING

A. Free of hazardous or toxic contaminates, or contaminants deleterious to proper compaction.

2.05 BASE COURSE ROCK

A. As specified in Section 32 11 23, Aggregate Base Course.

2.06 FOUNDATION STABILIZATION ROCK

A. Crushed rock or pit run rock.

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B. Uniformly graded from coarse to fine.

C. Free from excessive dirt and other organic material.

D. Maximum 2-1/2-inch particle size.

E. Access Road Surfacing: Gradation same as for base course.

PART 3 EXECUTION

3.01 GENERAL

A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.

D. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:

1. Fill or backfill to an elevation 2 feet above top of item to be laid.
2. Excavate trench for installation of item.
3. Install bedding, if applicable, as specified in Section 31 23 23.15, Trench Backfill.
4. Install item.
5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15, Trench Backfill, before resuming filling or backfilling specified in this section.

F. Tolerances:

1. Final Lines and Grades: Within a tolerance of 0.1-foot unless dimensions or grades are shown or specified otherwise.
2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

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G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.02 BACKFILL UNDER AND AROUND STRUCTURES

A. Under Facilities: Within influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 6-inch maximum thickness and compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D698.

B. Other Areas: Backfill with earthfill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 6-inch maximum thickness and compact each lift to minimum 90 percent relative compaction as determined in accordance with ASTM D698.

3.03 FILL

A. Outside Influence Areas beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities:

1. Unless otherwise shown, place earthfill as follows:
   a. Allow for 5-inch thickness of topsoil where required.
   b. Maximum 8-inch thick lifts.
   c. Compact to minimum 90 percent relative compaction as determined in accordance with ASTM D698.

3.04 SITE TESTING

A. Gradation:

1. Per City of Tulsa Standard Specifications Part 335 – Acceptance Sampling/Testing Requirements.
2. If test results indicate material does not meet specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet specification requirements.

B. In-Place Density Tests: Per City of Tulsa Standard Specifications Part 335 – Acceptance Sampling/Testing Requirements.

3.05 GRANULAR BASE, SUBBASE, AND SURFACING

A. Place and Compact as specified in Section 32 11 23, Aggregate Base Course.

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3.06 REPLACING OVEREXCAVATED MATERIAL

A. Replace excavation carried below grade lines shown or established by Engineer as follows:

1. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
2. Beneath Slabs-On-Grade: Granular fill.
3. Trenches:
    a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.15, Trench Backfill.
    b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.15, Trench Backfill.

3.07 ACCESS ROAD SURFACING

A. Place and compact as specified in Section 32 11 23, Aggregate Base Course.

END OF SECTION

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SECTION 31 23 23.15
TRENCH BACKFILL

PART 1 GENERAL

1.01 REFERENCES

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

1. American Public Works Association (APWA): Uniform Color Code.
2. ASTM International (ASTM):
   a. C33/C33M, Standard Specification for Concrete Aggregates.
   b. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   c. C117, Standard Test Method for Materials Finer than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
   d. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   e. C150/C150M, Standard Specification for Portland Cement.
   f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   g. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
   h. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
   i. D1140, Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75 micrometer) Sieve.
   j. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   k. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   l. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   m. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   n. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   o. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
3. National Electrical Manufacturers Association (NEMA): Z535.1, Safety Colors.

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1.02 DEFINITIONS

A. Base Rock: Granular material upon which manhole bases and other structures are placed.

B. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.

C. Imported Material: Material obtained by Contractor from source(s) offsite.

D. Lift: Loose (uncompacted) layer of material.

E. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

F. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.

G. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D698. Corrections for oversize material may be applied to either as-compacted field dry density or maximum dry density, as determined by Engineer.

H. Relative Density: As defined by ASTM D4253 and ASTM D4254.

I. Selected Backfill Material: Material available onsite that Engineer determines to be suitable for a specific use.

J. Well-Graded:

1. A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Satisfying both of the following requirements, as defined in ASTM D2487:
    a. Coefficient of Curvature: Greater than or equal to 1 and less than or equal to 3.
    b. Coefficient of Uniformity: Greater than or equal to 4 for materials classified as gravel, and greater than or equal to 6 for materials classified as sand.

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1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Manufacturer's descriptive literature for marking tapes and tracer wire.
2. Samples:
   a. Trench stabilization material.
   b. Bedding and pipe zone material.
   c. Granular drain.
   d. Granular backfill.
   e. Earth backfill.
   f. Sand(s).

B. Informational Submittals:

1. Catalog and manufacturer's data sheets for compaction equipment.
2. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to Site.
3. Controlled Low Strength Material: Certified mix design and test results. Include material types and weight per cubic yard for each component of mix.

PART 2 PRODUCTS

2.01 MARKING TAPE

A. Detectable:

1. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.
2. Foil Thickness: Minimum 0.35 mils.
3. Laminate Thickness: Minimum 5 mils.
4. Width: 3 inches.
5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
6. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.
7. Manufacturers and Products:
   a. Reef Industries; Terra Tape, Sentry Line Detectable.
   b. Mutual Industries; Detectable Tape.
   c. Presco; Detectable Tape.

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B. Color: In accordance with APWA Uniform Color Code.

Color*	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Potable water
Purple	Reclaimed water, irrigation, and slurry lines
*As specified in NEMA Z535.1, Safety Color Code.	

2.02 TRACER WIRE

A. Material: Minimum 12-gauge solid copper or copper jacket with a steel core, with high-density polyethylene (HDPE) or high-molecular weight polyethylene (HMWPE) insulation suitable for direct bury.

B. Splices: Use wire nut or lug suitable for direct burial as recommended by tracer wire manufacturer.

C. Manufacturers:

1. Copperhead Industries, LLC.
2. Performance Wire & Cable Inc.
3. Pro-line Safety Products Company.

2.03 TRENCH STABILIZATION MATERIAL

A. Base Rock:

1. Clean, hard, durable 3-inch minus crushed rock or gravel, or pit run, free from clay balls, other organic materials, or debris.
2. Uniformly graded from coarse to fine, less than 8 percent by weight passing the 1/4-inch sieve.

B. Granular Backfill:

1. Clean gravel or crushed rock, reasonably well-graded from coarse to fine.
2. Maximum Particle Size: 1 inch.

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2.04 BEDDING MATERIAL AND PIPE ZONE MATERIAL

A. Bedding Material shall be as specified in the City of Tulsa Specifications Section 302.3.

B. Minimum bedding thickness shall be 4 inches.

C. Initial backfill shall be as shown in City of Tulsa Standard Trench Details.

2.05 GRAVEL SURFACING ROCK

A. As specified in Section 32 11 23, Aggregate Base Course.

2.06 TOPSOIL

A. As per City of Tulsa Specification Section 302.5

2.07 SOURCE QUALITY CONTROL

A. Perform gradation analysis in accordance with ASTM C136 for:

1. Earth backfill, including specified class.
2. Trench stabilization material.
3. Bedding and pipe zone material.

B. Certify Laboratory Performance of Mix Designs:

1. Controlled low strength material.
2. Concrete.

PART 3 EXECUTION

3.01 TRENCH PREPARATION

A. Water Control:

1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water
2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
3. Provide continuous water control until trench backfill is complete.

B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

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3.02 TRENCH BOTTOM

A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.

B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer. Engineer will determine depth of overexcavation, if any required.

3.03 TRENCH STABILIZATION MATERIAL INSTALLATION

A. Rebuild trench bottom with trench stabilization material.

B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.

C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.04 BEDDING

A. Place over full width of prepared trench bottom in two equal lifts when required depth exceeds 8 inches.

B. Hand grade and compact each lift to provide a firm, unyielding surface.

C. Minimum Thickness: As follows.

1. Pipe 12 Inches and Smaller: 4 inches.
2. Pipe 15 Inches to 36 Inches: 6 inches.
3. Pipe 42 Inches and Larger: 8 inches.
4. Conduit: 3 inches.
5. Direct-Buried Cable: 3 inches.
6. Duct Banks: 3 inches.

D. Check grade and correct irregularities in bedding material. Loosen top 1 inch to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.

E. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

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F. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.05 BACKFILL PIPE ZONE

A. Upper limit of pipe zone shall not be less than following:

1. Pipe: 12 inches, unless shown otherwise.
2. Conduit: 3 inches, unless shown otherwise.
3. Direct-Buried Cable: 3 inches, unless shown otherwise.
4. Duct Bank: 3 inches, unless shown otherwise.

B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.

C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.

1. Pipe 10-Inch and Smaller Diameter: First lift less than or equal to 1/2 pipe diameter.
2. Pipe Over 10-Inch Diameter: Maximum 6-inch lifts.

D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under haunches with a shovel to ensure voids are completely filled before placing each succeeding lift.

3.06 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of buried piping, on top of last lift of pipe zone material. Coordinate with piping installation drawings.

1. Detectable Marking Tape: Install with nonmetallic piping and waterlines.

3.07 TRACER WIRE INSTALLATION AND TESTING

A. Install tracer wire continuously along centerline of nonmetallic buried piping.

B. Install splices in accordance with manufacturer’s instructions for direct bury applications. Tie ends of wire to be joined in a knot as required to reduce tension on splice.

C. Bring tracer wire to surface at each valve box, vault, and hydrant. Tracer wire shall be brought to surface at least every 1,000 feet. If distance between pipe

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appurtenances exceeds 1,000 feet, install valve box to allow access to tracer wire. Mark valve box cover with the word “TRACER”. Coil enough excess tracer wire at each appurtenance to extend wire 12 inches above ground.

D. Test continuity of tracer wire using electronic pipe locator in presence of Engineer prior to paving.

3.08 BACKFILL ABOVE PIPE ZONE

A. General:

1. Process excavated material to remove organic matter, trash, and other deleterious materials. Rocks larger than 3 inches shall not be allowed within 15 inches below finished grade or within 18 inches above the pipe crown.
2. Adjust moisture content as necessary to obtain specified compaction.
3. Do not allow backfill to free fall into trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over top of pipe.
4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
6. Backfill around structures with same class backfill as specified for adjacent trench, unless otherwise shown or specified.

B. Backfill:

1. Place in lifts not exceeding thickness of 12 inches.
2. Mechanically compact each lift to a minimum of 90 percent standard proctor density as determined by ASTM D698 and AASHTO T99 prior to placing succeeding lifts.

3.09 REPLACEMENT OF TOPSOIL

A. Replace topsoil in top minimum of 5 inches of backfilled trench.

B. Maintain finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

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3.10 MAINTENANCE OF TRENCH BACKFILL

A. After each section of trench is backfilled, maintain surface of backfilled trench even with adjacent ground surface until final surface restoration is completed.

B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep surface of backfilled trench even with adjacent ground surface, and grade and compact as necessary to keep surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.

C. Topsoil: Add topsoil where applicable and as necessary to maintain surface of backfilled trench level with adjacent ground surface.

D. Concrete Pavement: Replace settled slabs as specified in Section 32 12 16, Asphalt Paving.

E. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified in Section 32 12 16, Asphalt Paving.

F. Other Areas: Add excavated material where applicable and keep surface of backfilled trench level with adjacent ground surface.

3.11 SETTLEMENT OF BACKFILL

A. Settlement of trench backfill, or of fill, or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION

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SECTION 32 11 23
AGGREGATE BASE COURSE

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. C29/C29M, Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate.
   b. C88/C88M, Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   c. C117, Standard Method of Test for Materials Finer Than 75µm (No. 200) Sieve in Mineral Aggregates by Washing.
   d. C131/C131M, Standard Specification for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   e. C136/C136M, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregate.
   f. D75/D75M, Standard Practice for Sampling Aggregates.
   g. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 feet-lb/ft^3 (600 kN-m/m^3)).
   h. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 feet-lb/ft^3 (2700 kN-m/m^3)).
   i. D1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
   j. D2216, Standard Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
   k. D2419, Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
   l. D2844/D2844M, Standard Specification for Resistance R-Value and Expansion Pressure of Compacted Soils.
   m. D4318, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
   n. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
   o. D5195, Standard Test Method for Density of Soil and Rock In-Place Below Surface by Nuclear Methods.

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p. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

2. Oklahoma Department of Transportation (ODOT):
   a. Standard Specifications (2019).
   b. Qualified Products List.

1.02 DEFINITIONS

A. Base Course: Crushed aggregate or similar as specified placed and compacted on prepared subgrade or subbase course.

B. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.

C. Completed Lift: Compacted with uniform cross-section thickness.

D. Gravel Surfacing: Aggregate used for construction of low-volume access and staging area that can be easily graded and compacted.

E. Leveling Course: Crushed aggregate placed and compacted on base course to be used for finish grading.

F. Standard Specifications: When referenced in this section, shall mean Oklahoma Department of Transportation (ODOT) Standard Specifications (2019).

G. Subbase Course: Sandy, gravelly material placed and compacted on prepared subgrade.

1.03 SUBMITTALS

A. Informational Submittals:

1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 14 days prior to delivery of materials to Project showing materials meeting the physical qualities specified.

PART 2 PRODUCTS

2.01 BASE COURSE

A. As specified for Type A in Section 303 of the Standard Specifications.

B. Clean, hard durable, pit run gravel or crushed stone graded from coarse to fine containing enough fines to bind material when compacted.

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C. Physical Qualities:

1. Abrasion, ASTM C131: 35 percent maximum wear.
2. Fractured Face: 75 percent minimum particles.
3. Liquid Limit, ASTM D4318: Maximum 25 percent.
4. Plasticity Index, ASTM D4318: Maximum 6 percent.
5. Sand Equivalency, ASTM D2419: 35 percent, minimum.
6. Resistance (R) Value, ASTM D2844: 75 minimum.
7. CBR Value, ASTM D1883: 100 percent, minimum.
8. Soundness, ASTM C88: 12 percent, maximum.
9. Flat and Elongated Particles, ASTM D4791: 8 percent, maximum.

D. Gradation, ASTM C136/C136M and ASTM C117, Based on U.S. Standard Sieves and conforming to Section 703 of Standard Specifications for Type A aggregate. for Source Quality Control.

E. Perform tests necessary to locate acceptable source of materials meeting specified requirements.

F. Final approval of aggregate material will be based on test results of installed materials.

G. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. As specified in Section 310.04.B of the Standard Specifications.

B. Obtain Engineer’s acceptance of subgrade before placing base course or surfacing material.

C. Do not place base course or surfacing materials in snow or on soft, muddy, frozen subgrade.

3.02 EQUIPMENT

A. Compaction Equipment: Adequate in design and number to provide compaction and to obtain specified density for each layer.

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3.03 HAULING AND SPREADING

A. As specified in Section 303 of the Standard Specifications.

B. Hauling Materials:

1. Do not haul over surfacing in process of construction.
2. Loads: Uniform capacity.
3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

C. Spreading Materials:

1. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.
2. Produce even distribution of material upon roadway or prepared surface without segregation.
3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

3.04 CONSTRUCTION OF COURSES

A. As specified in Section 303 of the Standard Specifications.

3.05 ROLLING AND COMPACTION

A. Commence compaction of each layer of base course after spreading operations and continue until no loose stone is visible and receives approval of Engineer.

B. Commence rolling at outer edges and continue toward center; do not roll center of road first.

C. Apply water as needed to obtain specified densities.

D. Place and compact each lift to the required density before succeeding lift is placed.

E. Surface Defects: Remedy by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.

F. Finished surface shall be true to grade and crown before proceeding with surfacing.

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3.06 SURFACE TOLERANCES

A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.

B. Finished Surface of Untreated Aggregate Base Course: Within plus or minus 0.04-foot of grade shown at any individual point.

3.07 FIELD QUALITY CONTROL

A. In-Place Density Tests:

1. Provide testing laboratory at least 48 hours' advance notification prior to testing.
2. Show proof that areas meet specified requirements before identifying density test locations.
3. Sample of Aggregates: ASTM D75/D75M.
4. Refer to Section 303 of Standard Specifications for minimum sampling and testing requirements for aggregate base course and surfacing.

3.08 CLEANING

A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate.

END OF SECTION

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SECTION 32 12 16
ASPHALT PAVING

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):
   a. M17, Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
   b. M81, Standard Specification for Cut-Back Asphalt (Rapid Curing Type).
   c. M82, Standard Specification for Cut-Back Asphalt (Medium Curing Type).
   d. M140, Standard Specification for Emulsified Asphalt.
   e. M156, Standard Specification for Requirements for Mixing Plants for Hot-mixed, Hot-laid Bituminous Paving Mixes.
   f. M208, Standard Specification for Cationic Emulsified Asphalt.
   g. R35, Standard Practice for Superpave Volumetric Design for Hot Mix Asphalt.
   h. T166, Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Mixtures Using Saturated Surface-Dry Specimens.
   i. T176 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
   j. T209, Standard Method of Test for Theoretical Maximum Specific Gravity (Gmm) and Density of Asphalt Mixtures.
   k. T245, Standard Method of Test for Resistance to Plastic Flow of Asphalt Mixtures Using Marshall Apparatus.
   l. T246, Standard Method of Test for Resistance to Deformation and Cohesion of Hot Asphalt Mixture by Means of Hveem Apparatus.
   m. T247, Standard Method of Test for Preparation of Test Specimens of Hot Mix Asphalt (HMA) by Means of California Kneading Compactor.
   n. T283, Standard Method of Test for Resistance of Compacted Hot Asphalt Mixtures to Moisture-Induced Damage.
   o. T304, Standard Method of Test for Uncompacted Void Content of Fine Aggregate.

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p. T312, Standard Method of Test for Preparing and Determining the Density of Asphalt Mixture Specimens by Means of a Superpave Gyratory Compactor.

2. Asphalt Institute (AI): Asphalt MS-2 Asphalt Mix Design Methods.
3. ASTM International (ASTM):
   a. D140/D140M, Standard Practice for Sampling Asphalt Materials.
   b. D979/D979M, Standard Practice for Sampling Asphalt Mixtures.
   c. D2041/D2041M, Standard Test Method for Theoretical Maximum Specific Gravity and Density of Asphalt Mixtures.
   d. D2489/D2489M, Standard Test Method for Determining Degree of Particle Coating of Asphalt Mixtures.
   e. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   f. D2950/2950M, Standard Test Method for Density of Asphalt Mixtures in Place by Nuclear Methods.
   g. D4791, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
   h. D5821, Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.
   i. E329, Standard Specification for Agencies Engaged in Construction Inspection Testing, or Special Inspection.
4. Oklahoma Department of Transportation (ODOT):
   a. Standard Specifications (2019).
   b. Qualified Product List.

1.02 DEFINITIONS

A. Combined Aggregate: All mineral constituents of asphalt concrete mix, including mineral filler and separately sized aggregates.

B. Maximum Aggregate Size: One sieve size larger than the nominal aggregate size.

C. Nominal Aggregate Size: One sieve size larger than the first sieve that retains more than 10 percent aggregate.

D. Prime Coat: Low viscosity cutback or emulsified asphalt applied to granular base in preparation of paving to coat and bond loose materials, harden the surface, plug voids, prevent moisture migration, and provide adhesion.

E. Reclaimed asphalt pavement (RAP): Removed and/or processed pavement materials containing binder and aggregate.

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F. Seal Coat: Term used for various applications of emulsified asphalt, with or without sand or aggregate, to protect the asphalt surface from aging due to wear, degradation from the sun, wind, and water. Also used to improve skid resistance and aesthetics. The term seal coat can be used to define fog seal, slurry seal, chip seal or sand seal, depending on application.

G. Standard Specifications: ODOT Standard Specifications (2019).

H. Tack Coat: Thin layer of emulsified asphalt applied to hard surfaces, including new pavement lifts, to promote adhesion and bonding.

1.03 DESIGN REQUIREMENTS

A. Conform to Standard Specifications, Section 708: Plant Mix Bituminous Bases and Surfaces.

1.04 SUBMITTALS

A. Action Submittals:

1. Samples:
   a. Uncompacted Asphalt Mixture: Submit uncompacted mix samples when requested by the Engineer per Division II material sampling and Division III acceptance procedures.

B. Informational Submittals:

1. Asphalt Concrete Mix Formula:
   a. Submit minimum of 7 days prior to start of production.
   b. Submittal to include the following information:
      1) Gradation and portion for each aggregate constituent used in mixture to produce a single gradation of aggregate within specified limits.
      2) Bulk specific gravity for each aggregate constituent.
      3) Measured maximum specific gravity of mix at optimum asphalt content determined in accordance with ASTM D2041.
      4) Properties as stated in Standard Specifications Section 411 and Section 708.
      5) Percent of asphalt lost due to absorption by aggregate.
      6) Index of Retained Strength (TSR) at optimum asphalt content as determined by AASHTO T283.
      7) Percentage of asphalt cement, to nearest 0.1 percent, to be added to mixture.
      8) Optimum mixing temperature.

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9) Optimum compaction temperature.
10) Temperature-viscosity curve of asphalt cement to be used.
11) Brand name of any additive to be used and percentage added to mixture.

2. Test Report for Asphalt Cement:
   a. Submit minimum 10 days prior to start of production.
   b. Show appropriate test method(s) for each material and the test results.
3. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for the following materials:
   a. Aggregate: Gradation and source test results as defined in the Specifications Section 701.
   b. Asphalt for Binder: Type, grade, and viscosity-temperature curve.
   c. Prime Coat: Type and grade of asphalt.
   d. Tack Coat: Type and grade of asphalt.
   e. Additives.
   f. Mix: Conforms to job-mix formula.
4. Statement of qualification for independent testing laboratory.
5. Test Results:
   a. Mix design.
   b. Gradation and asphalt content of uncompacted mix.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Independent Testing Laboratory: In accordance with ASTM E329.
2. Asphalt concrete mix formula shall be prepared by approved certified independent laboratory under the supervision of a certified asphalt technician.
3. Hot mix asphalt concrete shall be prepared by a mixing plant meeting the requirements of AASHTO M156.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Do not apply asphalt materials or place asphalt mixes when ground temperature is lower than 50 degrees F or air temperature is lower than 40 degrees F. Measure ground and air temperature in shaded areas away from heat sources or wet surfaces.

B. Moisture: Do not apply asphalt materials or place asphalt mixes when application surface is wet.

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PART 2 PRODUCTS

2.01 MATERIALS

A. Shall be listed in ODOT Qualified Products List.

2.02 ASPHALT CONCRETE MIX

A. General:

1. Mix formula shall not be modified except with written approval of Engineer.
2. Source Changes:
   a. Should material source(s) change, establish new asphalt concrete mix formula before new material(s) is used.
   b. Perform check tests of properties of plant-mix bituminous materials on first day of production and as requested by Engineer to confirm that properties are in compliance with design criteria.
   c. Make adjustments in gradation or asphalt content as necessary to meet design criteria.

A. Informational Submittals:

1. Asphalt Concrete Mix Formula:
   a. Submit minimum of 7 days prior to start of production.
   b. Submittal to include the following information:
      1) Gradation and portion for each aggregate constituent used in mixture to produce a single gradation of aggregate within specified limits.
      2) Bulk specific gravity for each aggregate constituent.
      3) Measured maximum specific gravity of mix at optimum asphalt content determined in accordance with ASTM D2041.
      4) Properties as stated in Standard Specifications Section 411 and Section 708.
      5) Percent of asphalt lost due to absorption by aggregate.
      6) Index of Retained Strength (TSR) at optimum asphalt content as determined by AASHTO T283.
      7) Percentage of asphalt cement, to nearest 0.1 percent, to be added to mixture.
      8) Optimum mixing temperature.
      9) Optimum compaction temperature.
      10) Temperature-viscosity curve of asphalt cement to be used.
      11) Brand name of any additive to be used and percentage added to mixture.

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2. Test Report for Asphalt Cement:
   a. Submit minimum 10 days prior to start of production.
   b. Show appropriate test method(s) for each material and the test results.
3. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for the following materials:
   a. Aggregate: Gradation and source test results as defined in Standard Specifications Section 701.
   b. Asphalt for Binder: Type, grade, and viscosity-temperature curve.
   c. Prime Coat: Type and grade of asphalt.
   d. Tack Coat: Type and grade of asphalt.
   e. Additives.
   f. Mix: Conforms to job-mix formula.
4. Statement of qualification for independent testing laboratory.
5. Test Results:
   a. Mix design.
   b. Asphalt concrete core.
   c. Gradation and asphalt content of uncompacted mix.

B. Composition: Hot-plant mix of aggregate, mineral filler if required, and paving grade asphalt cement. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that resulting mixture meets grading requirements of mix formula.

C. Aggregate:

1. General: As specified in Section 708 of the Standard Specifications; however, RAP material will not be acceptable.

D. Mineral Filler: In accordance with Standard Specifications Section 708.

E. Asphalt Cement: Paving Grade 70-28 as specified in Standard Specifications Section 708.

PART 3 EXECUTION

3.01 GENERAL

A. Traffic Control:

1. In accordance with Section 01 50 00, Temporary Facilities and Controls.
2. Minimize inconvenience to traffic but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt.

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B. Driveways: Repave driveways from which pavement was removed. Leave driveways in as good or better condition than before start of construction.

3.02 LINE AND GRADE

A. Provide and maintain intermediate control of line and grade, independent of underlying base, to meet finish surface grades and minimum thickness.

B. Shoulders: Construct to line, grade, and cross-section shown.

3.03 PREPARATION

A. Prepare subgrade as specified in Standard Specifications Section 310.

B. Existing Roadway:

1. Modify profile by grinding, milling, or overlay methods as approved, to provide meet lines and surfaces and to produce smooth riding connection to existing facility.
2. Remove existing material to a minimum depth of 1-inch (25 millimeters).
3. Paint edges of meet line with tack coat prior to placing new pavement.

C. Thoroughly coat edges of contact surfaces (curbs, manhole frames) with emulsified asphalt or asphalt cement prior to laying new pavement. Prevent staining of adjacent surfaces.

3.04 PAVEMENT APPLICATION

A. General: Place asphalt concrete mixture on approved, prepared base in conformance with Standard Specifications Section 310.

B. Prime Coat:

1. Heat cutback asphalt as specified in Standard Specifications Section 408 prior to application.
2. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.
3. Do not apply when moisture content of upper 3 inches of base exceeds optimum moisture content of base, or if free moisture is present.
4. Application Rate: 0.15 gallon to 0.50 gallon per square yard of surface area.
5. Remove or redistribute excess material.

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C. Tack Coat:

1. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.
2. Do not apply more tack coat than necessary for the day's paving operation.
3. Touch up missed or lightly coated surfaces and remove excess material.
4. Application Rate: 0.05 gallon per square yard to 0.15 gallon per square yard of asphalt (residual if diluted emulsified asphalt).

D. Pavement Mix:

1. Prior to Paving:
   a. Sweep primed surface free of dirt, dust, or other foreign matter.
   b. Patch holes in primed surface with asphalt concrete pavement mix.
   c. Blot excess prime material with sand.
2. Place asphalt concrete pavement mix in two equal lifts.
3. Compacted Lift Thickness:
   a. Minimum: Twice maximum aggregate size, but in no case less than 1-inch.
   b. Maximum: 4 inches.
4. Total Compacted Thickness: As shown on plans.
5. Sequence placement so that meet lines are straight and edges are vertical.
6. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.
7. Joints:
   a. Offset edge of each layer a minimum of 6 inches so joints are not directly over those in underlying layer.
   b. Offset longitudinal joints in roadway pavements so longitudinal joints in wearing layer coincide with pavement centerlines and lane divider lines.
   c. Form transverse joints by cutting back on previous day's run to expose full vertical depth of layer.
8. Succeeding Lifts: Apply tack coat to pavement surface between each lift.
9. After placement of pavement, seal meet line by painting a minimum of 6 inches on each side of joint with cutback or emulsified asphalt. Cover immediately with sand.

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E. Compaction:

1. Roll until roller marks are eliminated and minimum density of 94 percent of the Maximum Theoretical Density is obtained. Conform to Standard Specifications Section 411.
2. Joint Compaction:
   a. Cut back previously compacted mixture when Work is resumed to produce slightly beveled edge for full thickness of layer.
   b. Cut away waste material and lay new mix against fresh cut.

F. Seal Coat:

1. General: Apply seal coat of paving grade or emulsified asphalt to finished surface at longitudinal and transverse joints, joints at abutting pavements, areas where asphalt concrete was placed by hand, patched surfaces, and other areas as directed by Engineer.
2. Preparation:
   a. Surfaces that are to be sealed shall be maintained free of holes, dry, and clean of dust and loose material.
   b. Seal in dry weather and when temperature is above 35 degrees F.
3. Application:
   a. Fill cracks over 1/16-inch in width with asphalt-sand slurry or approved crack sealer prior to sealing.
   b. When sealing patched surfaces and joints with existing pavements, extend minimum 6 inches beyond edges of patches.

3.05 PAVEMENT OVERLAY

A. Preparation:

1. Remove fatty asphalt, grease drippings, dust, and other deleterious matter.
2. Surface Depressions: Fill with asphalt concrete mix, and thoroughly compact.
3. Damaged Areas: Remove broken or deteriorated asphalt concrete and patch as specified in Article Patching.
4. Portland Cement Concrete Joints: Remove joint filler to minimum 1/2-inch below surface.

B. Application:

1. Tack Coat: As specified in this section.
2. Place and compact asphalt concrete as specified in Article Pavement Application.

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3. Place first layer to include widening of pavement and leveling of irregularities in surface of existing pavement.
4. When leveling irregular surfaces and raising low areas, the actual compacted thickness of any one lift shall not exceed 2 inches.
5. Actual compacted thickness of intermittent areas of 120 square yards or less may exceed 2 inches, but not 4 inches.
6. Final wearing layer shall be of uniform thickness and meet grade and cross-section as shown.

3.06 PATCHING

A. Preparation:

1. Remove damaged, broken, or unsound asphalt concrete adjacent to patches. Trim to straight lines exposing smooth, sound, vertical edges.
2. Prepare patch subgrade as specified in Standard Specifications Section 310.

B. Application:

1. Patch Thickness: 3 inches or thickness of adjacent asphalt concrete, whichever is greater.
2. Place asphalt concrete mix across full width of patch in layers of equal thickness.
3. Spread and grade asphalt concrete with hand tools or mechanical spreader, depending on size of area to be patched.

C. Compaction:

1. Roll patches with power rollers capable of providing compression of 200 pounds per linear inch to 300 pounds per linear inch. Use hand tampers where rolling is impractical.
2. Begin rolling top course at edges of patches, lapping adjacent asphalt surface at least one-half the roller width. Progress toward center of patch overlapping each preceding track by at least one-half width of roller.
3. Make sufficient passes over entire area to remove roller marks and to produce desired finished surface.

D. Tolerances:

1. Finished surface shall be flush with and match grade, slope, and crown of adjacent surface.
2. Tolerance: Surface smoothness shall not deviate more than plus 1/4-inch or minus 0-inch when straightedge is laid across patched area between edges of new pavement and surface of old surfacing.

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3.07 FIELD QUALITY CONTROL

A. General: Provide services of approved certified independent testing laboratory to conduct tests. Testing laboratory shall be certified meeting the requirements of ASTM E329.

B. Sampling for quality control shall conform to ASTM D979.

C. Field Density Tests:

1. Perform tests from cores or sawed samples in accordance with AASHTO T166.
2. Measure with properly operating and calibrated nuclear density gauge in accordance with ASTM D2950.
3. Maximum Density: In accordance with ASTM D2041, using sample of mix taken prior to compaction from same location as density test sample.

D. Testing Frequency:

1. Quality Control Tests:
   a. Asphalt Content, Aggregate Gradation: Once per every 500 tons of mix or once every 4 hours, whichever is greater.
   b. Mix Design Properties, Measured Maximum (Rice's) Specific Gravity: Once every 1,000 tons or once every 8 hours, whichever is greater.
2. Density Tests: Once every 2,000 square feet of pavement.

END OF SECTION

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SECTION 32 13 13
CONCRETE PAVING

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).
   a. M6, Standard Specification for Fine Aggregate for Portland Cement Concrete.
   b. M80, Standard Specification for Coarse Aggregate for Portland Cement Concrete.
   c. M153, Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
   d. M157, Standard Specification for Ready-Mixed Concrete.
   e. M213, Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
   f. M227/M227M, Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.
2. American Concrete Institute (ACI):
   a. 305R, Hot Weather Concreting.
   b. 306R, Cold Weather Concreting.
   c. 308, Standard Practice for Curing Concrete.
   d. 318/318R, Building Code Requirements for Structural Concrete and Commentary.
   e. 325.9R, Guide for Construction of Concrete Pavements and Concrete Bases.
3. ASTM International (ASTM):
   a. A615/A615M, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   b. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   c. C33, Specification for Concrete Aggregates.
   d. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   e. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

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f. C78, Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
g. C88, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
h. C94/C94M, Standard Specification for Ready-Mixed Concrete.
i. C143/C143M, Standard Test Method for Slump of Hydraulic Cement Concrete.
j. C150, Specification for Portland Cement.
k. C172, Standard Practice for Sampling Freshly Mixed Concrete.
l. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
m. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
n. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
o. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
p. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
q. C803/C803M, Test Method for Penetration Resistance of Hardened Concrete.
r. C1330, Specification for Cylindrical Seal Backing for Use With Cold Liquid Applied Sealants.
s. C805, Test Method for Rebound Number of Hardened Concrete.
t. D920, Standard Specification for Elastomeric Joint Seals.
u. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
v. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
w. D1752, Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
x. D2628, Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete.
y. D2828, Specification for Non-Bituminous Inserts for Contraction Joints in Portland Cement Concrete Airfield Pavements, Sawable Type.
z. D3406, Specification for Joint Sealant, Hot-Applied, Elastomeric-Type, for Portland Cement Concrete Pavements.
aa. D3569, Specification for Joint Sealant, Hot-Applied, Elastomeric, Jet-Fuel-Resistant Type for Portland Cement Concrete Pavements.

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bb. D3581, Specification for Joint Sealant, Hot-Applied, Jet-Fuel-Resistant-Type, for Portland Cement and Tar-Concrete Pavements.
cc. D5249, Specification for Backer Material for Use With Cold- and Hot-Applied Joint Sealants in Portland Cement Concrete and Asphalt Joints.
dd. D5893, Specification for Cold-Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.
ee. E329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

4. National Ready Mixed Concrete Association (NRMCA).
5. Oklahoma Department of Transportation (ODOT):
   a. Standard Specifications (2019).
   b. Qualified Products List.

1.02 DEFINITIONS

A. Standard Specification: ODOT Standard Specifications (2019).

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data: Admixtures.
2. Design Data:
   a. Concrete mix design signed by concrete mix designer.
   b. Minimum Information:
      1) Name of ready-mix plant.
      2) Project.
      3) Engineer.
      4) Contractor.
      5) Mix design number.
      6) Specified concrete strength.
      7) Water-cement-fly ash ratio.
      8) Maximum aggregate size.
      9) Cement content.
      10) Fly ash content.
      11) Water content.
      12) Type, name, and amount of admixtures.
      13) Unit weight.
      14) Slump.
      15) Ingredient proportions corrected for average moisture content for particular times of year.

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3. Jointing Drawings: Identify location and spacing of each type of joint.
4. Gradation for coarse and fine aggregates, and combined gradation. List percent passing each sieve size.
5. Detailed plan for cold weather placements, including curing and protection.
6. Detailed plans for hot weather placements, including curing and protection.

B. Informational Submittals:

1. Manufacturers' Certificate of Compliance:
   a. Portland cement.
   b. Admixtures.
   c. Fly ash.
   d. Aggregates.
2. Statements of Qualifications:
   a. Mix designer.
   b. Batch plant.
   c. Testing laboratory.
3. Test Reports:
   a. Admixtures: Chemical ingredients and percentage of chloride in each admixture and fly ash.
   b. Fly Ash: Source test analysis and amount used in accordance with ASTM C94/C94M, Section 16.
   c. Mix Design: For each trial, signed by qualified mix designer.
   d. Laboratory Mixes: Cylinder test results.
4. Concrete Delivery Tickets:
   a. For each batch of concrete before unloading at Site.
   b. Minimum Delivery Ticket Information:
      1) Name of ready-mix plant.
      2) Serial number of ticket.
      3) Date and truck number.
      4) Name of Contractor.
      5) Job name and location.
      6) Mix design number.
      7) Amount of concrete (cubic yards).
      8) Type and amount of admixtures.
      9) Amount of water added at batch plant.
      10) Time of loading, arriving at Site, and unloading.
      11) Volume of water added by receiver of concrete and their initials.
   c. Record of drum revolution counter, type, and brand.

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1.04 QUALITY ASSURANCE

A. Qualifications:

1. Mix Designer: Licensed professional engineer registered in the state of Project or a certified concrete mix designer approved by local Department of Transportation.
2. Testing or Inspection Agency: In conformance with ASTM E329.
3. Batch Plant: Currently certified by the National Ready Mixed Concrete Association.

B. Prepaving Conference:

1. Held between Contractor, Subcontractor involved in concrete paving, and Engineer.
2. To be conducted a minimum of 14 days prior to commencing paving.
3. Conference cannot be held until mix design and admixture Submittals have been received by Engineer.
4. Items to discuss shall include, but not be limited to:
    a. Mix design.
    b. Method of placement.
    c. Curing.
    d. Finishing schedule.
    e. Traffic control.
    f. Protection of work.

C. Hot Weather Concreting: Conform to ACI 305R.

D. Cold Weather Concreting: Conform to ACI 306R.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Transporting of ready-mix concrete shall be in accordance with ASTM C94/C94M.

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PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Materials shall be listed in Qualified Products List.

B. Cement:

1. Furnish cement for Project from one source.
2. Portland cement shall be Type II meeting the requirements of Section 701 of the Standard Specifications.
3. In accordance with ASTM C150.
4. Pozzolan: Shall meet requirements of Section 702 of the Standard Specifications.

C. Aggregates:

1. General:
   a. Aggregate for portland cement concrete mixture shall be 1-inch maximum size stone meeting requirements of Section 701 of the Standard Specification.
   b. Material: Natural aggregates, free from deleterious coatings.
   c. Aggregates shall not be potentially reactive as defined in ASTM C33.
   d. Aggregates not in compliance with soundness and durability requirements of ASTM C33 may be used with prior approval of Engineer; provided it can be shown by special testing or record of past performance that these aggregates produce concrete of adequate strength and durability. Aggregate soundness testing for fine and coarse aggregates shall be in accordance with ASTM C33 and ASTM C88.
2. Fine Aggregates: Must be graded coarse to fine within the limits given in Section 701 of the Standard Specifications.
3. Coarse Aggregate: Per Section 701 of the Standard Specifications for Class A Concrete.

D. Physical Properties: In accordance with Section 703 of the Standard Specifications.

E. Water: ASTM C94/C94M.

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F. Admixtures:

1. Add admixtures to mix at batch plant.
2. Air Entraining: ASTM C260.
3. Water Reducing:
   a. ASTM C494/C494M, Type A or Type D containing no chlorides and compatible with air-entraining admixtures.
   b. Do not use calcium chloride, salt, or antifreeze agents.

2.02 ANCILLARY MATERIALS

A. Tie Bars: Grade 40 deformed steel bars conforming to ASTM A615/A615M.

B. Dowels: Conform to requirements of AASHTO M227/M227M, Grade 70.

C. Joint Filler: Preformed expansion joint filler shall be listed in Qualified Products List.

D. Joint Sealant:

1. Preformed elastomeric joint seal conforming to Section 701.08 of the Standard Specifications.
2. Hot-poured elastomeric joint seal conforming to Section 701.08 of the Standard Specifications.
3. Cold-applied single component joint sealant conforming to ASTM D5893.
4. Elastomeric joint sealant conforming to ASTM C920.

E. Backer Rod:

1. Backer material conforming to ASTM D5249.
2. Cylindrical sealant backing conforming to ASTM C1330.

F. Curing Compound: ASTM C309, listed in Qualified Products List and suitable for spray application.

G. Curing Membranes:

1. White polyethylene sheeting.
2. Waterproof paper.
3. Cotton or jute mats.

H. Evaporation Retardant: Confilm as manufactured by Master Builders Company.

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2.03 EQUIPMENT

A. Ready-Mix Concrete Batch Plants: Certified by NRMCA.

B. Batch Plants:

1. Bins shall have adequate separate compartments for fine aggregate, each separate size of coarse aggregate and cement. Bins and compartments shall be tight and ample to prevent spilling from one bin to another. Separate compartments, including weighting hoppers, shall discharge freely and efficiently.
2. Scales for weighing aggregates and cement may be either beam type or springless dial type. They shall be accurate within 0.5 percent under operating conditions throughout the range of use and, tested and adjusted as often as Engineer may deem necessary to assure their continued accuracy.
3. Equipment for dispensing water and admixtures shall provide a separate feed, accurate quantity measurement, and shall inject water and admixture at a time in mixing process to ensure thorough and complete mixing throughout batch of portland cement concrete.
4. Automatically controlled batchers shall have automatically interlocked mechanisms providing the following:
    a. Positive weighing and discharge of cement and of each separate size of aggregate.
    b. Interlocking between weighing hoppers to prevent part of batch from being discharged until each separate hopper has been filled with correct proportion.
    c. Simultaneous discharge of hoppers.
    d. Lockable compartment containing time setting controls.
5. Equip mixers with a timing device that will not permit batch to be discharged until specified mixing time has elapsed. The means of storing, measuring, and introducing water into mixer shall provide positive control and accurate measurement.

C. Ready-Mix Concrete Trucks:

1. Agitator mixer type.
2. Equipped with operable electrically actuated drum revolution counters.
3. Use of nonagitator equipment will not be permitted.
4. Each mixer shall carry a clearly visible manufacturer’s plate showing capacity of mixer and other pertinent operating rates and limits.
5. Provision shall be made at mixer for controlled addition of air-entraining admixtures or other special components of mix.

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6. Mixing Speed: 70 to 100 revolutions at a mixing speed recommended by truck mixer manufacturer.

D. Hauling Equipment:

1. Hauling equipment shall conform to AASHTO M157, Paragraph 11.6 and Paragraph 12.
2. Upon delivery of each batch of concrete to Site, a trip ticket shall be submitted to Engineer.

E. Concrete Saws:

1. Provide power driven concrete saws for sawing joints or finishing concrete, adequate in number of units and power to complete sawing at required rate.
2. Saws and related equipment shall be of proven adequacy and design to perform efficiently and shall be subject to immediate replacement, if specified results are not obtained.
3. Standby saw shall be available at Site.

F. Smoothness Testing Equipment: Supply two 12-foot straightedges for determining smoothness.

2.04 CONCRETE MIX DESIGN

A. As specified in Section 710 of Standard Specifications, Hydraulic Cement Concrete, with a minimum flexural strength of 700 pounds per square inch.

B. Compressive strength of 4,000 pounds per square inch minimum and flexural strength of 700 pounds per square inch minimum, both at 28 days.

1. If the 700 pounds per square inch flexural strength specification requires a compressive strength in excess of 4,000 pounds per square inch, the higher compressive value shall be used as a standard minimum for compressive strength cylinder tests taken during construction.
2. The relationship between compressive strength f_c and modulus of rupture f_r shall be:

$$f_r = k\sqrt{f_c}$$

with k derived from the tests results.

C. Concrete target strengths shall be in accordance with ACI 318/318R.

D. Maximum water-cement ratio or water-cement plus pozzolan ratio, if applicable, shall not exceed 0.40.

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E. Replacement of cement with pozzolan shall not exceed 28 percent.

F. Maximum Aggregate Size: 1 inch minus.

G. Allowable Slump: 3 inches, plus or minus 1 inch.

H. Allowable Air Entrainment: 5 percent, plus or minus 1 percent by volume.

I. Concrete shall contain water reducer. Amount of admixture added to concrete shall be in accordance with manufacturer's written instructions.

J. Use of set-retarding admixtures shall be subject to prior approval by Engineer.

K. Do not use frozen materials or materials containing ice or snow.

L. Concrete temperature as delivered to Site ready for placement shall be above 50 degrees F and below 90 degrees F.

PART 3 EXECUTION

3.01 WEATHER LIMITATIONS

A. Concrete shall not be placed:

1. Until the air temperature in the shade is 35 degrees F and rising and is forecast to remain above 35 degrees F.
2. On frozen ground.
3. During periods of rain or snow.

B. Concrete placement shall not continue when air temperature drops below 40 degrees F.

C. Protect concrete pavement from inclement weather for 7 days after it has been placed, when rain is imminent, and when air temperature drops or is forecast to drop below 35 degrees F.

3.02 PREPARATION

A. Prepare base as specified in Section 32 11 23, Aggregate Base Courses.

B. Dampen base thoroughly prior to concrete placement; standing water will not be permitted.

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C. Formwork shall be complete prior to placement of concrete. Area in which concrete is to be placed, shall be smooth and free of ruts, projections, debris, spilled concrete, mud, sloughed soil, standing water, organic and other objectionable materials.

D. Construction Joints: Inspect prior to placement of concrete.

E. Prior to placing paving equipment in position, full width and length of the area on which the tracks of the paving equipment is to operate shall be brought to density and surface tolerances required.

F. Protect existing exposed surfaces such as grates, catch basins, air valves, manholes, and cleanout lids from splattered and spilled concrete during concrete placement by use of durable waterproof paper.

G. Furnish operable backup vibrator onsite prior to concrete placement.

3.03 STATIONARY SIDE FORM CONSTRUCTION

A. Defects:

1. Fill areas of minor honeycomb or other minor defect in composition of portland cement concrete along exposed edges of portland cement concrete with a stiff mortar of cement and fine aggregate. Apply to moistened portland cement concrete to satisfaction of Engineer.
2. Area showing serious defects in composition of concrete shall be removed and replaced with pavement of specified quality for full width of strip between longitudinal joints or edges and for a length not less than between the nearest transverse joints.

3.04 JOINTS

A. General:

1. Referred to as contraction or construction, either of which may be transverse or longitudinal, as called for by the Drawings or as approved by Engineer.
2. Joints, backer material, joint filler, and joint sealants shall extend to pavement edges or to each other, as the case may be, and shall be constructed perpendicular to surface of pavement.
3. Joints shall not vary from specified or indicated line by more than 1/4 inch.

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4. Contractor shall submit jointing plan and details to Engineer for approval. Take into consideration placement of joints in curb and gutter, at catch basins, and position of manholes and other large structures, as well as other limitations herein mentioned.
5. Place manhole or similar large structure in line of joint, or if impractical, isolate structure from pavement with premolded joint filler, 1/2 inch wide, conforming to AASHTO M213 and ASTM D1751.

B. Contraction Joints:

1. Sawed Type with Poured Filler:
   a. Sawing shall be to a depth as shown on the Drawings with a maximum width of 1/4 inch and a minimum width of 1/8 inch, in straight lines as shown or as approved by Engineer.
   b. Perform saw cuts as soon as portland cement concrete has set enough to permit sawing without tearing or raveling, before uncontrolled cracking results, and within 24 hours of placing portland cement concrete.
   c. Saws may be single or tandem, as Contractor may elect, and shall be controlled by guides to true line.
   d. Clean joints thoroughly of foreign matter before pouring approved rubber asphalt filler.
   e. Tops of joint filler shall be true to pavement cross-section within 1/8 inch and shall be protected from damage by portland cement concrete operations.
   f. Areas containing uncontrolled cracks shall be removed and replaced.
   g. Restore curing agents broken or damaged by sawing operations.
2. Space longitudinal joints as shown on the Drawings at the interface between lanes, normally at intervals between 12 feet to 16 feet.
3. Transverse joints shall be as shown on the Drawings or as approved by Engineer, with intervals of 12 feet to 16 feet.

C. Construction Joints:

1. Construct when there is an interruption of longer 45 minutes in portland cement concrete placing operations or where specified.
2. Place parallel with intended contraction joint.
3. Tool both free edges of joints with 1/8-inch radius rounder to remove laitance and mortar resulting from finishing operations and to provide clean rounded edge. Tooling shall not form ridges on surface of concrete.
4. New portland cement concrete placed contiguous to joint shall conform to proportions and consistency of previously placed concrete.

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5. Transverse Construction Joint:
   a. Doweled type using No. 8 by 36-inch long dowels at 12-inch centers coated with plastic, grease, heavy oil, or other approved material that will neither bond with nor be harmful to operation at a depth of 1/2 the pavement thickness parallel to centerline.
   b. If sufficient portland cement concrete has not been mixed at the time of interruption to place a construction joint at least 3 feet from a planned contraction joint, remove excess portland cement concrete back to a position to satisfactorily meet these criteria and to satisfaction of Engineer.
   c. Fill joint which has opened to a width of 1/8 inch or greater during construction or maintenance periods with poured filler.
   d. Do not construct within 3 feet of a transverse contraction joint.
6. Longitudinal Construction Joint:
   a. Tied type using No. 5 by 36-inch deformed tie bars at 12-inch centers.
   b. Tie Bars:
      1) Not required at construction joint between portland cement concrete pavement and gutter, except where shown on the Drawings and mentioned above.
      2) Placement:
         a) Plastic Portland Cement Concrete: Insert before vibrating and finishing portland cement concrete.
         b) Hardened Concrete:
            (1) Drill hole, insert, and grout tie bars into place.
            (2) Drill holes large and deep enough to allow tie bars to be inserted with grout.
            (3) Perform any time after portland cement concrete has attained enough strength to resist any damage caused by drilling.
            (4) Tie bars shall be grouted a maximum of 3 hours prior to placement of adjacent portland cement concrete.
      3) Replace loose tie bars by drilling and grouting as described.

D. Scored Joints:

1. Configuration: 1/4 inch wide by 1/4 inch deep at locations indicated on the Drawings formed by tooling of concrete while it is still fresh.
2. Do not fill or seal.
3. Layout of joints shall be straight and true and shall not vary from indicated line by more than 1/4 inch.

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3.05 SURFACE FINISHING

A. Use temporary screeds. Wet screeding and jitterbugging shall not be permitted.

B. Pavement shall have surface tolerance of 1/4 inch in 10 feet in accordance with ACI 325.9R.

C. Salting, spreading of cement or cement and sand mixture to speed up hardening shall not be permitted.

D. Exposed pavement edges shall be edged to a 1/2-inch radius after finishing. Edging shall not form ridges on pavement surface.

E. Pavement shall be treated and protected by use of evaporation retardant applied in accordance with manufacturer's written instructions. Flat surfaces shall be treated immediately after screeding and floating or if time period greater than 15 minutes occurs between finishing operations.

F. Pavement shall be screeded, floated, and given tine skid-resistant surface.

1. Tine Finish: Achieve by dragging a mechanical device or hand tool equipped with a tining head, such as a metal rake across width of pavement. Tines shall be space 1/2 inch to 1-1/2 inches with no more than 50 percent greater than 1 inch and shall be 1/8 inch to 1/4 inch deep and 1/8 inch wide.

3.06 CURING OF PORTLAND CEMENT CONCRETE

A. Immediately after the final floating, surface finishing, and edging has been completed, and while portland cement concrete surface is still moist, cover and cure entire exposed surface for at least 72 hours in accordance with one of the following provisions:

1. Liquid Membrane-Forming Compounds: Apply compound uniformly to portland cement concrete by pressure spray methods at a rate which will form an impervious membrane, but at least at a rate of 1 gallon per 150 square feet.
2. Other Membranes:
    a. Apply to damp portland cement concrete as soon as it can be placed without marring surface.
    b. Place in contact with surface, extend beyond sides or edges of slabs or forms, and fasten down to hold it in position as a waterproof and moisture proof covering.

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c. Laps shall be sufficient to maintain tightness equivalent to sheeting.
d. Transverse laps for waterproof paper shall be at least 18 inches, and longitudinal seams shall be cemented.
e. Cotton or jute mats shall be saturated with water prior to placing and kept fully wetted during curing period.

B. Concrete shall be cured by use of curing compound, for minimum of 7 days after concrete placement, in accordance with ACI 308. Curing compounds shall be applied in accordance with manufacturer's written instructions.

C. Exposed surfaces shall be sprayed with curing compound immediately after free surface water has disappeared from finished surface.

D. Concrete temperature shall be maintained in accordance with ACI 306R.

E. Curing compounds shall not come in contact with hardened concrete that is to be concreted against.

3.07 FIELD QUALITY CONTROL

A. Retain independent testing or inspection agency to perform inspection, sampling, and testing.

B. Concrete Sampling: In accordance with ASTM C172. Take sample not less than every 5,000 square feet or fraction thereof of concrete placed each day.

C. Perform following tests on each sampling:

1. Slump: ASTM C143/C143M.
2. Air Content: ASTM C231.
3. Compressive Strength: ASTM C39/C39M.
4. Flexural Strength: ASTM C78.

D. Strength Tests:

1. Make and cure cylinders and beams in accordance with ASTM C31/C31M.
2. Cylinders: Make four, standard 6 inches diameter by 12 inches high. Cure one in field and three in laboratory.
3. Beams: Make three, standard 6 inches by 6 inches by 21 inches. Cure in field.

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4. Compressive: Test one field-cured cylinder at 7 days and two laboratory-cured cylinders at 28 days. Test last cylinder at 56 days if 28-day cylinder is below specified strength.
5. Flexural: Test one beam at 7 days and two beams at 28 days.

E. Acceptance of concrete shall be in accordance with ACI 318/318R.

F. Concrete with compressive strength less than specified, as evidenced by cylinder tested at 56 days, shall be additionally tested as follows:

1. Less Than 500 pounds per square inch Low in Compression or Less Than 75 pounds per square inch Low in Flexure:
   a. Penetration Resistance Test: ASTM C803.
   b. Rebound Hammer Test: ASTM C805.
   c. Perform tests within 24 hours of noncomplying strength tests.
2. More Than 500 pounds per square inch Low in Compression or More Than 75 pounds per square inch Low in Flexure:
   a. Concrete Coring: Take three standard cores from concrete representing original specimens.
   b. Take and prepare cores in accordance with ASTM C42/C42M.
   c. Test cores in accordance with ASTM C39/C39M.
   d. Take cores within 24 hours of noncomplying strength test.

G. Pay Factor:

1. Portland cement concrete shall be accepted according to average compressive strengths of four or more cylinders taken for 28-day tests for each 500 cubic yards placed and the following acceptance schedule.

Acceptance Schedule Compressive Strength	
Pay Factor	**Percent of Specified Strength**
1.00	95 percent or higher
0.90	90 to 95 percent
0.70	80 to 90 percent
Remove and replace	Less than 80

2. Whenever percentage of specified compressive strength falls below the level of 80 percent, Engineer may require the portland cement concrete be removed and replaced to meet required Specifications.

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3. If the compressive strength, f_c, to comply with the flexural strength requirement is greater than 4,000 pounds per square inch, then the specified strength shall be multiplied by:

$$\frac{F_c}{4000}$$

3.08 CLEANING

A. Clean concrete splatter from exposed surfaces.

B. Thoroughly broom and wash concrete surfaces before opening to traffic.

3.09 PROTECTION OF CONCRETE

A. Do not operate construction equipment or allow traffic on newly placed portland cement concrete until the following requirements are met:

1. Joints have been filled as per Article Joints.
2. Concrete has attained a compressive strength of at least 4,000 pounds per square inch.

B. Protect new concrete from construction operations, mechanical disturbances, water flow, and soiling until open for traffic.

C. Erect and maintain suitable barriers to protect concrete from traffic or other detrimental trespass until pavement is opened to traffic.

D. Maintain watchmen after normal working hours for at least a 24-hour period to ensure barriers are not removed or destroyed, and that trespass and vandalism upon pavement does not occur.

E. Wherever it is necessary that traffic, including Contractor's vehicles and equipment, be carried from one side of pavement to the other, construct suitable bridges over pavement, and maintain them in good condition as long as they may be required. Leaving gaps in pavement to facilitate movement of traffic will not be allowed, unless prior written permission is obtained from Engineer.

F. Protect new concrete from dirt, asphalt, and other deleterious substances that may be tracked onto new pavement from construction activities.

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G. Pavement damaged by traffic or damaged from any other cause, prior to its official acceptance, shall be repaired or replaced to the satisfaction of Engineer.

END OF SECTION

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SECTION 33 05 01
CONVEYANCE PIPING—GENERAL

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): 301, Specifications for Structural Concrete.
2. American Water Works Association (AWWA):
   a. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
   b. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   c. C207, Steel Pipe Flanges for Waterworks Service - Sizes 4 in. Through 144 in. (100 mm Through 3,600 mm).
   d. C210 Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
   e. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   f. C217, Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines.
   g. C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
   h. C221, Fabricated Steel Mechanical Slip-Type Expansion Joints.
   i. C606, Grooved and Shouldered Joints.
3. ASTM International (ASTM):
   a. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
   b. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   c. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   d. C150/C150M, Standard Specification for Portland Cement.
   e. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
4. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

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1.02 SUBMITTALS

A. Action Submittals:

1. Detailed pipe fabrication drawings showing pipe details, special fittings and bends, dimensions, coatings, and other pertinent information.
2. Layout drawing showing location of each pipe section and each special length.
3. Pipe pressure class.

B. Informational Submittals: Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.

1.03 DELIVERY, STORAGE, AND HANDLING

A. In accordance with manufacturer's recommendations and as specified in individual Specification(s) following this section.

B. Marking at Plant: Mark each pipe and fitting at plant. Include date of manufacture, manufacturer's identification, specification standard, diameter of pipe dimension ratio, pipe class, pipe number for laying purposes, and other information required for type of pipe.

C. Pipe, specials, and fittings received at Project Site in damaged condition will not be accepted.

D. Gasket Storage: Store rubber gaskets in cool, well-ventilated place, and do not expose to direct rays of sun. Do not allow contact with oils, fuels, petroleum, or solvents.

E. Store and support pipe securely to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.

F. Handling:

1. Pipe shall be handled with proper equipment in a manner to prevent distortion or damage. Use of hooks, chains, wire ropes, or clamps that could damage pipe, damage coating or lining, or kink and bend pipe ends is not permitted.
2. Use heavy canvas, or nylon slings of suitable strength for lifting and supporting materials.
3. Lifting pipe during unloading or lifting into trench shall be done using two slings placed at quarter point of pipe section. Pipe may be lifted using one sling near center of pipe, provided pipe is guided to prevent

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uncontrolled swinging and no damage will result to pipe or harm to workers. Slings shall bear uniformly against pipe.

4. Pipe and fittings shall not be stored on rocks or gravel, or other hard material that might damage pipe. This includes storage area and along pipe trench.

PART 2 PRODUCTS

2.01 GENERAL

A. 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 PIPE

A. As specified in the individual specification(s) following this section.

2.03 JOINTS

A. As specified in the individual specification(s) following this section.

2.04 CONCRETE FOR THRUST BLOCKS

A. Thrust Block Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.

B. Reinforcing Steel: ASTM A615/A615M, Grade 60 deformed bars.

C. Welded Wire Fabric: ASTM A497/A497M.

D. Formwork: Plywood; earth cuts may be used as approved by Engineer.

2.05 PIPE LOCATING TAPE

A. As specified in Section 31 23 23.15, Trench Backfill.

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2.06 PIPE BEDDING AND PIPE ZONE MATERIAL

A. Granular material as specified in Section 31 23 23.15, Trench Backfill.

2.07 TRENCH STABILIZATION MATERIAL

A. As specified in Section 31 23 23.15, Trench Backfill.

PART 3 EXECUTION

3.01 GENERAL

A. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.

B. Furnish feeler gauges of proper size, type, and shape for use during installation for each type of pipe furnished.

C. Distributing Materials: Place materials along trench only as will be used each day, unless otherwise approved by Engineer. Placement of materials shall not be hazardous to traffic or to general public, obstruct access to adjacent property, or obstruct others working in area.

3.02 EXAMINATION

A. Verify size, material, joint types, elevation, and horizontal location of existing pipeline to be connected to new pipeline or new equipment.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

C. Damaged Coatings and Linings: Repair using coating and lining materials in accordance with manufacturer’s instructions.

3.03 PREPARATION OF TRENCH

A. Prepare trench per City of Tulsa Standard Specifications.

3.04 INSTALLATION

A. General:

1. Join pipe and fittings in accordance with manufacturer’s instructions, unless otherwise shown or specified.
2. Install individual pipe lengths in accordance with approved lay diagram. Misplaced pipe shall be removed and replaced.

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3. Inspect pipe and fittings before installation, clean ends thoroughly, remove foreign matter and dirt from inside.
4. Flanged Joints:
    a. Install perpendicular to pipe centerline.
    b. Bolt Holes: Straddle vertical centerline, aligned with connecting equipment flanges or as shown on the Drawings.
    c. Use torque-limiting wrenches to provide uniform bearing and proper bolt tightness.
    d. Flange Type: Use flat-faced flange when joining with flat-faced ductile or cast iron flange.

B. Buried Pressure Pipe:

1. Concrete Encased or Embedded Pipe: Do not encase joints in concrete, unless specifically shown on the Drawings.
2. Placement:
    a. Keep trench dry until pipe laying and joining is completed.
    b. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
    c. Measure for grade at pipe invert, not at top of pipe.
    d. Excavate trench bottom and sides of ample dimensions to permit proper joining, welding, visual inspection, and testing of entire joint.
    e. Prevent foreign material from entering pipe during placement.
    f. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.
    g. In general, lay pipe upgrade with bell ends pointing in direction of laying.
    h. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
        1) Shorter pipe lengths.
        2) Special mitered joints.
        3) Standard or special fabricated bends.
    i. Check gasket position with feeler gauge to assure proper seating.
    j. After joint has been made, check pipe alignment and grade.
    k. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
    l. Prevent uplift and floating of pipe prior to backfilling.
3. Tolerances:
    a. Deflection From Horizontal Line: Maximum 2 inches.
    b. Deflection From Vertical Line: Maximum 1 inch.

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c. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.
d. Horizontal position of pipe centerline on alignment around curves maximum variation of 1 foot from position shown.

4. Cover Over Top of Pipe: Minimum 2 feet, unless otherwise shown.

3.05 THRUST RESTRAINT

A. Location: At pipeline tees, plugs, caps, bends, and locations where unbalanced forces exist.

B. Thrust Blocking:

1. Place only where shown on the Drawings.
2. Quantity of Concrete: Sufficient to cover bearing area of pipe and provide required soil bearing area as shown on the Drawings.
3. Place blocking so pipe and fitting joints are accessible for repairs.
4. Place concrete in accordance with Section 03 30 00, Cast-in-Place Concrete.

3.06 PLACEMENT OF PIPE LOCATING TAPE

A. Place pipe locating tape in accordance with Section 31 23 23.15, Trench Backfill.

3.07 PIPE BEDDING AND ZONE MATERIAL

A. Place pipe bedding and pipe zone material in accordance with Section 31 23 23.15, Trench Backfill.

3.08 FIELD QUALITY CONTROL

A. Pressure Leakage Testing: As specified in the individual specification(s) following this section.

3.09 CLEANING AND DISINFECTION

A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines with water at 2.5 fps minimum flushing velocity until foreign matter is removed. Dispose of water and flushed foreign matter.

B. Remove accumulated debris through blowoffs 2 inches and larger or by removing spools and valves from piping.

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C. Disinfection: As specified in Section 33 13 00, Disinfection of Water Utility Distribution Facilities.

END OF SECTION

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SECTION 33 05 01.09
POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Water Works Association (AWWA):
   a. C110, Ductile-Iron and Gray-Iron Fittings.
   b. C153, Ductile-Iron Compact Fittings, for Water Service.
   c. C605, Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.
   d. C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inches Through 12 Inches (100 mm Through 300 mm), for Water Transmission and Distribution.
   e. C905, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 Inches through 48 Inches (350 mm through 1,200 mm) for Water Transmission and Distribution.
   f. C907, Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 Inches through 12 Inches (100 mm Through 300 mm), for Water, Wastewater, and Reclaimed Water Service.
2. ASTM International (ASTM):
   a. D2241, Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
   b. D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
   c. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   d. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   e. D2672, Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement.
   f. D2855, Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
   g. D3139, Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
3. NSF International (NSF).

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1.02 SUBMITTALS

A. Action Submittals: Drawings showing pipe diameter, pipe class, dimension ratio (DR) and fitting details.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
2. Hydrostatic Testing Plan:
   a. Submit at least 15 days prior to testing and at minimum, include the following:
      1) Testing dates.
      2) Piping systems and section(s) to be tested.
      3) Method of isolation.
      4) Method of conveying water from source to system being tested.
      5) Method of disposing of test water.
      6) Calculation of maximum allowable leakage for piping section(s) to be tested.
3. Certification of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
4. Test report documentation.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Solvent Cement: Store in accordance with ASTM D2855.

PART 2 PRODUCTS

2.01 MATERIALS

A. Pipe:

1. PVC, conforming to requirements of AWWA C900.
2. DR shall be 14.
3. Pipe to be used for potable water conveyance shall meet the requirements of NSF 61.

B. Joints:

1. Rubber gasketed.
2. Conform to AWWA C900.

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C. Fittings: Ductile iron, conforming to AWWA C153 or AWWA C110.

D. Restrained Joints:

1. Provide pipe restraint, where indicated on the Drawings, by system designed specifically for use with PVC pipe using wedges. Do not use systems with set screws, gripper rings, or gripper gaskets.
2. Minimum Pressure Rating: 125 psi.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with AWWA C605.

B. Solvent cement used for joints as recommended by pipe manufacturer.

C. Joints:

1. Rubber Gasketed: In accordance with manufacturer's written instructions.
2. Solvent Cemented: In accordance with ASTM D2855.
3. Restrained Joint Systems: In accordance with manufacturer's written instructions.

D. Pipe Bending for Horizontal or Vertical Curves:

1. Bending of pipe barrels larger than 12 inches in diameter is not allowed.
2. Radius of curves shall not exceed 75 percent of manufacturer's recommended values.
3. Use blocks or braces at pipe joints to ensure axial deflection in gasketed or mechanical joints does not exceed allowable deflection.

E. Maximum Joint Deflection at Mechanical Joint: 75 percent of manufacturer's recommended values.

F. No deflection is allowed at push-on joints.

3.02 INSPECTION AND HYDROSTATIC TESTING

A. General:

1. Notify Engineer in writing at least 5 days in advance of testing. Perform testing in presence of Engineer.
2. Using water as test medium, all newly installed pipelines must successfully pass hydrostatic leakage test prior to acceptance.

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3. Conduct field hydrostatic test on buried piping after trench has been completely backfilled and compacted. Testing may, as approved by Engineer, be done prior to placement of asphaltic concrete or roadway structural section.
4. Contractor may, if field conditions permit and as approved by Engineer, partially backfill trench and leave joints open for inspection and conduct an initial informal service leak test. Final field hydrostatic test shall not, however, be conducted until backfilling has been completed as specified above.
5. Supply of Temporary Water: In accordance with Section 01 50 00, Temporary Facilities and Controls.
6. Dispose of water used in testing in accordance with federal, state, and local requirements.
7. Install temporary thrust blocking or other restraint as necessary to prevent movement of pipe and protect adjacent piping or equipment. Make necessary taps in piping prior to testing.
8. Wait a minimum of 5 days after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
9. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
10. New Piping Connected to Existing Piping:
    a. Isolate new piping with grooved-end pipe caps, blind flanges, or other means as acceptable to Engineer.
    b. Provide appropriate thrust blocking.

B. Hydrostatic Testing Procedure:

1. Furnish testing equipment, as approved by Engineer, which provides observable and accurate measurements of leakage under specified conditions.
2. Maximum Filling Velocity: 0.25 foot per second calculated based on full area of pipe.
3. Expel air from piping system during filling.
4. Test Pressure: 125 psi as measured at low point of pipeline.
5. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
6. Maintain hydrostatic test pressure continuously for 2 hours minimum, adding make-up water only as necessary to restore test pressure to within 5 psi of specified hydrostatic test pressure.
7. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

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C. Maximum Allowable Leakage:

$$L = \frac{ND(P)^{1/2}}{7400}$$

where:

L = Allowable leakage, in gallons per hour.
N = Number of joints in tested line.
D = Nominal diameter of pipe, in inches.
P = Average test pressure during leakage test, in pounds per square inch.

END OF SECTION

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SECTION 33 12 19
WATER UTILITY DISTRIBUTION FIRE HYDRANTS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Water Works Association (AWWA):
   a. C502, Dry-Barrel Fire Hydrants.
   b. C503, Wet Barrel Fire Hydrants.
   c. C600, Installation of Ductile-Iron Mains and Their Appurtenances.
2. ASTM International (ASTM): C94, Standard Specification for Ready-Mixed Concrete.
3. FM Global Approved.
4. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
5. UL: 246, Standard for Hydrants for Fire-Protection Service.

1.02 SUBMITTALS

A. Action Submittals: Catalog cuts of system components.

1. Include calculations for thrust blocks for high-pressure installations (if required).

B. Informational Submittal:

1. Certificate of Compliance: Upon completion of the system installation, verify all fire department hose connections, and check all fire safety devices to ensure their readiness for emergency connection and operation.

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PART 2 PRODUCTS

2.01 GENERAL

A. 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 HIGH PRESSURE HYDRANTS

A. Hydrant:

1. Safety top type.
2. Nominal 5-1/4-inch main valve opening with 6-inch bottom connections.
3. Conform to AWWA C502, except working pressure of 250 pounds per square inch.
4. Two 2-1/2-inch hose nozzles.
5. One 4-1/2-inch pumper nozzle.
6. Operating Nut: 1-1/2-inch National Standard pentagon nut.
7. Mechanical joint inlet connection.
8. Red aboveground line.
9. Manufacturers and Product:
   a. Mueller Co.
   b. American; Valve.

B. Main Valve:

1. Depth of bury 2 feet.
2. Equip with O-ring seals.
3. Valve opens on counterclockwise rotation.

2.03 PRECAST CONCRETE PIER BLOCK

A. Nominal dimensions of 8-inch thickness by 16-inch square base.

B. Compressive Strength: 3,000 pounds per square inch at 28 days.

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2.04 GRAVEL FOR DRAINAGE

A. Washed 3/4-inch drainage gravel. Free of organic matter, sand, loam, clay, and other small particles that will restrict water flow through gravel.

2.05 FOUNDATION STABILIZATION MATERIAL

A. Furnish when existing trench material or imported pipe base material will not support soft or flooded spots in excavated trench.

B. Maximum 3-inch hard rock free from excessive clay material, but enough fines to bind larger fragments.

2.06 CONCRETE FOR THRUST BLOCKING

A. Per Section 03 30 00, Cast-in-Place Concrete.

2.07 THRUST TIES

A. 3/4-inch diameter steel rods.

B. Duc-Lugs Manufacturer: Romac.

PART 3 EXECUTION

3.01 GENERAL

A. Install hydrants in accordance with Section 3.7 and Section 3.8 of AWWA C600, unless specified otherwise.

3.02 EXCAVATION

A. Excavate to subgrade. Fill over excavated areas with foundation stabilization material. Tamp to provide firm foundation.

3.03 BASE BLOCK

A. Place on firm, level subgrade to ensure uniform support.

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3.04 INSTALLATION OF HYDRANTS

A. Locate hydrants to provide accessibility and to minimize potential damage from vehicles.

1. Relocate improperly set hydrants.
2. Hydrant Located behind Curbs: Set barrel so pumper nozzle or hose nozzle caps are a minimum of 18 inches from gutter face of curb.
3. Hydrant Located in Space between Curb and Sidewalk: Not less than 8 inches, clear from sidewalks.
4. Hydrant Located between Sidewalk and Property Line: Minimum clearance 8 inches from sidewalk.
5. Set hydrants so safety flange is a minimum of 2 inches above finished ground or sidewalk level.

B. Place hydrant on base block carefully to prevent the base block from breaking.

C. Joints shall conform to Section 3.4 of AWWA C600 when cast or ductile iron pipe is used.

D. Maintain hydrant in a plumb position during subsequent Work.

3.05 GRAVEL FOR DRAINAGE

A. Place gravel around base block and hydrant bottom in accordance with Section 3.7 of AWWA C600.

3.06 CONCRETE THRUST BLOCKING

A. Place blocking after hydrant is set in final position and join to pipe.

B. Concrete thrust block shall have a minimum of 4 square feet of bearing area against undisturbed earth for a standard pressure installation.

1. Calculate required bearing area for high pressure installation.

3.07 THRUST TIES

A. Install thrust ties in lieu of concrete thrust blocking when ground surface behind hydrant is less than 2 feet above top of hydrant base.

END OF SECTION

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SECTION 33 13 00
DISINFECTION OF WATER UTILITY DISTRIBUTION FACILITIES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Water Works Association (AWWA):
   a. B300, Hypochlorites.
   b. B301, Liquid Chlorine.
   c. C651, Disinfecting Water Mains.
   d. C652, Disinfection of Water Storage Facilities.
   e. C653, Disinfection of Water Treatment Plants.
   f. C655, Field Dechlorination.
2. Standard Methods for the Examination of Water and Wastewater, as published by American Public Health Association, American Water Works Association, and the Water Environment Federation.

1.02 SUBMITTALS

A. Informational Submittals:

1. Plan describing and illustrating conformance to appropriate AWWA standards and this specification.
2. Procedure and plan for cleaning system.
3. Procedures and plans for disinfection and testing.
4. Proposed locations within system where Samples will be taken.
5. Type of disinfecting solution and method of preparation.
6. Method of disposal for highly chlorinated disinfecting water.
7. Coordinate with the City of Tulsa for disinfection testing support including sampling and laboratory testing.

1.03 QUALITY ASSURANCE

A. Provide support to the City of Tulsa to obtain samples to confirm chlorine residual and bacterial testing.

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1.04 SEQUENCING

A. Commence disinfection after completion of following:

1. Hydrostatic and pneumatic testing, pressure testing, functional and performance testing and acceptance of pipelines, structures, and equipment.

PART 2 PRODUCTS

2.01 WATER FOR DISINFECTION AND TESTING

A. Clean, uncontaminated, and potable.

B. Convey Owner-supplied potable water from onsite fire hydrants in disinfected pipelines or containers.

2.02 DISINFECTANT

A. Provide disinfectant product conforming to AWWA standards.

PART 3 EXECUTION

3.01 GENERAL

A. Provide acceptance sampling and testing per the requirements of the City of Tulsa Standard Specifications.

B. Conform to AWWA C651 for pipes and pipelines, except as modified in these Specifications.

C. Contractor’s Equipment:

1. Furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.
2. Water used to fill pipeline may be supplied using a temporary connection to existing distribution system. Provide protection against cross-connections as required by AWWA C651.

D. Disinfect the following items installed or modified under this Project, intended to hold, transport, or otherwise contact potable water:

1. Pipelines: Disinfect new pipelines that connect to existing pipelines up to point of connection.
2. Disinfect surfaces of materials that will contact finished water, both during and following construction, using one of the methods described

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in AWWA C652 and AWWA C653. Disinfect prior to contact with finished water. Take care to avoid recontamination following disinfection.

E. Prior to application of disinfectants, clean pipelines of loose and suspended material.

F. Allow freshwater and disinfectant solution to flow into pipe or vessel at a measured rate so chlorine-water solution is at specified strength. Do not place concentrated liquid commercial disinfectant in pipeline or other facilities to be disinfected before it is filled with water.

3.02 TURBIDITY

A. Cleaning of equipment and facilities shall include removal of materials that result in a turbidity exceeding limits stated in Article Testing.

3.03 PIPING

A. Cleaning:

1. Before disinfecting, clean foreign matter from pipe in accordance with AWWA C651.
2. Flush service connections and hydrants. Flush distribution lines prior to flushing hydrants and service connections. Operate valves during flushing process at least twice during each flush.
3. Flush pipe through flushing branches and remove branches after flushing is completed.

B. Disinfecting Procedure: In accordance with AWWA C651, unless herein modified.

3.04 DISPOSAL OF CHLORINATED WATER

A. Do not allow flow into a waterway without neutralizing disinfectant residual.

B. Dechlorination Procedure: In accordance with AWWA C655, unless herein modified.

3.05 TESTING

A. Collection of Samples:

1. Coordinate activities to allow Samples to be taken in accordance with this specification.

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2. Provide valves at sampling points.
3. Provide access to sampling points.

B. Test Equipment:

1. Clean containers and equipment used in sampling and make sure they are free of contamination.
2. Obtain sampling bottles with instructions for handling from Owner's laboratory.

C. Chlorine Concentration Sampling and Analysis:

1. Collect and analyze Samples in accordance with AWWA 651.
2. Sampling Locations: Provide support and access to sampling locations as required by the City of Tulsa.
3. Analysis to be performed by Owner's laboratory.

D. After facilities or piping have been cleaned, disinfected, and refilled with potable water, Owner will take water Samples and have them analyzed for conformance to bacterial limitations for public drinking water supplies.

1. Collect Samples in accordance with applicable AWWA Standard.
2. Analyze Samples for coliform concentrations in accordance with latest edition of Standard Methods for the Examination of Water and Wastewater.
3. Obtain and analyze a minimum of two Samples on each of 2 consecutive days from each separable structure and every 1,000 feet of pipeline by standard procedures outlined by state and local regulatory agencies.
4. Sampling points shall be representative and accepted by Owner.

E. Turbidity Sampling and Analysis:

1. After facilities or piping have been cleaned, disinfected, and refilled with potable water, Owner will take water Samples and have them analyzed for conformance to turbidity limitations for public drinking water supplies. Turbidity shall not exceed 0.3 NTU.
2. If turbidity is in excess of the limit, dispose of the water in accordance with this specification and applicable regulations, take action to remove source of turbidity, refill system, and retest.

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F. If minimum Samples required above are bacterially positive, disinfecting procedures and bacteriological testing shall be repeated until bacterial limits are met.

END OF SECTION

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SECTION 40 05 15
PIPING SUPPORT SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
2. American Society of Mechanical Engineers (ASME): B31.1, Power Piping.
3. ASTM International (ASTM):
   a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
   c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
4. International Building Code (IBC).
5. International Code Council (ICC).
6. International Mechanical Code (IMC).
7. Manufacturers' Standardization Society (MSS):
   a. SP 58, Pipe Hangers and Supports—Materials, Design and Manufacture.
   b. SP 127, Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, and Application.

1.02 DEFINITIONS

A. Wetted or Submerged: Submerged, less than 1-foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

1.03 SUBMITTALS

A. Action Submittals:

1. Catalog information and drawings of piping support system, locating each support, sway brace, seismic brace, hanger, guide, component, and anchor for piping 6 inches and larger. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.

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2. Calculations for each type of pipe support, attachment and anchor.
3. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.
4. 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. Maintenance information on piping support system.

1.04 QUALIFICATIONS

A. Piping support systems shall be designed and Shop Drawings prepared and sealed by a Registered Professional Engineer in the state of Oklahoma.

1.05 DESIGN REQUIREMENTS

A. General:

1. Design, size, and locate piping support systems throughout facility, whether shown or not.
2. Piping Smaller than 30 Inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.
3. Meet requirements of MSS SP 58 and ASME B31.1 or as modified by this section.

B. Pipe Support Systems:

1. Design pipe support systems for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.
2. Seismic loads in accordance with governing codes.
3. Wind loads in accordance with governing codes.
4. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.
    a. Ductile-iron Pipe 8 Inches and Under: Maximum span limited to that for standard weight steel pipe for water service.
    b. Ductile-iron Pipe 10 Inches and Larger: Maximum span limited to 20 feet.

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5. Electrical Conduit Support: Include in design of framing support system.

C. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

D. Vertical Sway Bracing: 10-foot maximum centers or as shown.

E. Existing Support Systems: Use existing supports systems to support new piping only if Contractor can show they are adequate for additional load, or if they are strengthened to support additional load.

PART 2 PRODUCTS

2.01 GENERAL

A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated.

B. Special support and hanger details may be required for cases where standard catalog supports are not applicable.

C. Materials: In accordance with Table 1 and Table 2, attached as Supplements at end of section.

2.02 HANGERS

A. Clevis: MSS SP 58, Type 1.

1. Anvil; Figure 260 for steel pipe and Figure 590 for ductile-iron pipe, sizes 1/2-inch through 30 inches.
2. Insulated Steel Pipe: Anvil; Figure 260 with insulated saddle system (ISS), sizes 1/2-inch through 16 inches.
3. B-Line; Figure B3100, sizes 1/2-inch through 30 inches.

B. Adjustable Swivel Split-Ring Pipe Clamp: MSS SP 58, Type 6.

1. Anvil; Figure 104, sizes 3/4-inch through 8 inches.
2. B-Line; Figure B3171, sizes 3/4-inch through 8 inches.

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C. Steel Yoke Pipe Rolls and Roller Supports: MSS SP 58, Type 41 or Type 43.

1. Anvil; Figure 181 for sizes 2-1/2 inches through 24 inches, and Figure 171 for sizes 1-inch through 30 inches.
2. B-Line; Figure B3110 for sizes 2 inches through 24 inches and Figure B3114 for 30 inches.

D. Pipe Rollers and Supports: MSS SP 58, Type 44.

1. Anvil; Figure 175, sizes 2 inches through 30 inches.
2. B-Line; Figure B3120, sizes 2 inches through 24 inches.

2.03 WALL BRACKETS, SUPPORTS, AND GUIDES

A. Adjustable “J” hanger MSS SP 58, Type 5:

1. Anvil; Figure 67, sizes 1/2-inch through 8 inches.
2. B-Line; Figure B3690, sizes 1/2-inch through 8 inches.

B. Channel Type:

1. Unistrut.
2. Anvil; Power-Strut.
3. B-Line; Strut System.
4. Aickinstrut (FRP).

2.04 CHANNEL TYPE SUPPORT SYSTEMS

A. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, or 1-1/2-inch wide, minimum FRP.

B. Members and Connections: Design for loads using one-half of manufacturer’s allowable loads.

C. Fasteners: Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.

D. Manufacturers and Products:

1. B-Line; Strut System.
2. Unistrut.
3. Anvil; Power-Strut.
4. Aickinstrut (FRP System).
5. Enduro-Durostrut (FRP Systems).

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2.05 PIPE CLAMPS

A. Riser Clamp: MSS SP 58, Type 8.

1. Anvil; Figure 261, sizes 3/4-inch through 24 inches.
2. B-Line; Figure B3373, sizes 1/2-inch through 30 inches.

2.06 SEISMIC RESTRAINTS

A. Solid pipe bracing attachment to pipe clevis with clevis cross brace and angle rod reinforcement.

B. Manufacturers:

1. Mason Industries.
2. B-Line.
3. Anvil.

2.07 ACCESSORIES

A. Anchor Bolts:

1. Size and Material: Sized by Contractor for required loads, and as specified in Section 05 50 00, Metal Fabrications.
2. Bolt Length (Extension Above Top of Nut):
   a. Minimum Length: Flush with top of nut preferred. If not flush, shall be no more than one thread recessed below top of nut.
   b. Maximum Length: No more than a full nut depth above top of nut.

B. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

C. Plastic Pipe Support Channel:

1. Type: Continuous support for plastic pipe and to increase support spacing.
2. Manufacturer and Product: B Line; Figure Series B3106V, sizes 1/2-inch through 6 inches with Figure B3106 Vee bottom hanger.

D. Attachments:

1. I-Beam Clamp: Concentric loading type, MSS SP 58, Type 21, Type 28, Type 29, or Type 30, which engage both sides of flange.
2. Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.

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3. Welded Beam Attachment: MSS SP 58, Type 22.
   a. Anvil; Figure 66.
   b. B-Line; Figure B3083.
4. U-Channel Concrete Inserts: As specified in Section 05 50 00, Metal Fabrications.
5. Concrete Attachment Plates:
   a. Anvil; Figure 47, Figure 49, or Figure 52.
   b. B-Line; Figure B3084, Figure B3085, or Figure B3086.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install support systems in accordance with MSS SP 58, unless shown otherwise.
2. Install pipe hanger rods plumb, within 4 degrees of vertical during shut down, start up or operations.
3. Support piping connections to equipment by pipe support and not by equipment.
4. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
5. Support no pipe from pipe above it.
6. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
7. Do not use adhesive anchors for attachment of supports to ceiling or walls.
8. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
9. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
10. Install lateral supports for seismic loads at changes in direction.
11. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
12. Repair mounting surfaces to original condition after attachments are completed.

B. Standard Pipe Supports:

1. Horizontal Suspended Piping:
   a. Single Pipes: Clevis hangers or adjustable swivel split-ring.
   b. Grouped Pipes: Trapeze hanger system.

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2. Horizontal Piping Supported from Walls:
   a. Single Pipes: Wall brackets, or attached to wall mounted framing with anchors.
   b. Stacked Piping: Wall mounted framing system and “J” hangers acceptable for pipe smaller than 3 inches.
   c. Pipe clamp that resists axial movement of pipe through support is not acceptable. Use pipe rollers supported from wall bracket.
3. Horizontal Piping Supported from Floors:
   a. Floor Mounted Channel Supports:
      1) Use for pipe smaller than 3 inches running along floors and in trenches at pipe elevations lower than can be accommodated using pedestal pipe supports.
      2) Attach channel framing to floors with baseplate on minimum 1-1/2-inch nonshrink grout and with anchor bolts.
      3) Attach pipe to channel with clips or pipe clamps.
   b. Concrete Cradles: Use for pipe larger than 3 inches along floor and in trenches at pipe elevations lower than can be accommodated using stanchion type.
4. Vertical Pipe: Support with wall bracket and elbow support, or riser clamp on floor penetration.

C. Standard Attachments:

1. Existing Concrete Ceilings:
   a. Channel type support with minimum of two anchor points, concrete attachment plates or concrete anchors as limited below:
      1) Single point attachment to ceiling is allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
      2) Where there is vibration or bending considerations do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.
         a) These lines include air operated diagram pumps.
2. Steel Beams: I-beam clamp or welded attachments.
3. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
4. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

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D. Accessories:

1. Dielectric Barrier:
   a. Provide between painted or galvanized carbon steel members and copper pipe or between stainless steel supports and nonstainless steel ferrous metal piping.
   b. Install rubber wrap between submerged metal pipe and oversized clamps.

3.02 FIELD FINISHING

A. Paint atmospheric exposed surfaces hot-dip galvanized steel components as specified in Section 09 90 00, Painting and Coating.

3.03 SUPPLEMENT

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

1. Table 1: Nonchemical Areas.

END OF SECTION

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Table 1 Nonchemical Areas	
Exposure Conditions	**Support Material**
Indoor Process Areas: Wetted or Submerged	Stainless steel or FRP
Notes: 1. Stainless steel to be Type 304.	

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SECTION 40 27 00
PROCESS PIPING—GENERAL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. Air Force: A-A-58092, Tape, Antiseize, Polytetrafluorethylene.
2. American Association of State Highway and Transportation Officials (AASHTO): HB-17, Standard Specifications for Highway Bridges.
3. American Petroleum Institute (API): SPEC 5L, Specification for Line Pipe.
4. American Society of Mechanical Engineers (ASME):
   a. Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
   b. B1.20.1, Pipe Threads, General Purpose (Inch).
   c. B16.1, Gray Iron Pipe Flanges and Flanged Fittings Class 25, Class 125, and Class 250.
   d. B16.3, Malleable Iron Threaded Fittings Class 150 and Class 300.
   e. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard.
   f. B16.9, Factory-Made Wrought Buttwelding Fittings.
   g. B16.11, Forged Fittings, Socket-Welding and Threaded.
   h. B16.15, Cast Copper Alloy Threaded Fittings Class 125 and Class 250.
   i. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   j. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   k. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, Class 300, Class 600, Class 900, Class 1500, and Class 2500.
   l. B16.25, Buttwelding Ends.
   m. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Class 150 and Class 300.
   n. B31.1, Power Piping.
   o. B31.3, Process Piping.
   p. B31.9, Building Services Piping.
   q. B36.10M, Welded and Seamless Wrought Steel Pipe.

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5. American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Recommended Practice for Personal Qualification and Certification in Nondestructive Testing.
6. American Water Works Association (AWWA): C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
7. American Welding Society (AWS):
    a. Brazing Handbook.
    b. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.
    c. D1.1/D1.1M, Structural Welding Code - Steel.
    d. QC1, Standard for AWS Certification of Welding Inspectors.
8. ASTM International (ASTM):
    a. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
    b. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
    c. A135/A135M, Standard Specification for Electric-Resistance-Welder Steel Pipe.
    d. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.
    e. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
    f. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 pounds per square inch Tensile Strength.
    g. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
    h. A536, Standard Specification for Ductile Iron Castings.
    i. A563, Standard Specification for Carbon and Alloy Steel Nuts.
    j. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
    k. B32, Standard Specification for Solder Metal.
    l. B75/B75M, Standard Specification for Seamless Copper Tube.
    m. B88, Standard Specification for Seamless Copper Water Tube.
    n. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes.
    o. D1330, Standard Specification for Rubber Sheet Gaskets.
    p. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
    q. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40, Schedule 80, and Schedule 120.
    r. D2000, Standard Classification System for Rubber Products in Automotive Applications.

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s. D2310, Standard Classification for Machine-Made “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
t. D2464, Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
u. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
v. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
w. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
x. D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
y. F436, Standard Specification for Hardened Steel Washers.
z. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

9. FM Global (FM).
10. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP 43, Wrought and Fabricated Butt-Welding Fittings for Low-Pressure, Corrosion Resistant Applications.
11. National Electrical Manufacturers Association (NEMA): LI 1, Industrial Laminating Thermosetting Products.
12. NSF International (NSF): 61 Drinking Water System Components—Health Effects.

1.02 DESIGN REQUIREMENTS

A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

1. Process Piping: ASME B31.3, normal fluid service unless otherwise specified.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Fabricated Piping:
a. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.

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b. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.

2. Pipe Wall Thickness: Identify wall thickness and rational method or standard applied to determine wall thickness for each size of each different service including exposed, submerged, buried, and concrete-encased installations for Contractor-designed piping.
3. Pipe Corrosion Protection: Product data.
4. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Manufacturer's Certification of Compliance, in accordance with Section 01 61 00, Common Product Requirements:
   a. Pipe and fittings.
   b. Factory applied resins and coatings.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Qualifications:
   a. Nondestructive Testing Personnel: SNT-TC-1A Level II certification and qualifications.
   b. AWS QC1 Certified Welding Inspector: Submit evidence of current certification prior to commencement of welding activities.
   c. Welders:
      1) Continuity log for welders and welding operators.
      2) Welder qualification test records conducted by Contractor or manufacturer.
4. Welding Procedures: Qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
5. Nondestructive inspection and testing procedures.
6. Test logs.
7. Pipe coating applicator certification.
8. Laboratory Testing Equipment: Certified calibrations, manufacturer's product data, and test procedures.
9. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
10. Torquing requirements and procedures, including torque values, for flanged piping assemblies.

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1.04 QUALITY ASSURANCE

A. Qualifications:

1. Welding Procedures: In accordance with ASME BPVC SEC IX (Form QW-482 and Form QW-483) or AWS D1.1/D1.1M (Annex N Forms).
2. Welder Qualifications: In accordance ASME BPVC SEC IX (Form QW-484) or AWS D1.1/D1.1M (Annex N Forms).
3. Solvent Welder for Plastic Piping: Qualified in accordance with Chapter VII of the ASME B31.3 Code, Part 9, Paragraph A328.

1.05 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements, and:

1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
3. Linings and Coatings: Prevent excessive drying.
4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2 PRODUCTS

2.01 GENERAL

A. 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.

B. Piping materials and accessories designed for contact with public drinking water systems shall meet the requirements of USEPA Safe Drinking Water Act.

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2.02 PIPING

A. All piping for this Project is part of in-kind replacement, so piping materials shall match existing piping in the Dewatering Building.

B. Diameters Shown:

1. Standardized Products: Nominal size, unless noted otherwise.

2.03 JOINTS

A. Threaded Joints: NPT taper pipe threads in accordance with ASME B1.20.1.

B. Mechanical Joint Anchor Gland Follower:

1. Ductile iron anchor type, wedge action, with break-off tightening bolts.
2. Thrust rated to 250 pounds per square inch minimum.
3. Rated operating deflection not less than:
   a. 3 degrees for sizes through 12 inches.
   b. 2 degrees for sizes 14 inches through 16 inches.
   c. 1.5 degrees for sizes 18 inches through 24 inches.
   d. 1 degree for sizes 30 inches through 48 inches.
4. UL and FM approved.

C. Flexible Mechanical Compression Joint Coupling:

1. Stainless steel, ASTM A276, Type 305 bands.
2. Manufacturer:
   a. Fernco Joint Sealer Co.
   b. Or Engineer approved equivalent.

2.04 GASKET LUBRICANT

A. Lubricant shall be supplied by pipe manufacturer and no substitute or Engineer approved equivalent will be allowed.

2.05 FINISHES

A. Factory prepare, prime, and finish coat in accordance with the Piping Schedule and Section 09 90 00, Painting and Coating.

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PART 3 EXECUTION

3.01 EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

3.02 PREPARATION

A. Section 09 90 00, Painting and Coating, for additional requirements.

B. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.

C. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

D. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer's instructions, except for damaged glass-lined pipe or PVDF-lined pipe that is to be promptly removed from Site.

3.03 INSTALLATION—GENERAL

A. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

B. Remove foreign objects prior to assembly and installation.

C. Flanged Joints:

1. Install perpendicular to pipe centerline.
2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
5. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast-iron flange.
6. Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.

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7. Flange fillers are to be avoided, but, if necessary, may be used to make up for small angles up to 6 degrees and for filling gaps up to 2 inches between flanges. Stacked flange fillers shall not be used.
8. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.
9. Manufacturer: Same as pipe manufacturer.

D. Threaded and Coupled Joints:

1. Conform to ASME B1.20.1.
2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
3. Countersink pipe ends, ream and clean chips and burrs after threading.
4. Make connections with not more than three threads exposed.
5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

E. PVC Piping:

1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.
3. Do not thread Schedule 40 pipe.

3.04 INSTALLATION—EXPOSED PIPING

A. Piping Runs:

1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

B. Supports: As specified in Section 40 05 15, Piping Support Systems.

C. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

D. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

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E. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

F. Piping clearance, unless otherwise shown:

1. Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
3. From Adjacent Work: Minimum 1-inch from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
5. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.
6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

G. Provide bird and insect screen on open pipe ends connected to process piping (such as, vent piping), unless otherwise indicated on the Drawings.

3.05 INSTALLATION—BURIED PIPE

A. In accordance with Section 31 23 23.15, Trench and Backfill and Section 33 05 01, Conveyance Piping General.

3.06 PIPE CORROSION PROTECTION

A. Ductile Iron Pipe and Fittings:

1. Exposed: As specified in Section 09 90 00, Painting and Coating.
2. Submerged or Embedded: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating. If in potable water service, use NSF 61 approved epoxy.

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B. Copper Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating.

C. PVC and CPVC Pipe, Exposed: As specified in Section 09 90 00, Painting and Coating.

D. Piping Accessories:

1. Exposed:
   a. Field paint black and galvanized steel, brass, copper, and bronze piping components as specified in Section 09 90 00, Painting and Coating, as applicable to base metal material.
   b. Accessories include, but are not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves, and fasteners.
2. Buried:
   a. Ferrous Metal and Stainless Steel Components: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating.
   b. Bolts, Nuts, and Similar Items: Coat with bituminous paint.
   c. Flexible Couplings, Grooved Couplings, and Similar Items: Wrap with heat shrink wrap or coat with cement.
   d. Buried Valves and Similar Elements on Wrapped Pipelines: Coat with bituminous paint and wrap entire valve in polyethylene encasement.
   e. Cement-Coated Pipelines: Cement coat appurtenances same as pipe.

E. Insulating Flanges, Couplings, and Unions:

1. Applications:
   a. Dissimilar metal piping connections.
   b. Cathodically protected piping penetration to buildings and watertight structures.
   c. Submerged to unsubmerged metallic piping connections.
   d. Connections to existing metallic pipe.
   e. Where required for electrically insulated connection.
2. Pipe Installation:
   a. Insulating joints connecting immersed piping to nonimmersed piping shall be installed above maximum water surface elevation.
   b. Submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete shall be isolated from the concrete reinforcement steel.

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c. Align and install insulating joints as shown on the Drawings and according to manufacturer's recommendations. Bolt lubricants that contain graphite or other metallic or electrically conductive components that can interfere with the insulating capabilities of the completed flange shall not be used.

3.07 THRUST RESTRAINT

A. Location:

1. Buried Piping: Where shown and where required to restrain force developed at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist because of hydrostatic testing and normal operating pressure.
2. Exposed Piping: At all joints in piping.
3. Submerged Piping: At all joints in piping.

B. Thrust Ties:

1. Steel Pipe: Attach with lugs fabricated in accordance with details shown on the Drawings.
2. Ductile Iron Pipe: Attach with socket clamps anchored against grooved joint coupling or flange.
3. Flanged Coupling Adapters: For exposed installations, install manufacturer's anchor studs through coupling sleeve or use dismantling joints.

C. Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping: Install pipe joint manufacturer's adapter gland follower and pipe end retainer, or mechanical joint anchor gland follower.

D. Thrust Blocking:

1. Place between undisturbed ground and fitting to be anchored.
2. Quantity of Concrete: Sufficient to cover bearing area on pipe and provide required soil bearing area as shown.
3. Place blocking so that pipe and fitting joints will be accessible for repairs.
4. Place concrete in accordance with Section 03 30 00, Cast-in-Place Concrete.

3.08 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Application and Installation: As specified in Section 40 27 01, Process Piping Specialties.

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3.09 BRANCH CONNECTIONS

A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.

B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including first block valve in the line carrying the lower pressure, unless otherwise shown.

C. Threaded Pipe Tap Connections:

1. Ductile Iron Piping: Connect only with service saddle or at tapping boss of a fitting, valve body, or equipment casting.
2. Welded Steel or Alloy Piping: Connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.
3. Limitations: Threaded taps in pipe barrel are unacceptable.

3.10 VENTS AND DRAINS

A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines at all low and high point locations.

3.11 FIELD FINISHING

A. Notify Engineer at least 3 days prior to start of surface preparation or coating application work.

B. As specified in Section 09 90 00, Painting and Coating.

3.12 PIPE IDENTIFICATION

A. As specified in Section 09 90 00, Painting and Coating.

3.13 FIELD QUALITY CONTROL

A. Pressure Leakage Testing: As specified in Section 40 80 01, Process Piping Leakage Testing.

B. Minimum Duties of Welding Inspector:

1. Job material verification and storage.
2. Qualification of welders.

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3. Certify conformance with approved welding procedures.
4. Maintenance of records and preparation of reports in a timely manner.
5. Notification to Engineer of unsatisfactory weld performance within 24 hours of weld test failure.

3.14 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, to assist with unloading of the double wall containment piping system, system tests, containment pipe joint closure, installation and testing of leak detection system, and training of Owner's personnel in operation and maintenance of leak detection system. Manufacturer's representative shall complete a Manufacturer's Certificate of Proper Installation. Inspection and examination practices shall be according to ASME B31.3 for Normal Fluid Service.

3.15 CLEANING

A. Following assembly and testing, and prior to final acceptance, flush pipelines, except as stated below, with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

B. Blow clean of loose debris compressed air and instrument air lines with compressed air at 4,000 fpm; do not flush with water.

C. If impractical to flush large diameter pipe at 2.5 fps or blow at 4,000 fpm velocity, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

D. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

E. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

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3.16 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Piping Schedule.
2. Data Sheets.

Number	Title
40 27 00.10	Polyvinyl Chloride (PVC) Pipe and Fittings
40 27 00.13	Copper and Copper Alloy Pipe, Tubing, and Fittings
40 27 00.15	Polyurethane Tubing

END OF SECTION

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PIPING SCHEDULE

FLOWSTREAM (NOTE 1)	SERVICE	SIZE (INCHES) (NOTES 2, 3)	EXPOSURE (NOTE 4)	MATERIAL (NOTE 5)	SPECIFICATION SECTION	JOINT TYPES (NOTE 6)	LINING/ COATING (NOTE 7)	OPERATING PRESSURE (NOTE 8)	PRESSURE TEST (PRESSURE /TYPE) (NOTE 8)
CA	COMPRESSED AIR	> 1/4	EXP	CU	40 27 00.13	S, W	NONE / NONE	100 PSIG	150 PSIG
		<= 1/4		POLY-TUBING	40 27 00.15	PO	NONE / NONE		
CAP	POLYMER, CATIONIC	ALL	EXP	PVC	40 27 00.10	FL, W	NONE / NO. 25	50 PSIG	75 PSIG
FW	FIRE WATER	>= 6	BUR	PVC-C900	33 05 01.09	RG, MJ	NONE / NONE	100 PSIG	PER SPEC
POA	POLYMER, ANIONIC	ALL	EXP	PVC	40 27 00.10	FL, W	NONE / NO. 25	50 PSIG	75 PSIG
WW	WASH WATER	ALL	EXP	PVC	40 27 00.10	FL, W	NONE / NO. 25	60 PSIG	90 PSIG

NOTES:

1. FLOWSTREAM ID MAY NOT BE DEFINED IN THE ABBREVIATIONS INCLUDED WITH THE GENERAL DRAWINGS. REFER TO THIS SHEET FOR ALL PIPING ABBREVIATIONS.
2. SIZE RANGES:

   ">" - GREATER THAN

   "<" - LESS THAN

   "<=" - LESS THAN OR EQUAL TO

   ">=" - GREATER THAN OR EQUAL TO

   "ALL" - ALL SIZES WITHIN THE LISTED INSTALLATION

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3. ALL PIPE SIZES WITHIN THE SIZE RANGE MAY NOT BE REQUIRED. REFER TO THE DRAWINGS FOR SIZES.
4. EXPOSURE TYPES:

   "BUR" – BURIED

   "EXP" - EXPOSED (OUTDOOR AND INDOOR EXPOSURES)
5. MATERIAL ABBREVIATIONS:

   "CU" – COPPER

   "POLY-TUBING" - POLYURETHANE TUBING

   "PVC" - POLYVINYL CHLORIDE

   "PVC-C900" - POLYVINYL CHLORIDE, PRESSURE PIPE
6. JOINT TYPES ARE SPECIFIED IN SECTION 40 27 00 - PROCESS PIPING GENERAL, AND ON THE PIPE DATA SHEETS.

   "FL" – FLANGED

   "MJ" - MECHANICAL JOINT (INCLUDING PROPRIETARY RESTRAINED PRODUCTS, WHERE REQUIRED)

   "PO" - PUSH ON

   "S" - SCREWED (OR THREADED)

   "W" - WELDED (INCLUDING SOLVENT, OR SOLDER WELDS. AS DESCRIBED ON THE PIPE DATA SHEETS)

   "RG" - RUBBER GASKET
7. LINING AND COATING TYPES:

   "NO. XX" - SYSTEM NUMBER AS SPECIFIED IN SECTION 09 90 00 - PAINTING AND COATING

   "NONE" - NO MODIFICATIONS TO MANUFACTURER'S FINISHED SURFACE
8. PRESSURE TEST TYPES ARE SPECIFIED IN SECTION 40 80 01 - PROCESS PIPING LEAKAGE TESTING.

   "H" - HYDROSTATIC TEST FOR PRESSURE PIPING

   "P" - PNEUMATIC TEST FOR PRESSURE PIPING

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SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
General	All	Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454 conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One-piece, molded hub type PVC flat face flange in accordance with Fittings above, ASME B16.1, Class 125 drilling.
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M heavy hex head or stud bolts, ASTM A194/A194M Grade 8M heavy hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Torque bolts per gasket manufacturer recommendations. With Raised Face Mating Flange: Carbon steel ASTM A307 Grade B heavy hex head or stud bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Torque bolts per gasket manufacturer recommendations.

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SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch thick Durlon, 9200W RCA, Garlock Gylon 3510. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	Socket type joints shall be made employing solvent cement that meets or exceeds requirements of ASTM D2564 and primer that meets or exceeds requirements of ASTM F656, chemically resistant to the fluid service, and as recommended by pipe and fitting manufacturer. Solvent weld cement for PVC pipe joints in chemical service shall be free of silica filler and shall be certified by the manufacturer to be suitable for the intended service, IPS Weld-On 724, or Engineer approved equivalent. Certification shall be submitted. Solvent cement and primer shall be listed by NSF 61 for contact with potable water.
Thread Lubricant	All	Teflon Tape.

END OF SECTION

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SECTION 40 27 00.13 COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS	
Item	**Description**
General	Materials in contact with potable water shall conform to NSF 61 acceptance.
Tubing	Seamless, conforming to ASTM B88 as follows: Compressed air service.....Type L, hard drawn.
Fittings	ASTM B75/B75M commercially pure wrought copper, socket joint, dimensions conforming to ASME B16.22.
Flanges	Class 150, ASTM B75/B75M commercially pure wrought copper, socket joint, ASME B16.24 standard.
Bolting	ASTM A307, carbon steel, Grade A hex head bolts, ASTM A563 Grade A hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	1/16-inch thick nonasbestos compression type, full face, Cranite, John Manville.
Solder	Joints 2-1/2 Inches and Smaller: Wire solder (95 percent tin), conforming to ASTM B32 Alloy Grade Sn95. Do not use cored solder. Joints Larger Than 2-1/2 Inches: Wire solder, melt range approximately 440 degrees F to 660 degrees F, conforming to ASTM B32 Alloy Grade HB or Grade HN. Do not use cored solder.

END OF SECTION

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SECTION 40 27 00.15 POLYURETHANE TUBING	
Item	**Description**
Polyurethane Tubing	Polyurethane tubing, size 1/2 inches or less. Solid blue color. Rated for a minimum working pressure of 175 psig at 75 degrees F. Tubing sizes shall be designated by outside diameter dimensions. Polyurethane tubing shall be Freelin-Wade, Fre-Thane, or Engineer approved equivalent.
Tubing Joints	Push-to-connect unions, designed for use in compressed air systems. Polymer body with stainless steel gripping ring. Working pressure equal to 0 greater than the connecting tubing. Unions shall be Freelin-Wade, Coilock, or Engineer approved equivalent.
Tubing Fittings	Transition Fittings: Push-to-connect fittings, designed for use in compressed air systems. Type 304 stainless steel body with male NPT threaded connector on pipe side. Transition fittings shall be Freelin-Wade, Coilock, or Engineer approved equivalent.

END OF SECTION

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SECTION 40 27 01
PROCESS PIPING SPECIALTIES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Class 25, Class 125, and Class 250).
   b. B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
2. American Water Works Association (AWWA):
   a. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
   b. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
   c. C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
   d. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   e. C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
   f. Manual M11, Steel Pipe—A Guide for Design and Installation.
3. ASTM International (ASTM):
   a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. A276, Standard Specification for Stainless Steel Bars and Shapes.
4. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
5. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 SUBMITTALS

A. Action Submittals: Manufacturer’s data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable).

B. Informational Submittals: Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

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PART 2 PRODUCTS

2.01 GENERAL

A. Provide required piping specialty items, whether shown or not shown on the Drawings, as required by applicable codes and standard industry practice.

B. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded, screwed, and flanged pipe joints are not considered flexible.

C. 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 CONNECTORS

A. Flexible Metal Hose Connector:

1. Type: Close pitch, annular corrugated with single braided jacket.
2. Material: Bronze.
3. End Connections: Female copper solder joint.
4. Minimum Burst Pressure: 500 pounds per square inch gauge at 70 degrees F.
5. Length: Minimum manufacturer recommendation for vibration isolation.
6. Manufacturers:
   a. Anamet Industrial, Inc.
   b. Unisource Manufacturing, Inc.; Style BF11.
   c. Senior Flexonics Pathway, Inc.

2.03 COUPLINGS

A. General:

1. Coupling linings for use in potable water systems shall be in conformance with NSF/ANSI 61.

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2. Couplings shall be rated for working pressure not less than indicated in Piping Schedule for the service and not less than 150 pounds per square inch.
3. Couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.
4. Unless thrust restraint is provided by other means, couplings shall be harnessed in accordance with requirements of AWWA Manual M11 or as shown on the Drawings.

B. Restrained Flange Adapter:

1. Pressure Rating:
   a. Minimum Working Pressure Rating: Not less than 150 pounds per square inch.
   b. Safety Factor: Not less than two times working pressure and shall be supported by manufacturer's proof testing.
2. Thrust Restraint:
   a. Provide hardened steel wedges that bear against and engage outer pipe surface, and allow articulation of pipe joint after assembly while wedges remain in their original setting position on pipe surface.
   b. Products employing set screws that bear directly on pipe will not be acceptable.
3. Manufacturer and Product: EBAA Iron Sales Co.; Mega-Flange.

2.04 EXPANSION JOINTS

A. Copper Pipe Expansion Compensator:

1. Material: Stainless steel bellows with female copper solder joint ends.
2. Working Pressure Rating: 175 pounds per square inch gauge, minimum.
3. Accessories: Anti-torque device to protect bellows.
4. Manufacturers and Products:
   a. Senior Flexonics; Model HB.
   b. Hyspan; Model 8510.
   c. Unisource Manufacturing, Inc.; Style EC-FFS.

2.05 SERVICE SADDLES

A. Double-Strap Iron:

1. Pressure Rating: Capable of withstanding 150 pounds per square inch internal pressure without leakage or over stressing.
2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.

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3. Taps: Iron pipe threads.
4. Materials:
    a. Body: Malleable or ductile iron.
    b. Straps: Galvanized steel.
    c. Hex Nuts and Washers: Steel.
    d. Seal: Rubber.
5. Manufacturers and Products:
    a. Smith-Blair; Series 313 or Series 366.
    b. Dresser; Style 91.

B. Nylon-Coated Iron:

1. Pressure Rating: Capable of withstanding 150 pounds per square inch internal pressure without leakage or over stressing.
2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
3. Materials:
    a. Body: Nylon-coated iron.
    b. Seal: Buna-N.
    c. Clamps and Nuts: Stainless steel.
4. Manufacturer: Smith-Blair; Style 315 or Style 317.

2.06 OUTLET/TAPPING SADDLES

A. Materials:

1. Straps: Alloy steel with 3/4-inch threaded ends.
2. Seal: O-Ring SBR rubber gasket.
3. Compatible with ductile iron pipe.

B. Connection: AWWA C110/A21.10 flange, or mechanical joint outlet.

C. Pressure Rating: Capable of withstanding 250 pounds per square inch internal pressure without leakage over stressing.

D. Manufacturer and Product: American Ductile Iron; Outlet/Tapping Saddle.

2.07 PIPE SLEEVES

A. Steel Pipe Sleeve:

1. Minimum Thickness: 3/16-inch.
2. Seep Ring:
    a. Center steel flange for water stoppage on sleeves in exterior or water-bearing walls, 3/16-inch minimum thickness.

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b. Outside Diameter: Unless otherwise shown, 3 inches greater than pipe sleeve outside diameter.
c. Continuously fillet weld on each side all around.

3. Factory Finish:
   a. Galvanizing:
      1) Hot-dip applied, meeting requirements of ASTM A153/A153M.
      2) Electroplated zinc or cadmium plating is unacceptable.
   b. Shop Lining and Coating: Factory prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

B. Molded Polyethylene Pipe Sleeve:

1. Molded HDPE with integral water stop ring not less than 3 inches larger than sleeve.
2. Provided with end caps for support during concrete placement.
3. Manufacturer and Product: Century-Line, Model CS sleeves as manufactured by PSI-Thunderline/Link-Seal.

C. Insulated and Encased Pipe Sleeve:

1. Manufacturer and Product: Pipe Shields, Inc.; Models WFB, WFB-CS and -CW Series, as applicable.

D. Modular Mechanical Seal:

1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
2. Fabrication:
   a. Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts and nuts.
   b. Pressure plates shall be reinforced nylon polymer.
3. Size: According to manufacturer's instructions for size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic head of 40 feet of water.
4. Manufacturer: Thunderline Corp., Link-Seal Division.

2.08 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

A. Steel or Stainless Steel Wall Pipe:

1. Same material and thickness as connecting pipe, except 1/4-inch minimum thickness.
2. Lining: Same as connecting pipe.

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3. Thrust Collar:
   a. Outside Diameter: Unless otherwise shown, 3 inches greater than outside diameter of wall pipe.
   b. Continuously fillet welded on each side all around.

2.09 MISCELLANEOUS SPECIALTIES

A. Wash Water Spray Nozzles

1. Wide angle, flat spray pattern with uniform distribution.
2. Spray Angle: 90 degrees at 40 pounds per square inch gauge.
3. Capacity: 3 gpm at 40 pounds per square inch gauge.
4. Orifice Diameter: 0.133 inches.
5. End Connection: 1/2-inch male, NPT.
6. Material: PVC.
7. Manufacturer and Products:
   a. Spraying System Co.; H1/2U-PVC9530.

B. Compressed Air Filters:

1. Inlet/Outlet Connections: 1/2-inch, NPT.
2. Capacity (at 100 psig): 50 scfm.
3. Manufacturer and Product: Hankison Air; NGF Series, Model PF F04.

C. Bird and Insect Screens:

1. Type 304 stainless steel woven mesh, ten openings per linear inch, 0.025-inch wire diameter.
2. Install the screen sandwiched between pipe flange and backing flange.

PART 3 EXECUTION

3.01 GENERAL

A. Provide accessibility to piping specialties for control and maintenance.

3.02 PIPING FLEXIBILITY PROVISIONS

A. General:

1. Thrust restraint shall be provided as specified in Section 40 27 00, Process Piping—General.
2. Install flexible couplings to facilitate piping installation, in accordance with approved Shop Drawings.

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3. Install a second flexible joint, whether or not shown.
    a. Pipe Diameter 18 Inches and Smaller: Within 18 inches of first joint.
    b. Pipe Diameter Larger than 18 Inches: Within two to three pipe diameter of first joint.

3.03 PIPING TRANSITION

A. Applications:

1. Provide complete closure assembly where pipes meet other pipes or structures.
2. Pressure Pipeline Closures: Plain end pieces with double flexible couplings, unless otherwise shown.
3. Restrained Joint Pipe Closures: Install with thrust tie-rod assemblies as shown or in accordance with NFPA 24.
4. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.
5. Concrete Closures: Use to make connections between dissimilar pipe where standard rubber gasketed joints or flexible couplings are impractical, as approved.
6. Elastomer sleeves bonded to pipe ends are not acceptable.

B. Installation:

1. Flexible Transition Couplings: Install in accordance with coupling manufacturer’s instructions to connect dissimilar pipe and pipes with a small difference in outside diameter.
2. Concrete Closures:
    a. Locate away from structures so there are at least two flexible joints between closure and pipe entering structure.
    b. Clean pipe surface before placing closure collars.
    c. Wet nonmetallic pipe thoroughly prior to pouring collars.
    d. Prevent concrete from entering pipe.
    e. Extend collar a minimum of 12 inches on each side of joint with minimum thickness of 6 inches around outside diameter of pipe.
    f. Make entire collar in one placement.
    g. After concrete has reached initial set, cure by covering with well-moistened earth.

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3.04 COUPLINGS

A. General:

1. Install in accordance with manufacturer's written instructions.
2. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
3. Remove pipe coating if necessary to present smooth surface.
4. Application:
   a. Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.
   b. Concrete Encased Couplings: Flexible coupling.

3.05 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

A. Install to prevent piping from being supported by equipment, for vibration isolation, and where shown.

B. Product Applications Unless Shown Otherwise:

1. Nonmetallic Piping: Teflon bellows connector.
2. Copper Piping: Flexible metal hose connector.
3. All Other Piping: Elastomer bellows connector.

C. Limit Bolts and Control Rods: Tighten snug prior to applying pressure to system.

END OF SECTION

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SECTION 40 27 02
PROCESS VALVES AND OPERATORS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Class 25, Class 125, and Class 250.
   b. B16.44, Manually Operated Metallic Gas Valves for Use in Above Ground Piping Systems up to 5 pounds per square inch.
2. American Society of Sanitary Engineers (ASSE): 1011, Performance Requirements for Hose Connection Vacuum Breakers.
3. American Water Works Association (AWWA):
   a. C500, Metal-Seated Gate Valves for Water Supply Service.
   b. C504, Rubber-Seated Butterfly Valves, 3 Inches (75 mm) Through 72 Inches (1,800 mm).
   c. C508, Swing-Check Valves for Waterworks Service, 2-Inches Through 24-Inches (50-mm Through 600-mm) NPS.
   d. C509, Resilient-Seated Gate Valves for Water Supply Service.
   e. C510, Double Check Valve Backflow Prevention Assembly.
   f. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
   g. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
   h. C515, Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
   i. C541, Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
   j. C542, Electric Motor Actuators for Valves and Slide Gates.
   k. C550, Protective Interior Coatings for Valves and Hydrants.
   l. C606, Grooved and Shouldered Joints.
   m. C800, Underground Service Line Valves and Fittings.
4. ASTM International (ASTM):
   a. A276, Standard Specification for Stainless Steel Bars and Shapes.
   b. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   c. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.

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d. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
e. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
f. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
g. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
h. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
i. D429, Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
j. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

5. FM Global (FM).
6. Food and Drug Administration (FDA).
7. International Association of Plumbing and Mechanical Officials (IAPMO).
8. Manufacturers Standardization Society (MSS):
   a. SP-88, Diaphragm Valves.
   b. SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
9. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
10. NSF International (NSF):
    a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
    b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
11. UL.
12. USC Foundation for Cross-Connection Control and Hydraulic Research.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product data sheets for each make and model. Indicate valve Type Number, applicable Tag Number, and facility name/number or service where used.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

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c. Certification for compliance to NSF/ANSI 61 for valves used for drinking water service.
d. Power and control wiring diagrams, including terminals and numbers.
e. For each power actuator provided, manufacturer's standard data sheet, with application specific features and options clearly identified.
f. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for:
   a. Electric actuators; full compliance with AWWA C542.
   b. Butterfly valves; full compliance with AWWA C504.
3. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
4. Tests and inspection data.
5. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
6. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

PART 2 PRODUCTS

2.01 GENERAL

A. Valves to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, operating nut, chain, wrench, and accessories to allow a complete operation from the intended operating level.

B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

C. Valve same size as adjoining pipe, unless otherwise called out on the Drawings or in Supplements.

D. Valve ends to suit adjacent piping.

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E. Resilient seated valves shall have no leakage (drip-tight) in either direction at valve rated design pressure. All other valves shall have no leakage (drip-tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in stated valve standard.

F. Size operators and actuators to operate valve for full range of pressures and velocities.

G. Valve to open by turning counterclockwise, unless otherwise specified.

H. Factory mount operator, actuator, and accessories.

2.02 MATERIALS

A. 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. Coatings materials to be formulated from materials deemed acceptable to NSF/ANSI 61.

2.03 FACTORY FINISHING

A. General:

1. Interior coatings for valves and hydrants shall be in accordance with AWWA C550, unless otherwise specified.
2. Exterior coating for valves and hydrants shall be in accordance with Section 09 90 00, Painting and Coating.
3. Material in contact with potable water shall conform to NSF/ANSI 61.
4. Exposed safety isolation valves and lockout valves with handles, handwheels, or chain wheels shall be “safety yellow.”

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B. Where epoxy lining and coating are specified, factory finishing shall be as follows:

1. In accordance with AWWA C550.
2. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.
3. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

2.04 VALVES

A. Gate Valves:

1. General:
   a. AWWA gate valves to be in full compliance with stated AWWA standard and the following requirements:
      1) Provide 2-inch operating nut and handwheel for AWWA gate valves 12 inches and smaller.
      2) Provide totally enclosed spur or bevel gear operator with indicator for AWWA gate valves 14 inches and larger.
      3) Provide Affidavit of Compliance per the applicable AWWA standard for AWWA gate valves.
      4) Mark AWWA gate valves with manufacturer’s name or mark, year of valve casting, valve size, and working water pressure.
      5) Repaired AWWA gate valves shall not be submitted or supplied.
      6) Supply AWWA gate valves with stainless steel bolting.
      7) AWWA C509 and AWWA C515 valves may be substituted for each other.
2. Type V132 Resilient Seated Gate Valve 3 Inches to 12 Inches, for Buried Service:
   a. Iron body, resilient seat, bronze stem and stem nut, mechanical joint ends, nonrising stem, in accordance with AWWA C509, 2-inch operating nut, minimum design working water pressure 200 pounds per square inch gauge, full port, fusion epoxy coated inside and outside per AWWA C550, NSF 61 certified.
   b. Manufacturers and Products:
      1) M&H Valve; AWWA C509.
      2) U.S. Pipe; A-USPO.

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B. Ball Valves:

1. Type V300 Ball Valve 3 Inches and Smaller for General Water and Air Service:
   a. Two-piece, standard port, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, adjustable packing gland, zinc-coated steel hand lever operator with vinyl grip, rated 600-pound WOG, 150-pound SWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Threaded:
         a) Conbraco Apollo; 70-100.
         b) Nibco; T-580-70.
      2) Soldered:
         a) Conbraco Apollo; 70-200.
         b) Nibco; S-580-70.
2. Type V303 Ball Valve 2 Inches and Smaller for Equipment Air System Shutoff:
   a. Two-piece, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, adjustable packing gland, 125-psig rated, safety exhaust port to exhaust downstream side when valve is in closed position, zinc-coated steel locking handle with vinyl grip.
   b. Meets OSHA Regulation 29 CFR Part 1910.147 requirements.
   c. Manufacturers and Products:
      1) Conbraco Apollo; 75-100-41.
      2) Nibco; T-580-70-SV/T-585-70-SV.
3. Type V330 PVC Ball Valve 2 Inches and Smaller:
   a. Rated 150 pounds per square inch at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions. Provide pressure relief hole drilled on low pressure side of ball.
   b. Manufacturers and Products:
      1) Nibco; Chemtrol Tru-Bloc.
      2) ASAHI/America; Type 21.
      3) Spears; True Union.

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4. Type V331 PVC Ball Valve 3 Inches and 4 Inches:
   a. Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 PVC full port body, Teflon seat, Viton O-ring stem, face and carrier seals, end entry design with dual union, solvent-weld socket ends, or single union ball valve with flanged ends drilled to ASME B16.1. Provide pressure relief hole drilled on low pressure side of ball.
   b. Manufacturers and Products:
      1) Nibco; Chemtrol Tru-Bloc.
      2) ASAHI/America; Type 21.

C. Self-Regulated Automatic Valves:

1. Type V710 Pressure-Reducing Valve 2-1/2 Inches and Smaller:
   a. Direct diaphragm operated, spring controlled, bronze body, NPT threaded ends, 200 psig rated minimum.
   b. Size/Rating: 1-1/2-inch, maximum of 80 gpm, with inlet pressure of 50 psig minimum. Outlet pressure set at 100 psig maximum. As shown in Valve Schedule.
   c. Manufacturers and Products:
      1) Fisher; Type 75A.
      2) Watts; Series 223.

D. Miscellaneous Valves:

1. Type V940 Solenoid Valve 1/4 Inch to 2 Inches:
   a. Two-way internal pilot operated diaphragm type, brass body, resilient seat suitable for air or water, solenoid coil molded epoxy, NEMA insulation Class F, 120V ac, 60-Hz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Normally closed (when de-energized).
   b. Minimum operating pressure differential no greater than 5 pounds per square inch gauge, maximum operating pressure differential not less than 125 pounds per square inch gauge.
   c. Manufacturers:
      1) ASCO.
      2) Skinner.

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2.05 OPERATORS AND ACTUATORS

A. Manual Operators:

1. General:
   a. For AWWA valves, operator force not to exceed requirements of applicable valve standard. Provide gear reduction operator when force exceeds requirements.
   b. For non-AWWA valves, operator force not to exceed applicable industry standard or 80 pounds, whichever is less, under operating condition, including initial breakaway. Provide gear reduction operator when force exceeds requirements.
   c. Operator self-locking type or equipped with self-locking device.
   d. Position indicator on quarter-turn valves.
   e. Worm and gear operators one-piece design, worm-gears of gear bronze material. Worm of hardened alloy steel with thread ground and polished. Traveling nut type operator's threaded steel reach rod with internally threaded bronze or ductile iron nut.
2. Exposed Operator:
   a. Galvanized and painted handwheel.
   b. Cranks on gear type operator.
   c. Chain wheel operator with tieback, extension stem, floor stand, and other accessories to permit operation from normal operation level.
   d. Valve handles to take a padlock, and wheels a chain and padlock.

PART 3 EXECUTION

3.01 INSTALLATION

A. Flange Ends:

1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

B. Screwed Ends:

1. Clean threads by wire brushing or swabbing.
2. Apply joint compound.

C. PVC and CPVC Valves: Install using solvents approved for valve service conditions.

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D. Valve Installation and Orientation:

1. General:
   a. Install valves so handles operate from fully open to fully closed without encountering obstructions.
   b. Install valves in location for easy access for routine operation and maintenance.
   c. Install valves per manufacturer's recommendations.
2. Gate, Globe, and Ball Valves:
   a. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
   b. Install operating stem horizontal in horizontal runs of pipe having centerline elevations greater than 4 feet 6 inches above finish floor, unless otherwise shown.

E. Install line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

F. Install safety isolation valves on compressed air.

G. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

H. Extension Stem for Operator: Where depth of valve operating nut is 3 feet or greater below finish grade, furnish operating extension stem with 2-inch operating nut to bring operating nut to a point within 6 inches of finish grade.

I. Torque Tube: Where operator for quarter-turn valve is located on floor stand, furnish extension stem torque tube of a type properly sized for maximum torque capacity of valve.

J. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

3.02 TESTS AND INSPECTION

A. Valve may be either tested while testing pipelines, or as a separate step.

B. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.

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C. Count and record number of turns to open and close valve; account for discrepancies with manufacturer's data.

D. Set, verify, and record set pressures for relief and regulating valves.

E. Automatic valves to be tested in conjunction with control system testing. Set opening and closing speeds, limit switches, as required or recommended by Engineer.

3.03 MANUFACTURER'S SERVICES

A. See Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

3.04 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this specification:

1. Self-Regulated Valve Schedule.

END OF SECTION

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Self-Regulated Valve Schedule							
Tag No.	**Valve Type No.**	**Size (inches)**	**Inlet* Pressure**	**Outlet* Pressure**	**Maximum psig**	**Flow (gpm)**	**Fluid**
--	V710	1-1/2	Varies	50 (minimum)	100	19 (minimum)	Water
*Inlet Pressure = Set pressure for pressure relief valve or downstream set pressure for pressure reducing valve.							

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SECTION 40 80 01
PROCESS PIPING LEAKAGE TESTING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Testing Plan:
   a. Submit prior to testing and include at least the information that follows.
      1) Testing dates.
      2) Piping systems and section(s) to be tested.
      3) Test type.
      4) Method of isolation.
      5) Calculation of maximum allowable leakage for piping section(s) to be tested.
2. Certifications of Calibration: Testing equipment.
3. Certified Test Report.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.

B. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
2. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

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4. New Piping Connected to Existing Piping:
   a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.
   b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.
5. Items that do not require testing include: Equipment drains.
6. Test Pressure: As indicated on Piping Schedule, included as a supplement to Section 40 27 00, Process Piping General.

C. Test section may be filled with water and allowed to stand under low pressure prior to testing.

3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

B. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.
2. Maximum Filling Velocity: 0.25-foot per second, applied over full area of pipe.
3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
4. Maintain hydrostatic test pressure continuously for 30 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
5. Examine joints and connections for leakage.
6. Correct visible leakage and retest as specified.
7. Leave pipe full of water after repair of leaks.

C. Buried Piping:

1. In accordance with Section 33 05 01, Conveyance Piping General and Section 33 05 01.09, Polyvinyl Chloride Pressure Pipe and Fittings.

3.03 PNEUMATIC TEST FOR PRESSURE PIPING

A. Do not perform on:

1. PVC or CPVC pipe.
2. Piping larger than 18 inches.
3. Buried and other non-exposed piping.

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B. Fluid: Oil-free, dry air.

C. Procedure:

1. Apply preliminary pneumatic test pressure of 25 pounds per square inch gauge maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.
2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
5. Correct visible leakage and retest as specified.

D. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

E. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

3.04 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.
2. Description and identification of piping tested.
3. Test fluid.
4. Test pressure.
5. Remarks, including:
   a. Leaks (type, location).
   b. Repair/replacement performed to remedy excessive leakage.
6. Signed by Contractor and Engineer to represent that test has been satisfactorily completed.

END OF SECTION

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SECTION 40 90 01
INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

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. A182, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   b. A276, Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
   c. A312, Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
   d. B32, Standard Specification for Solder Metal.
   e. B88, Standard Specification for Seamless Copper Water Tube.
2. International Society of Automation (ISA):
   a. S5.1, Instrumentation Symbols and Identification (NRC ADOPTED).
   b. PR12.6, Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations.
   c. S5.4, Standard Instrument Loop Diagrams.
   d. S20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
   e. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. ICS 1, General Standards for Industrial Control and Systems.
4. National Institute of Standards and Technology (NIST).
5. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
6. UL: 508A, Standard for Safety, Industrial Control Panels.

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1.02 SUMMARY

A. Work Includes:

1. Engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and Owner training for complete Process Instrumentation and Control (PIC) for plant.
2. Major parts are:
   a. Primary elements, transmitters, and control devices including new Polymer Radar Level Transmitters.
   b. CAT 6 Ethernet cables.
   c. Interfaces with existing control systems including the following:
      1) Belt Filter Press Control Panels.
      2) Conveyor Local Control Panel.
      3) New Dry Polyment Local Control Panels.
3. The project PLC programming and SCADA configuration will be offered by the PIC supplier as an additive alternate. If the additive alternate is not chosen by the Owner, the PIC supplier shall be responsible for supporting startup and commissioning with the Engineer.

B. Detailed Design: PIC as shown and specified includes functional and performance requirements and component specifications. Complete detailed PIC design.

1.03 DEFINITIONS

A. Abbreviations:

1. LCP: Local Control Panel.
2. MCC: Motor Control Center.
3. PAT: Performance Acceptance Test.
4. PIC: Process Instrumentation and Control.
5. PLC: Programmable Logic Controller.

B. Instrument Tag Numbers: As shown in P&ID’s.

C. Rising/Falling: Terms used to define actions of discrete devices about their setpoints.

1. Rising: Contacts close when an increasing process variable rises through setpoint.
2. Falling: Contacts close when a decreasing process variable falls through setpoint.

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D. Signal Types:

1. Analog Signals, Current Type:
   a. 4 mA dc to 20 mA dc signals conforming to ISA S50.1.
   b. Unless otherwise indicated for specific PIC Subsystem components, use the following ISA 50.1 options:
      1) Transmitter Type: Number 2, two-wire.
      2) Transmitter Load Resistance Capacity: Class L.
      3) Fully isolated transmitters and receivers.
2. Analog Signals, Voltage Type: 1V dc to 5V dc within panels where a common high precision dropping resistor is used.
3. Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.
4. Pulse Frequency Signals:
   a. Direct current pulses whose repetition rate is linearly proportional to process variable.
   b. Pulses generated by contact closures or solid state switches as indicated.
   c. Power source less than 30V dc.
5. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

1.04 SUBMITTALS

A. Action Submittals:

1. General:
   a. Shop Drawings, full-scaled details, wiring diagrams, catalog cuts, and descriptive literature.
   b. Identify proposed items and options. Identify installed spares and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
   c. Legends and Abbreviation Lists: Complete definition of symbols and abbreviations used on this Project (for example, engineering units, flow streams, instruments, structures, and other process items used in nameplates, legends, and data sheets).
2. Bill of Materials: List of required equipment.
   a. Group equipment items by enclosure and field, and within an enclosure, as follows:
      1) I&C Components: By component identification code.
      2) Other Equipment: By equipment type.

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b. Data Included:
    1) Equipment tag number.
    2) Description.
    3) Manufacturer, complete model number, and all options not defined by model number.
    4) Quantity supplied.
    5) Component identification code where applicable.

3. Catalog Cuts:
    a. I&C Components, Electrical Devices, and Mechanical Devices:
        1) Catalog information, mark to identify proposed items and options.
        2) Descriptive literature.
        3) External power and signal connections.
        4) Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.
4. Component Data Sheets: Data sheets for I&C components.
    a. Format and Level of Detail: In accordance with ISA-S20.
    b. Include component type identification code and tag number on data sheet.
    c. Specific features and configuration data for each component:
        1) Location or service.
        2) Manufacturer and complete model number.
        3) Size and scale range.
        4) Setpoints.
        5) Materials of construction.
        6) Options included.
    d. Name, address, and telephone number of manufacturer’s local office, representative, distributor, or service facility.
5. Sizing and Selection Calculations:
    a. Primary Elements: Complete calculations plus process data used. Example, for flow elements, minimum and maximum values, permanent head loss, and assumptions made.
    b. Controlling, Computing and Function Generating Modules: Actual scaling factors with units and how they were computed.
6. Panel Construction Drawings:
    a. Scale Drawings: Show dimensions and location of panel mounted devices, doors, louvers, and subpanels, internal and external.
    b. Panel Legend: List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
    c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.

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d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
e. Construction Notes: Finishes, wire color schemes, wire ratings, wire and terminal block, numbering and labeling scheme.

7. Panel Control Diagrams: For discrete control and power circuits.
   a. Diagram Type: Ladder diagrams. Include devices, related to discrete functions, that are mounted in or on the panel and that require electrical connections. Show unique rung numbers on left side of each rung.
   b. Item Identification: Identify each item with attributes listed.
      1) Wires: Wire number and color. Cable number if part of multiconductor cable.
      2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.
      3) Discrete Components:
         a) Tag number, terminal numbers, and location ("FIELD", enclosure number, or MCC number).
         b) Switching action (open or close on rising or falling process variable), setpoint value and units, and process variable description (for example, Sump Level High).
      4) Relay Coils:
         a) Tag number and its function.
         b) On right side of run where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.
      5) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).
   c. Show each circuit individually. No "typical" diagrams or "typical" wire lists will be permitted.
   d. Ground wires, surge protectors, and connections.
   e. Circuit Names: Show names corresponding to Circuit and Raceway Schedule for circuits entering and leaving a panel. Refer to Division 26, Electrical.
8. Panel Wiring Diagrams: Show point-to-point and terminal-to-terminal wiring within panel.

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9. Panel Plumbing Diagrams:
    a. For each panel containing piping and tubing. Show type and size for:
        1) Pipes and Tubes: Thickness, pressure rating, and materials.
            a) Components: Valves, regulators, and filters.
            b) Connections to panel mounted devices.
            c) Panel interface connections.
10. Loop Diagrams: Individual wiring diagram for each analog or pulse frequency loop.
    a. Conform to the minimum requirements of ISA S5.4.
    b. Under Paragraph 5.3 of ISA S5.4, include the information listed under Subparagraphs 2 and 6.
    c. Drawing Size: Individual 11-inch by 17-inch sheet for each loop.
    d. Divide each loop diagram into areas for panel face, back-of-panel, and field.
    e. Show:
        1) Terminal numbers, location of dc power supply, and location of common dropping resistors.
        2) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.
        3) Tabular summary on each diagram:
            a) Transmitting Instruments: Output capability.
            b) Receiving Instruments: Input impedance.
            c) Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.
            d) Total loop impedance.
            e) Reserve output capacity.
        4) Circuit and raceway schedule names.
11. Interconnecting Wiring Diagrams:
    a. Diagrams, device designations, and symbols in accordance with NEMA ICS 1.
    b. Diagrams shall bear electrical Subcontractor’s signature attesting diagrams have been coordinated with Division 26, Electrical.
    c. Show:
        1) Electrical connections between equipment, consoles, panels, terminal junction boxes, and field mounted components.
        2) Component and panel terminal board identification numbers, and external wire and cable numbers.
        3) Circuit names matching Circuit and Raceway Schedule.
        4) Intermediate terminations between field elements and panels (for example, to terminal junction boxes and pull boxes).
        5) Pull boxes.

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12. Installation Details: Include modifications or further details required to adequately define installation of I&C components.
13. List of spares, expendables, test equipment and tools.
14. Additional Equipment Recommended: List of, and descriptive literature for, additional spares, expendables, test equipment and tools recommended. Include unit prices and total costs as specified in Section 01 29 00, Payment Procedures.

B. Informational Submittals: For PIC equipment, provide Manufacturer's Certificate of Proper Installation and readiness for operation.

1. Owner Training Plan. Reference Section 01 43 33, Manufacturers' Field Services.
2. Operation and Maintenance (O&M) Manuals: In accordance with Section 01 78 23, Operation and Maintenance Data, unless otherwise specified in this section.
    a. Content and Format:
        1) Complete sets O&M manuals.
        2) Sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for each PIC component.
        3) Final versions of Legend and Abbreviation Lists.
        4) Manual format in accordance with Section 01 78 23, Operation and Maintenance Data.
    b. Include:
        1) Process and Instrumentation Diagrams: One reproducible copy of revised P&ID to reflect as-built PIC design.
        2) Refer to Paragraph Shop Drawings for the following items:
            a) Bill of Materials.
            b) Catalog Cuts.
            c) Component Data Sheets.
            d) Panel Control Diagrams.
            e) Panel Wiring Diagrams, one reproducible copy.
            f) Panel Plumbing Diagrams, one reproducible copy.
            g) Loop Diagrams, one reproducible copy.
            h) Interconnecting Wiring Diagrams, one reproducible copy.
            i) Application Software Documentation.
        3) Device O&M manuals for components, electrical devices, and mechanical devices include:
            a) Operations procedures.
            b) Installation requirements and procedures.
            c) Maintenance requirements and procedures.
            d) Troubleshooting procedures.

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e) Calibration procedures.
f) Internal schematic and wiring diagrams.
g) Component Calibration Sheets from field quality control calibrations.

4) List of spares, expendables, test equipment and tools provided.
5) List of additional spares, expendables, test equipment and tools recommended.

3. Performance Acceptance Tests (PAT) Submittals:
   a. Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.
   b. Final Test Procedures: Proposed test procedures, forms, and checklists.
   c. Test Documentation: Copy of signed off test procedures when tests are completed.

1.05 QUALITY ASSURANCE

A. Calibration Instruments: Each instrument used for calibrating PIC equipment shall bear the seal of a reputable laboratory certifying that instrument has been calibrated within the previous 12 months to a standard endorsed by the NIST.

B. Coordination Meetings:

1. In accordance with Section 01 31 13, Project Coordination.
2. Location: Project Site.
3. Attended By: Engineer, Owner, and Contractor.
4. Minimum of two are required. Specific dates will be established in Progress Schedule.
5. First Meeting: Within 60 days after Notice to Proceed.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide Site and warehouse storage facilities for PIC equipment.

B. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers, and related equipment as recommended by the capsule manufacturer.

C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

D. Cover panels and other elements that are exposed to dusty construction environments.

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1.07 ENVIRONMENTAL REQUIREMENTS

A. Standard Environmental Requirements:

1. Unless otherwise noted, design equipment for continuous operation in these environments:
   a. Freestanding Panel and Consoles:
      1) Inside, Air Conditioned: NEMA 1.
      2) Inside: NEMA 12.
   b. Smaller Panels and Assemblies (that are not Freestanding):
      1) Inside, Air Conditioned: NEMA 12.
      2) All Other Locations: NEMA 4X.
   c. Field Elements: Outside.

B. Environmental Design Requirements:

1. Following defines the types of environments referred to in the above:
   a. Inside, Air Conditioned:
      1) Temperature:
         a) Normal: 60 degrees F to 80 degrees F.
         b) With Up to 4-Hour HVAC System Interruptions: 40 degrees F to 105 degrees F.
      2) Relative Humidity:
         a) Normal: 10 percent (winter) to 70 percent (summer).
         b) With Up to 4-Hour HVAC System Interruption: 10 percent to 100 percent.
      3) NEC Classification: Nonhazardous.
   b. Inside:
      1) Temperature: 20 degrees F to 104 degrees F.
      2) Relative Humidity: 10 percent to 100 percent.
      3) NEC Classification: Nonhazardous.
   c. Inside, Corrosive:
      1) Temperature: Minus 20 degrees F to 104 degrees F.
      2) Relative Humidity: 10 percent to 100 percent.
      3) Corrosive Environment: Hydrogen sulfide gas.
      4) NEC Classification: Nonhazardous.
   d. Outside:
      1) Temperature: 20 degrees F to 104 degrees F.
      2) Relative Humidity: 10 percent to 100 percent, rain, snow, freezing rain.
      3) NEC Classification: Nonhazardous.

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e. Outside, Corrosive:
   1) Temperature: Minus 20 degrees F to 104 degrees F.
   2) Relative Humidity: 0 percent to 100 percent, rain, snow, freezing rain.
   3) Corrosive Environment: Hydrogen sulfide gas.
   4) NEC Classification: Nonhazardous.

1.08 SEQUENCING AND SCHEDULING

A. Activity Completion:

1. The following is a list of key activities and their completion criteria:
   a. Shop Drawings: Reviewed and approved.
   b. Quality Control Submittals: Reviewed and accepted.
   c. Hardware Delivery: Hardware delivered to Site and inventoried by Owner.
   d. PAT: Completed and required test documentation accepted.

B. PIC Substantial Completion: When Engineer issues Certificate of Substantial Completion.

1. Prerequisites:
   a. All PIC Submittals have been completed.
   b. PIC has successfully completed PAT.
   c. Owner training plan is on schedule.
   d. All spares, expendables, and test equipment have been delivered to Owner.

C. PIC Acceptance: When Engineer issues a written notice of Final Payment and Acceptance.

1. Prerequisites:
   a. Certificate of Substantial Completion issued for PIC.
   b. Punch-list items completed.
   c. Final revisions to O&M manuals accepted.
   d. Maintenance service agreements for PIC accepted by Owner.

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D. Prerequisite Activities and Lead Times:

1. Do not start the following key Project activities until the prerequisite activities and lead times listed below have been completed and satisfied:

Activity	Prerequisites and Lead Times
Submittal reviews by Engineer	Engineer acceptance of Submittal breakdown and schedule.
Hardware purchasing, fabrication, and assembly	Associated Shop Drawing Submittals completed.
Shipment	Completion of PIC Shop Drawing Submittals and preliminary O&M manuals.
Owner Training	Owner training plan completed
PAT	Startup, Owner training, and PAT procedures completed; notice 4 weeks prior to start.

PART 2 PRODUCTS

2.01 GENERAL

A. PIC functions as shown on the Drawings and as required for each loop. Furnish equipment items as required. Furnish all materials, equipment, and software, necessary to effect required system and loop performance.

B. First Named Manufacturer: PIC design is based on first named manufacturers of equipment and materials.

1. If an item is proposed from other than first named manufacturer, obtain approval from Engineer for such changes in accordance with Article Submittals.
2. If using proposed item requires other changes, provide work and equipment to implement these changes. Changes that may be required include, but are not limited to: different installation, wiring, raceway, enclosures, connections, isolators, intrinsically safe barriers, software, and accessories.

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C. Like Equipment Items:

1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.
2. Implement all same or similar functions in same or similar manner. For example, control logic, sequence controls, and display layouts.

D. 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 LOOP SPECIFICATIONS

A. Location: Article Supplements.

B. Organization: By unit process and loop number.

C. Functional Requirements for Control Loops:

1. Shown on the Drawings, in Panel Control Diagrams, and Process and Instrumentation Diagrams (P&ID). P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on the Drawings.
2. Supplemented by Loop Specifications.

D. Subheadings for Each Loop:

1. Functions: Clarifies functional performance of loop.
   a. Components: Lists major components for each loop. Information listed include: Tag numbers.
   b. Component Identification Codes: Alphanumeric codes of required components. Refer to Component Specification referenced in Article Supplements.
   c. Component Names and Options: Required to tailor general Component Specifications to specific application. For example, special materials, mounting, size, unit range, scale, setpoints, and controller options.

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2.03 I&C COMPONENTS

A. Components for Each Loop: Major components for each loop are listed under Components in Loop Specification and in Instrument List and on Data Sheets referenced in Article Supplements. Furnish all equipment that is necessary to achieve required loop performance.

B. Component Specifications: Generalized specifications for each type of component are located in Article Supplements.

2.04 NAMEPLATES AND TAGS

A. Panel Nameplates: Enclosure identification located on the enclosure face.

1. Location and Inscription: As shown.
2. Materials: Laminated plastic attached to panel with stainless steel screws.
3. Letters: 1/2 inch white on black background, unless otherwise noted.

B. Component Nameplates—Panel Face: Component identification located on panel face under or near component.

1. Location and Inscription: As shown.
2. Materials: Laminated plastic attached to panel with stainless steel screws.
3. Letters: 3/16 inch white on black background, unless otherwise noted.

C. Component Nameplates—Back of Panel: Component identification located on or near component inside of enclosure.

1. Inscription: Component tag number.
2. Materials: Adhesive backed, laminated plastic.
3. Letters: 3/16 inch white on black background, unless otherwise noted.

D. Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches.

1. Inscription:
   a. Refer to:
      1) Table under Paragraph Standard Pushbutton Colors and Inscriptions.
      2) Table under Paragraph Standard Light Colors and Inscriptions.
      3) P&IDs on the Drawings.

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2. Materials: Stainless steel, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.
3. Letters: Black on gray or white background.

E. Service Legends: Component identification nameplate located on face of component.

1. Inscription: As shown.
2. Materials: Adhesive backed, laminated plastic.
3. Letters: 3/16 inch white on black background, unless otherwise noted.

F. Nametags: Component identification for field devices.

1. Inscription: Component tag number.
2. Materials: 16-gauge, Type 304 stainless steel.
3. Letters: 3/16 inch imposed.
4. Mounting: Affix to component with 16-gauge or 18-gauge stainless steel wire or stainless steel screws.

2.05 ELECTRICAL REQUIREMENTS

A. In accordance with Division 26, Electrical.

B. I&C and Electrical Components, Terminals, Wires, and Enclosures: UL listed.

C. Wires within Enclosures:

1. ac Circuits:
   a. Type: 300-volt, Type MTW stranded copper.
   b. Size: For current to be carried, but not less than 18 AWG.
2. Analog Signal Circuits:
   a. Type: 300-volt stranded copper, twisted shielded pairs.
   b. Size: 18 AWG, minimum.
3. Other dc Circuits.
   a. Type: 300-volt, Type MTW stranded copper.
   b. Size: For current carried, but not less than 18 AWG.
4. Special Signal Circuits: Use manufacturer’s standard cables.
5. Wire Identification: Numbered and tagged at each termination.
   a. Wire Tags: Machine printed, heat shrink.
   b. Manufacturers:
      1) Brady PermaSleeve.
      2) Tyco Electronics.

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D. Wires entering or leaving enclosures, terminate and identify as follows:

1. Analog and discrete signal, terminate at numbered terminal blocks.
2. Special signals, terminated using manufacturer's standard connectors.
3. Identify wiring in accordance with Section 26 05 01, Electrical.

E. Terminal Blocks for Enclosures:

1. Quantity:
   a. Accommodate present and spare indicated needs.
   b. Wire spare PLC I/O points to terminal blocks.
   c. One wire per terminal for field wires entering enclosures.
   d. Maximum of two wires per terminal for 18 AWG wire for internal enclosure wiring.
   e. Spare Terminals: 20 percent of all connected terminals, but not less than 10 per terminal block.
2. General:
   a. Connection Type: Screw compression clamp.
   b. Compression Clamp:
      1) Complies with DIN-VDE 0611.
      2) Hardened steel clamp with transversal groves that penetrate wire strands providing a vibration-proof connection.
      3) Guides strands of wire into terminal.
   c. Screws: Hardened steel, captive and self-locking.
   d. Current Bar: Copper or treated brass.
   e. Insulation:
      1) Thermoplastic rated for minus 55 degrees C to plus 110 degree C.
      2) Two funneled shaped inputs to facilitate wire entry.
   f. Mounting:
      1) Standard DIN rail.
      2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
      3) End Stops: Minimum of one at each end of rail.
   g. Wire preparation: Stripping only permitted.
   h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
   i. Marking System:
      1) Terminal number shown on both sides of terminal block
      2) Allow use of preprinted and field marked tags.
      3) Terminal strip numbers shown on end stops.
      4) Mark terminal block and terminal strip numbers as shown on Panel Control Diagrams and Loop Diagrams.

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5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.

j. Test Plugs: Soldered connections for 18 AWG wire.
1) Pin Diameter: 0.079 inch.
2) Quantity: Two.
3) Manufacturer and Product: Entrelec; Type FC2.

3. Terminal Block, General-Purpose:
a. Rated Voltage: 600V ac.
b. Rated Current: 30 amp.
c. Wire Size: 22 AWG to 10 AWG.
d. Rated Wire Size: 10 AWG.
e. Color: Grey body.
f. Spacing: 0.25 inch, maximum.
g. Test Sockets: One screw test socket 0.079 inch diameter.
h. Manufacturer and Product: Entrelec; Type M4/6.T.

4. Terminal Block, Ground:
a. Wire Size: 22 AWG to 12 AWG.
b. Rated Wire Size: 12 AWG.
c. Color: Green and yellow body.
d. Spacing: 0.25 inch, maximum.
e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
f. Manufacturer and Product: Entrelec; Type M4/6.P.

5. Terminal Block, Blade Disconnect Switch:
a. Rated Voltage: 600V ac.
b. Rated Current: 10 amp.
c. Wire Size: 22 AWG to 12 AWG.
d. Rated Wire Size: 12 AWG.
e. Color: Grey body, orange switch.
f. Spacing: 0.25 inch, maximum.
g. Manufacturer and Product: Entrelec; Type M4/6.SN.T.

6. Terminal Block, Fused, 24V dc:
a. Rated Voltage: 600V dc.
b. Rated Current: 16 amp.
c. Wire Size: 22 AWG to 10 AWG.
d. Rated Wire Size: 10 AWG.
e. Color: Grey body.
f. Fuse: 0.25 inch by 1.25 inches.
g. Indication: LED diode 24V dc.
h. Spacing: 0.512 inch, maximum.
i. Manufacturer and Product: Entrelec; Type M10/13T.SFL.

7. Terminal Block, Fused, 120V ac:
a. Rated Voltage: 600V ac.
b. Rated Current: 16 amp.

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c. Wire Size: 22 AWG to 10 AWG.
d. Rated Wire Size: 10 AWG.
e. Color: Grey body.
f. Fuse: 0.25 inch by 1.25 inches.
g. Indication: Neon Lamp 110V ac.
h. Leakage Current: 1.8 mA, maximum.
i. Spacing: 0.512 inch, maximum
j. Manufacturer and Product: Entrelec; Type M10/13T.SFL.

8. Terminal Block, Fused, 120V ac, High Current:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 35 amps.
   c. Wire Size: 18 AWG to 8 AWG.
   d. Rated Wire Size: 8 AWG.
   e. Color: Grey.
   f. Fuse: 13/32 inch by 1.5 inches.
   g. Spacing: 0.95 inch, maximum.
   h. Manufacturer and Product: Entrelec; Type MB10/24.SF.

F. Grounding of Enclosures:

1. Furnish isolated copper grounding bus for signal and shield ground connections.
2. Ground bus grounded at a common signal ground point in accordance with National Electrical Code requirements.
3. Single Point Ground for Each Analog Loop:
   a. Locate at dc power supply for loop.
   b. Use to ground wire shields for loop.
   c. Group and connect shields in following locations:
      1) Common instrument ground bar.
4. Ground terminal block rails to ground bus.

G. Analog Signal Isolators: Furnish signal isolation for analog signals that are sent from one enclosure to another. Do not wire in series instruments on different panels, cabinets, or enclosures.

H. Power Distribution within Panels:

1. Feeder Circuits:
   a. One or more 120V ac, 60-Hz feeder circuits as shown on the Drawings.
   b. Make provisions for feeder circuit conduit entry.
   c. Furnish terminal board for termination of wires.

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2. Power Panel: Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
   a. Locate to provide clear view of and access to breakers when door is open.
   b. Breaker sizes: Coordinate such that fault in branch circuit will blow only branch breaker but not trip the main breaker.
      1) Branch Circuit Breaker: 15 amps at 250V ac.
   c. Breaker Manufacturer and Product: Square D; Type QO.
3. Circuit Wiring:
   a. P&IDs and Control Diagrams on the Drawings show function only. Use following rules for actual circuit wiring:
      1) Devices on Single Circuit: 20, maximum.
      2) Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
      3) Branch Circuit Loading: 12 amperes continuous, maximum.
      4) Panel Lighting and Service Outlets: Put on separate 15-amp, 120V ac branch circuit.
      5) Provide 120V ac plugmold for panel components with line cords.

I. Signal Distribution:

1. Within Panels: 4 mA dc to 20 mA dc signals may be distributed as 1V dc to 5V dc.
2. Outside Panels: Isolated 4 mA dc to 20 mA dc only.
3. All signal wiring twisted in shielded pairs.

J. Signal Switching:

1. Use dry circuit type relays or switches.
2. No interruption of 4 mA to 20 mA loops during switching.
3. Switching Transients in Associated Signal Circuit:
   a. 4 mA dc to 20 mA dc Signals: 0.2 mA, maximum.
   b. 1V dc to 5V dc Signals: 0.05V, maximum.

K. Relays:

1. General:
   a. Relay Mounting: Plug-in type socket.
   b. Relay Enclosure: Furnish dust cover.
   c. Socket Type: Screw terminal interface with wiring.

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d. Socket Mounting: Rail.
e. Provide holddown clips.

2. Signal Switching Relay:
   a. Type: Dry circuit.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 0 amp to 5 amps at 28V dc or 120V ac.
   d. Contact Material: Gold or silver.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 0.9 watts (dc), 1.2VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Seal Type: Hermetically sealed case.
   k. Manufacturer and Product: Potter and Brumfield; Series KH/KHA.
3. Control Circuit Switching Relay, Nonlatching:
   a. Type: Compact general-purpose plug-in.
   b. Contact Arrangement: 3 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Push to test button.
   k. Manufacturer and Product: Potter and Brumfield; Series KUP.
4. Control Circuit Switching Relay, Latching:
   a. Type: Dual coil mechanical latching relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
   g. Expected Mechanical Life: 500,000 operations.
   h. Expected Electrical Life at Rated Load: 50,000 operations.
   i. Manufacturer and Product: Potter and Brumfield; Series KB/KBP.
5. Control Circuit Switching Relay, Time Delay:
   a. Type: Adjustable time delay relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 240V ac.
      1) Contact Material: Silver cadmium oxide alloy.
   d. Coil Voltage: As noted or shown.
   e. Operating Temperature: Minus 10 degrees C to 55 degrees C.

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f. Repeatability: Plus or minus 2 percent.
g. Delay Time Range: Select range such that time delay setpoint fall between 20 percent to 80 percent of range.
h. Time Delay Setpoint: As noted or shown.
i. Mode of Operation: As noted or shown.
j. Adjustment Type: Integral potentiometer with knob external to dust cover.
k. Manufacturer and Products: Potter and Brumfield:
    1) Series CB for 0.1-second to 100-minute delay time ranges.
    2) Series CK for 0.1-second to 120-second delay time ranges.

L. Power Supplies:

1. Furnish to power instruments requiring external dc power, including two-wire transmitters and dc relays.
2. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
3. Provide output over voltage and over current protective devices to:
    a. Protect instruments from damage due to power supply failure.
    b. Protect power supply from damage due to external failure.
4. Enclosures: NEMA 1 in accordance with NEMA 250.
5. Mount such that dissipated heat does not adversely affect other components.
6. Fuses: For each dc supply line to each individual two-wire transmitter.
    a. Type: Indicating.
    b. Mount so fuses can be easily seen and replaced.

M. Internal Panel Lights for Freestanding Panels:

1. Type: Switched 100-watt incandescent back-of-panel lights.
2. Quantity: One light for every 4 feet of panel width.
3. Mounting: Inside and in the top of back-of-panel area.
4. Protective metal shield for lights.

N. Service Outlets for Freestanding Panels:

1. Type: Three-wire, 120-volt, 15-ampere, GFCI duplex receptacles.
2. Quantity:
    a. For panels 4 feet wide and smaller: One.
    b. For panels wider than 4 feet: One for every 4 feet of panel width, two minimum per panel.
3. Mounting: Evenly spaced along back-of-panel area.

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O. Internal Panel Lights and Service Outlets for Smaller Panels:

1. Internal Panel Light: Switched 100-watt incandescent light.
2. Service Outlet: Breaker protected 120-volt, 15-amp, GFCI duplex receptacle.

P. Standard Pushbutton Colors and Inscriptions: Use following color code and inscriptions for pushbuttons, unless otherwise noted on the P&ID's or wiring schematics.

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black
MA	MANUAL AUTO	Black Black
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

1. Lettering Color:
   a. Black on white and yellow buttons.
   b. White on black, red, and green buttons.

Q. Standard Light Colors and Inscriptions: Use following color code and inscriptions for service legends and lens colors for indicating lights, unless otherwise noted in the P&ID's or wiring schematics.

Tag Function	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green

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Tag Function	Inscription(s)	Color
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Green
FAIL	FAIL	Amber
HIGH	HIGH	Red
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

1. Lettering Color:
   a. Black on white and amber lenses.
   b. White on red and green lenses.

2.06 MECHANICAL SYSTEMS

A. Flow Element, Rotameter, Purge:

1. For air service, unless otherwise noted.
2. Materials: Glass tube, fiberglass body, stainless steel float, nylon ball check valve.
3. Direct-Reading Scale Length: 2-1/2 inches, minimum.
4. Scale Ranges: 0 scfh to 2.5 scfh for air service or 0 gph to 10 gph for water service.
5. Integral inlet needle valves.
6. Integral Differential Pressure Regulators:
   a. For water service.
   b. For air service for level ranges greater than 10 feet of water.
7. Manufacturers and Products:
   a. Fischer & Porter; Series 10A3130.
   b. Brooks; Series DS-1350.

B. Manifold, Three-Valve Equalizing:

1. Type: For isolation and equalization of differential pressure transducers.
2. Materials: Stainless steel.
3. Manufacturers and Product:
   a. Anderson, Greenwood and Co.; Type M1.
   b. Evans.

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C. Pressure Gauge: For other than process variable measurement.

1. Dial Size: Nominal 2-inch dial size.
2. Accuracy: 2 percent of span.
3. Scale Range: Such that normal operating pressure lies between 50 percent and 80 percent of scale range.
4. Connection: 1/4-inch NPT through bottom, unless otherwise noted.
5. Manufacturers and Products:
    a. Ashcroft Utility; Gauge Series 1000.
    b. Marsh; Standard Gauge Series.
    c. Ametek U.S.; Gauge Series P500.
    d. Acculite; Series 2000.

D. Valve, Needle:

1. Materials: Stainless steel body with 0.020-inch orifice.
2. Manufacturers and Products:
    a. Whitey; Model 21RF2.
    b. Hoke; 3700 Series.

E. ON/OFF Valves:

1. Type: Ball valve.
2. Materials: Stainless steel.
3. Manufacturers and Products:
    a. Whitey; Series 41 through Series 43.
    b. Hoke; Flomite 7100 Series.

F. Regulating Valves:

1. Type: Needle valves, with regulating stems and screwed bonnets.
2. Materials: Stainless steel.
3. Manufacturers and Products:
    a. Whitey; Catalog No. RF or RS.
    b. Hoke; 3100 through 3300 Series.

G. Valve, Three-Way:

1. Type: Ball valve.
2. Materials: Stainless steel with nylon handle.
3. Manufacturers and Products:
    a. Whitey; Series 41 through Series 43.
    b. Hoke; Selecto-Mite Series.

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H. Valve, Four-Way:

1. Type: Four-way, two-position ball valve.
2. Materials:
   a. Body and Stem: Type 316 stainless steel.
   b. Handle: Black nylon.
   c. Packing Gland: Teflon.
3. Ball and stem bed, one-piece assembly.
4. Machined handle stops and directional nameplates.
5. Manufacturers and Products:
   a. Whitey; Series 457.
   b. Hoke; Multi-Mite Series.

I. Spool Valve:

1. Type: Five-port arrangement as shown, two-position, push-to-operate knob attached to the spool stem, and spring return.
2. Materials: Aluminum construction with Teflon impregnated aluminum spool, stainless steel spring, and Buna-N O-rings.
3. Port Connection: 1/4-inch OD tube fittings.
4. Manufacturer and Product: Norgren; T71DAOO-TSO-TKO.

J. Solenoid Valve, Two-Way:

1. Type: Globe valve directly actuated by solenoid and not requiring minimum pressure differential for operation.
2. Materials:
   a. Body: Brassed globe valves.
   b. Valve Seat: Buna-N.
3. Size: As noted and normally closed or opened, as noted.
4. Coil: 115V ac, unless noted otherwise.
5. Solenoid Enclosure: NEMA 4.
6. Manufacturer and Product: ASCO; Red Hat Series 8260.

K. Pressure Regulator, Air:

1. Provide air at reduced pressures, as shown, constant to within plus or minus 10 percent for flows from 0 scfh to 300 scfh with 100 psi supply pressure.
2. Setscrew for outlet pressure adjustment.
3. Integral filter and relief valve.
4. Manufacturers and Products:
   a. Masoneilan; Series 77-4.
   b. Fisher; Series 67FR.

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L. Pressure Regulator, Water:

1. Materials:
   a. Body: Bronze.
   b. Spring Case: Cast iron.
   c. Seat Rings: Brass.
   d. Valve Disk and Holder: Buna-N and bronze.
   e. Diaphragm: Buna-N diaphragm.
2. Sizing: For maximum of 7 psi offset pressure.
3. Manufacturers and Products:
   a. Fisher; Controls Type 95H or 95L.
   b. Masoneilan; Series 17.

M. Test Tap:

1. Manufacturers and Products:
   a. Imperial-Eastman; quick-disconnect couplings No. 292-P and caps No. 259-P.
   b. Crawford Fitting Co.; Swagelok quick-connects Series QC4 and caps QC4-DC.
   c. Parker; CPI Series precision quick couplings.

N. Copper Tubing and Fittings:

1. Type K hard copper, ASTM B88, with commercially pure wrought copper solder joint fittings. Make joints with 95-5 wire solder, ASTM B32, Grade 95 TA. Do not use cored solder.
2. Alternatively, Type K, soft temper copper tubing, ASTM B88, with brass compression type fittings may be used where shown on the Drawings.
3. Manufacturers:
   a. Parker-Hannifin.
   b. Swagelok tube fittings.

O. Plastic Tubing and Fittings:

1. Tubing: Polyethylene capable of withstanding 190 psig at 175 degrees F.
   a. Manufacturers and Products:
      1) Dekoron; Type P.
      2) Imperial Eastman; Poly-Flo black instrument tubing.

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2. Fittings:
   a. Type: Brass compression.
   b. Manufacturers and Products:
      1) Imperial Eastman; Poly-Flo tube fittings.
      2) Dekoron; E-Z fittings.

P. Stainless Steel Tubing: ASTM A312, Type 316, seamless, soft annealed, as shown on the Drawings, 0.065-inch wall.

Q. Stainless Steel Fittings:

1. Compression Type:
   a. Materials: Stainless steel, ASTM A182 forged bodies or ASTM A276 barstock bodies, Type 316, flareless.
   b. Manufacturers and Products:
      1) Parker Flodar; BA Series.
      2) Swagelok tube fittings.
      3) Parker CPI tube fittings; Parker A-LOK dual ferrule tube fittings.
2. Socket Weld Type:
   a. Materials: Stainless steel, ASTM A182 forged bodies or ASTM A276 barstock bodies, Type 316 for 3,000 psi maximum working pressure, safety factor 4:1.
   b. Manufacturers:
      1) Cajon.
      2) Swagelok.
      3) Parker WELDLOK.

R. Air Set: Consist of a shutoff valve, pressure regulator, discharge pressure gauge, and interconnecting tubing.

S. Purge Set:

1. Parts: Purge rotameter flow element, pressure regulator, pressure gauge, test tap, shutoff valve, spool valve, and interconnecting tubing as shown on the Drawings and as specified.
2. Pressure Gauge Scale Range: 150 percent of the process variable.
3. Mounting: Within consoles, panels, or a separate enclosure as shown. For separate enclosure mounted purge sets, refer to Paragraph Nonfreestanding Panel Construction and Paragraph Factory Finishing for enclosure requirements.

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T. Tubing Raceways:

1. Cable tray systems complete with tees, elbows, reducers, and covers.
2. Size in accordance with manufacturer's recommendations for the intended service.
3. Materials: Aluminum.
4. Manufacturers:
   a. Globetray.
   b. Cope.

U. Air Supply Sets:

1. Parts: Integrally Mounted:
   a. Pressure Controls: Automatic START/STOP, factory set at 30 psig to 50 psig.
   b. Valves: Manual drain, manual shutoff, pressure relief, and check valve.
   c. Pressure gauge.
   d. Inlet filter muffler.
   e. Power: 120V ac.
   f. Compressor: Oilless, single cylinder, rated for at least 1 scfm at 50 psig.
   g. Manufacturers and Products:
      1) ITT Pneumotive; GH Series.
      2) Gast.
2. Simplex Air Supply Sets:
   a. Air Receiver: 2 gallons.
   b. Compressors: One.
3. Duplex Air Supply Sets:
   a. Air Receiver: 20 gallons.
   b. Compressors: Two.
   c. Automatic Failover Control: Factory set at 20 psig.

2.07 TEST EQUIPMENT AND TOOLS

Item	Qty.	Options and Model
Digital Multimeter	2	Fluke Model 87V/E Industrial Electrician Combo Kit with test leads, removable test probes, long reach alligator clips, magnetic hanger, temperature probe, and carrying case.
Clamp-on Ammeter	1	3-1/2-digit display unit with protective case; TES Model 3040 or Fluke Model 337E.

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Item	Qty.	Options and Model
DC Digital Process Signal Calibrator	2	Portable, two-channel, with test leads, rechargeable batteries, charger, and carrying case; Transmation Model 1045-01.
Recorder	1	Portable, two-channel, batteries, carrying case, Z-fold charts. Powered by internal rechargeable batteries and external 120V ac and 12V dc. Input ranges from 10mV to 50V dc. Chart speeds from 60 cm/min to 2 cm/hr; Omega Model RD3057-22.
Pressure and Electrical Calibrator	1	Transmation Model 1091PLUS-LP with test leads, rechargeable batteries, ac charger, pressure transducer modules, and protective case. Transducer pressure ranges: Appropriate for pressure devices provided.
Pressure Pump Kit	1	Hand pump (0 psig to 300 psig), calibration labels, tubing, fittings, and carrying case. Transmation Pump Kit 22980P-300.
Small Tool Kit	1	Kit of instrument maintenance tools in soft, zipper case; Jensen Tools Model JTK-47CG Field Engineer's Kit.
Large Tool Kit	1	Kit of instrument maintenance tools in high-density polyethylene case; Jensen Tools Model JTK-17LST.
Screw Starters	1	Kits of slotted screw starters with magnetic retrievers; Jensen Tools Model 23B021 and 23B023.
Terminal Kit	1	Kit of solderless terminals and cable ties; Jensen Tools Model 23B210

2.08 SPARE PARTS

Description	Percent of Each Type and Size Used	No Less Than
Annunciator light bulbs	20	10
Annunciator window module	10	5
dc power supplies	20	2
Fuses	20	5
Indicating light bulb	20	10

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Description	Percent of Each Type and Size Used	No Less Than
Relays	20	3
Terminal Blocks	10	10
Hand Switches	10	5

2.09 EXPENDABLES

Item	Quantity
Recorder chart paper and pens	Manufacturer's recommended 2-year supply
Chemicals for analyzers	Manufacturer's recommended 2-year supply
Corrosion-inhibiting vapor capsules	Manufacturer's recommended 2-year supply
pH sensor overhaul kits	
Spray pump filter adhesive; Hoffman Model A-FLTAD	One pint per panel with air filters

2.10 FABRICATION

A. General:

1. Panels with external dimensions and instruments arrangement as shown on the Drawings.
2. Panel Construction and Interior Wiring: In accordance with the National Electrical Code, state and local codes, NEMA, ANSI, UL, and ICECA.
3. Fabricate panels, install instruments, wire, and plumb, at the PIC factory.
4. Electrical Work: In accordance with Division 26, Electrical.

B. Factory Assembly: Assemble panels at the manufacturer's factory. No fabrication other than correction of minor defects or minor transit damage shall be done on panels at Site.

C. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A.

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D. Wiring Within PIC Panels:

1. Restrain by plastic ties or ducts or metal raceways.
2. Hinge Wiring: Secure at each end so that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
3. Arrange wiring neatly, cut to proper length, and remove surplus wire.
4. Abrasion protection for wire bundles which pass through holes or across edges of sheet metal.
5. Connections to Screw Type Terminals:
    a. Locking-fork-tongue or ring-tongue lugs.
    b. Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations.
    c. Wires terminated in a crimp lug, maximum of one.
    d. Lugs installed on a screw terminal, maximum of two.
6. Connections to Compression Clamp Type Terminals:
    a. Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
    b. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.
7. Splicing and tapping of wires, allowed only at device terminals or terminal blocks.
8. Terminate 24V dc and analog signal circuits on separate terminal block from ac circuit terminal blocks.
9. Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
10. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
11. Plastic Wire Ducts Fill: Do not exceed manufacturer's recommendation.

E. Temperature Control:

1. Freestanding Panels:
    a. Nonventilated Panels: Size to adequately dissipate heat from equipment mounted inside panel or on panel.
    b. Ventilated Panels:
        1) Furnish with louvers and forced ventilation as required to prevent temperature buildup from equipment mounted inside panel or on panel.
        2) For panels with backs against wall, furnish louvers on top and bottom of panel sides.
        3) For panels without backs against wall, furnish louvers on top and bottom of panel back.

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4) Louver Construction: Stamped sheet metal.
5) Ventilation Fans:
   a) Furnish where required to provide adequate cooling.
   b) Create positive internal pressure within panel.
   c) Fan Motor Power: 120V ac, 60-Hz, thermostatically controlled.
6) Air Filters: Washable aluminum, Hoffman Series A-FLT.

2. Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel or in panel face.
3. Space Heaters: Thermostatically controlled to maintain internal panel temperatures above dew point.

F. Freestanding Panel Construction:

1. Materials: Sheet steel, unless otherwise shown on the Drawings with minimum thickness of 10-gauge, unless otherwise noted.
2. Panel Fronts:
   a. Fabricated from a single piece of sheet steel, unless otherwise shown on the Drawings.
   b. No seams or bolt heads visible when viewed from front.
   c. Panel Cutouts: Smoothly finished with rounded edges.
   d. Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.
3. Internal Framework:
   a. Structural steel for instrument support and panel bracing.
   b. Permit panel lifting without racking or distortion.
4. Lifting rings to allow simple, safe rigging and lifting of panel during installation.
5. Adjacent Panels: Securely bolted together so front faces are parallel.
6. Doors: Full height, fully gasketed access doors where shown on the Drawings.
   a. Latches: Three-point, Southco Type 44.
   b. Handles: “D” ring, foldable type.
   c. Hinges: Full length, continuous, piano type, steel hinges with stainless steel pins.
   d. Rear Access Doors: Extend no further than 24 inches beyond panel when opened to 90-degree position.
   e. Front and Side Access Doors: As shown on the Drawings.

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G. Nonfreestanding Panel Construction:

1. Based on environmental design requirements required and referenced in Article Environmental Requirements, provide the following:
   a. For panels listed as inside, air conditioned:
      1) Enclosure Type: NEMA 12 in accordance with NEMA 250.
      2) Materials: Steel.
   b. For all other panels:
      1) Enclosure Type: NEMA 4X in accordance with NEMA 250.
      2) Materials: Type 316 stainless steel.
2. Metal Thickness: 14-gauge, minimum.
3. Doors:
   a. Rubber-gasketed with continuous hinge.
   b. Stainless steel lockable quick-release clamps.
4. Manufacturers:
   a. Hoffman Engineering Co.
   b. Rittal.

H. Factory Finishing:

1. Enclosures:
   a. Stainless Steel and Aluminum: Not painted.
   b. Nonmetallic Panels: Not painted.
   c. Steel Panels:
      1) Sand panel and remove mill scale, rust, grease, and oil.
      2) Fill imperfections and sand smooth.
      3) Paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.
      4) Sand surfaces lightly between coats.
      5) Dry Film Thickness: 3 mils, minimum.
   d. Manufacturer’s standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment with light gray color.

2.11 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsule Manufacturers:

1. Northern Instruments; Model Zerust VC.
2. Hoffmann Engineering Co; Model A-HCI.

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2.12 SOURCE QUALITY CONTROL

A. Scope: Inspect and test entire PIC to ensure it is ready for shipment, installation, and operation.

B. Location: Manufacturer's factory or Engineer approved staging site.

C. Test: Exercise and test all functions.

D. Temporary PLC software configuring to allow PLC testing.

2.13 ELECTRICAL TRANSIENT PROTECTION

A. General:

1. Function: Protect elements of PIC against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
2. Implementation:
   a. Provide, install, coordinate, and inspect grounding of surge suppressors at:
      1) Connection of ac power to PIC equipment including panels, consoles assembles, and field mounted analog transmitters and receivers.
      2) At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.
3. Construction: First-stage high energy metal oxide varistor and second-stage bipolar silicon avalanche device separated by series impedance. Includes grounding wire, stud, or terminal.
4. Response: 5 nanoseconds maximum.
5. Recovery: Automatic.
6. Temperature Range: Minus 20 degrees C to plus 85 degrees C.

B. Suppressors on 120V ac Power Supply Connections:

1. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE 587 Category B test waveform.
2. First-Stage Clamping Voltage: 350 volts or less.
3. Second-Stage Clamping Voltage: 210 volts or less.
4. Continuous Operation: Power supplies for one four-wire transmitter or receiver: 5 amps minimum at 130V ac. All other applications: 30 amps minimum at 130V ac.

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C. Suppressors on Analog Signal Lines:

1. Test Waveform: Linear 8 microsecond rise in current form 0 amps to a peak current value followed by an exponential decay of current reaching one half the peak value in 20 microseconds.
2. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
   a. dc Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
   b. dc Clamping Voltage Tolerance: Less than plus or minus 10 percent.
   c. Maximum Loop Resistance: 18 ohms per conductor.

D. Physical Characteristics:

1. Mounted in Enclosures: Encapsulated inflame retardant epoxy.
2. For Analog Signals Lines: EDCO PC-642 or SRA-64 series.
3. For 120V ac Lines: EDCO HSP-121.
4. Field Mounted at Two-Wire Instruments: Encapsulated in stainless steel pipe nipples. EDCO SS64 series.
5. Field Mounted at Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, and 10-ohm resistors on signal lines, all in enclosure.
   a. Enclosure: NEMA 4X fiberglass or Type 316 stainless steel with door.
      1) Maximum Size: 12 inches by 12 inches by 8 inches deep.
   b. Manufacturer and Product: EDCO; SLAC series.

PART 3 EXECUTION

3.01 EXAMINATION

A. For equipment not provided by PIC, but that directly interfaces with the PIC, verify the following conditions:

1. Proper installation.
2. Calibration and adjustment of positioners and I/P transducers.
3. Correct control action.
4. Switch settings and dead bands.
5. Opening and closing speeds and travel stops.
6. Input and output signals.

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3.02 INSTALLATION

A. Material and Equipment Installation: Retain a copy of manufacturers' instructions at Site, available for review at all times.

B. Electrical Wiring: As specified in Division 26, Electrical.

C. Mechanical Systems:

1. Drawings for PIC Mechanical Systems are diagrammatic and not intended to specifically define element locations or piping and tubing run lengths. Base materials and installations on field measurements.
2. Copper and Stainless Steel Tubing Support: Continuously supported by an aluminum tubing raceway system.
3. Plastic Tubing Supports: Except as shown on the Drawings, provide continuous support in conduits or by aluminum tubing raceway system.
4. Install tubing conduit for plastic tubing and tubing raceways parallel with, or at right angles to, structural members of buildings. Make vertical runs straight and plumb.
5. Tubing and Conduit Bends:
    a. Tool-formed without flattening, and all of same radius.
    b. Bend Radius: Equal to or larger than conduit and tubing manufacturer's recommended minimum bend radius.
    c. Slope instrument connection tubing in accordance with installation details.
    d. Do not run liquid filled instrument tubing immediately over or within a 3-foot plan view clearance of electrical panels, motor starters, or mechanical mounting panel without additional protection. Where tubing must be located in these zones, shield electrical device to prevent water access to electrical equipment.
    e. Straighten coiled tubing by unrolling on flat surface. Do not pull to straighten.
    f. Cut tubing square with sharp tubing cutter. Deburr cuts and remove chips. Do not gouge or scratch surface of tubing.
    g. Blow debris from inside of tubing.
    h. Make up and install fittings in accordance with manufacturer's recommendations. Verify makeup of tube fittings with manufacturer's inspection gauge.
    i. Use lubricating compound or TFE tape on stainless steel threads to prevent seizing or galling.
    j. Run tubing to allow, for example, clear access to doors, controls, and control panels; and to allow for easy removal of equipment.
    k. Provide separate support for components in tubing runs.

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l. Supply expansion loops and use adapters at pipe, valve, or component connections for proper orientation of fitting.
m. Keep tubing and conduit runs at least 12 inches from hot pipes.
n. Locate and install tubing raceways in accordance with manufacturer's recommendations. Locate tubing to prevent spillage, overflow, or dirt from above.
o. Securely attach tubing raceways to building structural members.

6. Enclosure Lifting Rings: Remove rings following installation and plug holes.

D. Removal or Relocation of Materials and Equipment:

1. Remove from Site materials that were part of the existing facility but are no longer used, unless otherwise directed by Engineer to deliver to Owner.
2. Repair affected surfaces to conform to type, quality, and finish of surrounding surface.

3.03 FIELD FINISHING

A. Refer to Section 09 90 00, Painting and Coating.

3.04 FIELD QUALITY CONTROL

A. Startup and Testing Team:

1. Thoroughly inspect installation, termination, and adjustment for components and systems.
2. Complete onsite tests.
3. Complete onsite training.
4. Provide startup assistance.

B. Operational Readiness Inspections and Calibrations: Prior to startup, inspect and test to ensure that entire PIC is ready for operation.

1. Loop/Component Inspections and Calibrations:
a. Check PIC for proper installation, calibration, and adjustment on a loop-by-loop and component-by-component basis.
b. Prepare component calibration sheet for each active component (except simple hand switches, lights, gauges, and similar items).
1) Project name.
2) Loop number.
3) Component tag number.
4) Component code number.
5) Manufacturer for elements.

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6) Model number/serial number.
7) Summary of functional requirements, for example:
   a) Indicators and recorders, scale and chart ranges.
   b) Transmitters/converters, input and output ranges.
   c) Computing elements' function.
   d) Controllers, action (direct/reverse) and control modes (PID).
   e) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
8) Calibrations, for example:
   a) Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.
   b) Discrete Devices: Actual trip points and reset points.
   c) Controllers: Mode settings (PID).
9) Space for comments.

c. These inspections and calibrations will be spot checked by Engineer.

2. Leak Test: In accordance with Section 40 80 01, Process Piping Leakage Testing.

C. Performance Acceptance Tests (PAT): These are the activities that Section 01 91 14, Equipment Testing and Facility Startup, refers to as Performance Testing.

1. General:
   a. Test all PIC elements to demonstrate that PIC satisfies all requirements.
   b. Test Format: Cause and effect.
      1) Person conducting test initiates an input (cause).
      2) Specific test requirement is satisfied if correct result (effect) occurs.
   c. Procedures, Forms, and Checklists:
      1) Conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
      2) Describe each test item to be performed.
      3) Have space after each test item description for sign off by appropriate party after satisfactory completion.
   d. Required Test Documentation: Test procedures, forms, and checklists. All signed by Engineer and Contractor.
   e. Conducting Tests:
      1) Provide special testing materials, equipment, and software.
      2) Wherever possible, perform tests using actual process variables, equipment, and data.

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3) If it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation.
4) Define simulation techniques in test procedures.

f. Coordinate PIC testing with Owner and affected Subcontractors.
1) Excessive Test Witnessing: Refer to Supplementary Conditions.

2. Test Requirements:
a. Once facility has been started up and is operating, perform a witnessed PAT on complete PIC to demonstrate that it is operating as required. Demonstrate each required function on a paragraph-by-paragraph and loop-by-loop basis.
b. Perform local and manual tests for each loop before proceeding to remote and automatic modes.
c. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.
d. Make updated versions of documentation required for PAT available to Engineer at Site, both before and during tests.
e. Make one copy of O&M manuals available to Engineer at the Site both before and during testing.
f. Refer to referenced examples of PAT procedures and forms in Article Supplements.

3.05 MANUFACTURER'S SERVICES

A. Specialty Equipment: For following equipment, provide the services of a qualified manufacturer's representative during installation, startup, and demonstration testing and Owner training. Provide original equipment manufacturer's services for polymer and conveyor systems.

3.06 TRAINING

A. General:

1. Provide an integrated training program to meet specific needs of Owner's personnel.
2. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.

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3. Provide instruction on two working shift(s) as needed to accommodate the Owner's personnel schedule.
4. Owner reserves the right to make and reuse video tapes of training sessions.

B. Operations and Maintenance Training:

1. Include a review of O&M manuals and survey of spares, expendables, and test equipment.
2. Use equipment similar to that provided or currently owned by Owner.
3. Provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics or instrumentation.

C. Operations Training:

1. Training Session Duration: One 8-hour instructor days.
2. Number of Training Sessions: Two.
3. Location: Site.
4. Content: Conduct training on loop-by-loop basis.
    a. Loop Functions: Understanding of loop functions, including interlocks for each loop.
    b. Loop Operation: For example, adjusting process variable setpoints, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.
    c. Interfaces with other control systems.

D. Maintenance Training:

1. Training Session Duration: One 8-hour instructor days.
2. Number of Training Sessions: Two.
3. Location: Project Site.
4. Content: Provide training for each type of component and function provided.
    a. Loop Functions: Understanding details of each loop and how they function.
    b. Component calibration.
    c. Adjustments: For example, controller tuning constants, current switch trip points, and similar items.
    d. Troubleshooting and diagnosis for components.
    e. Replacing lamps, chart paper, fuses.
    f. Component removal and replacement.
    g. Periodic maintenance.

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3.07 CLEANING/ADJUSTING

A. Repair affected surfaces to conform to type, quality, and finish of surrounding surface.

B. Cleaning:

1. Prior to closing system using tubing, clear tubing of interior moisture and debris.
2. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.08 PROTECTION

A. Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.

B. Periodically replace capsules in accordance with capsule manufacturer's recommendations. Replace capsules just prior to Final Payment and Acceptance.

3.09 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Component Specifications.
2. Instrument List.
3. Loop Specifications.
4. IO List.
5. Instrument Calibration Sheet: Provides detailed information on each instrument (except simple hand switches, lights, and similar items).
6. I&C Valve Adjustment Sheet: Each sheet shows detailed information for installation, adjustment, and calibration of a given valve.
7. Performance Acceptance Test Sheet: Describes the PAT for a given loop. The format is mostly free form.
    a. Lists the requirements of the loop.
    b. Briefly describes the test.
    c. Cites expected results.
    d. Provides space for check off by witness.

END OF SECTION

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COMPONENT SPECIFICATIONS

A. L29 Level Element and Transmitter, Radar:

1. General:
   a. Function: Continuous level measurement.
   b. Type: Radar; noncontacting.
   c. Loop-powered.
   d. Parts: Element/integral transmitter and accessories as noted.
2. Service:
   a. Application: If and as noted.
   b. Operating Temperature Range:
      1) Outside Ambient: Minus 40 degrees F to plus 176 degrees F.
      2) Transducer (inside vessel): Minus 40 degrees F to 212 degrees F.
3. Performance:
   a. Process Range: As noted.
   b. Zero Reference: As noted.
   c. Frequency: 78 GHz FMCW (Frequency Modulating, Continuous Wave).
   d. Accuracy: The greater of 25 mm (1 inch) or 0.25 percent of range from minimum detectable distance to full range.
   e. Medium Suitability: Noncontacting element for medium with dielectric constant greater than 1.6.
   f. Blanking Distance: 15.75 inches.
4. Element/Integral Transmitter:
   a. Enclosure Rating:
      1) NEMA 4X/IP67 watertight.
      2) NEMA 6/IP68.
   b. Enclosure Material: Type 316L stainless steel.
   c. Lens Antenna:
      1) Lens Antenna Material: PEI.
      2) Include flange adapters.
      3) Process Connection:
         a) 6-inch ASME 150 pound, flat faced flange, unless otherwise noted.
         b) Material: Type 316L stainless steel.
      4) Process Seal/Gasket: As required.
      5) Pressure Rating of 7.25 psig Maximum: If noted.
   d. Beam Angle: 4 degrees.
   e. Approvals:
      1) FM, Class II, Division 1, Groups E, F and G.
      2) FM, Class I, Division 2, Groups A, B, C, D and T4.

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f. Element Beam Angle: 4 degrees inclusive.
g. Display: Local LCD with bar graph (Local Display Interface).

5. Signal Interface:
   a. Analog: 4 mA dc to 20 mA dc (HART) with maximum impedance of 550 ohms and nominal 24V dc power supply.
   b. Digital, HART.
6. Conduit Entry: 1/2-inch NPT.
7. Accessories:
   a. Handheld Programmer:
      1) One per lot of level units provided, if noted.
      2) Intrinsically safe version, unless otherwise noted.
   b. Integral sunshield.
   c. Stainless steel tag.
   d. Others: As noted.
8. Manufacturers and Products:
   a. Vega; VEGAPULS 6X.
   b. Endress and Hauser; FMR62.
   c. Siemens; SITRANS LR 560.
   d. Or approved equal.

B. P04 Pressure Gauge:

1. General:
   a. Function: Local pressure indication.
   b. Type: Bourdon tube element.
2. Performance:
   a. Scale Range: As noted.
   b. Accuracy: Plus or minus 0.50 percent of full scale.
3. Features:
   a. Dial: 4-1/2-inch diameter.
   b. Pointer Vibration Reduction: Required, unless otherwise noted. Use the following method.
      1) Liquid filled gauge front, unless otherwise noted.
         a) Glycerine fill, unless otherwise noted.
   c. Case Material: Black thermoplastic, unless otherwise noted.
   d. Materials of Wetted Parts (including element, socket/process connection, throttling device (if specified) and secondary components):
      1) Stainless steel, unless otherwise noted.
   e. Pointer: Adjustable by removing ring and window.
   f. Window: Glass or acrylic, unless otherwise noted.
   g. Threaded reinforced polypropylene front ring.
   h. Case Type: Solid front with blow-out back.

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4. Process Connection:
   a. Mounting: Lower stem, unless otherwise noted.
   b. Size: 1/2-inch MNPT, unless otherwise noted.
   c. Diaphragm Seal: Component P06 where noted or shown.
5. Accessories:
   a. Throttling Device: Required, unless otherwise noted.
      1) Type suitable for the intended service.
      2) Install in gauge socket bore.
6. Manufacturers and Products:
   a. Ashcroft; Duragauge 1259/Model, 1279/Model, 1279 PLUS.
   b. Ametek U.S. Gauge; Solfrunt Model 19XX/1981 Advantage.
   c. WIKA; Type 2XX.34.

C. P06 Pressure Seal, Diaphragm:

1. General:
   a. Function: Isolate sensing element from process fluid.
   b. Type:
      1) Diaphragm.
      2) Fluid filled between diaphragm and sensing element.
2. Service:
   a. Pressure: Same as associated sensor.
   b. Temperature Range: If noted.
3. Performance:
   a. Pressure:
      1) For threaded process connections, at least 2,500 psig at 100 degrees F.
      2) Glycerin Fill: Suitable only for pressure (not vacuum applications).
   b. Temperature:
      1) Dependent upon fill fluid.
         a) Glycerin (food grade): 0 degree F to 400 degrees F.
         b) Silicone: Minus 40 degrees F to plus 600 degrees F.
         c) Silicone (food grade): 0 degree F to 375 degrees F.
         d) Halocarbon: Minus 70 degrees F to 300 degrees F.
4. Features:
   a. Materials:
      1) Lower Housing: Type 316 stainless steel, unless otherwise noted or recommended by manufacturer.
      2) Diaphragm Material: Type 316 stainless steel, unless otherwise noted or recommended by manufacturer.
      3) Top Housing: Steel, unless otherwise noted.
   b. Diaphragm: Welded to upper housing, unless otherwise noted.
   c. Filling screw in upper housing.

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d. Fill Fluid:
    1) As noted.
    2) Or Engineer approved equivalent.
    3) Factory assembled and filled.
e. Flushing Connection: 1/4-inch NPT in lower housing.
f. Diaphragm Seal Displacement: 0.1-cubic-inch, nominal.

5. Connections:
    a. Instrument: 1/2-inch female NPT, unless otherwise noted or shown.
    b. Process: 1/2-inch female NPT, unless otherwise noted or shown.
6. Manufacturers and Products:
    a. Ashcroft; Type 201.
    b. Ametek; Mansfield and Green Division; Type SG.
    c. WIKA; Type L990.10.

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INSTRUMENT LIST

Tag Number	Comp Code	Component Title	Options	P&ID	Panel Number
LE/LIT-1820-01	L50	RADAR LEVEL ELEMENT AND TRANSMITTER		09-I-4	SLUDGE DEWATERING PLC PANEL
LE/LIT-1820-02	L50	RADAR LEVEL ELEMENT AND TRANSMITTER		09-I-4	SLUDGE DEWATERING PLC PANEL
LE/LIT-1820-03	L50	RADAR LEVEL ELEMENT AND TRANSMITTER		09-I-4	SLUDGE DEWATERING PLC PANEL
LE/LIT-1820-04	L50	RADAR LEVEL ELEMENT AND TRANSMITTER		4	SLUDGE DEWATERING PLC PANEL

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LOOP SPECIFICATIONS

1.01 GENERAL SCADA REQUIREMENTS

A. These general descriptions cover the Residual Improvements Project at the Tulsa, OK A.B. Jewell Water Treatment Plant. Apply these requirements where applicable.

B. Refer to Specification Section 44 44 63.02B – Polymer Feed System Dry for additional I/O interfacing and SCADA programming requirements.

C. Refer to Specification Section 44 44 13.01B – Belt Conveyor System for additional I/O interfacing and SCADA programming requirements.

D. Numbers shown at the end of a device tag number encased in parenthesis indicate multiple instruments and / or devices with the same tag number but the final digit of the tag number shall be sequential, not to exceed the number encased in parenthesis. Example: FIT-0103-(3) would indicate three flow indicating transmitters with the tag designation of FIT-0103-1, FIT-0103-2 and WW1000 FIT-0103-3.

E. Provide “bumpless” transfer when changing from SCADA Manual to SCADA Automatic control and from SCADA Automatic to SCADA Manual control. Provide “bumpless” transfer when changing from LOCAL to PLC control and from REMOTE to LOCAL control.

F. Provide discrepancy alarms for all discrete control outputs that have corresponding discrete status inputs. Provide an adjustable time delay for each such alarm. Treat discrepancy alarms as priority 400 (minor) alarms (coordinate with the Water Treatment Plant’s alarm standards and requirements).

G. 7Standard “Local” control functions: Motorized equipment at the A.B. Jewell Water Treatment Plant facilities shall have standardized local controls available, here after referred to as “Standard Local Controls”. Unless otherwise noted in the loop descriptions, these controls consist of:

1. A local LOCAL/OFF/REMOTE hand switch. In the LOCAL switch position, the motorized equipment can be started and stopped using the local STOP/ START push buttons. In the OFF position, the motorized equipment is shut down. In the REMOTE position, control is from the SCADA system.
2. Local STOP/START push buttons. When the LOCAL/REMOTE hand switch is in the LOCAL position, the motorized equipment can be

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started and stopped using these push buttons. When the LOCAL/REMOTE hand switch is in the REMOTE position, the STOP button shall stop the equipment, but the START button shall not start the equipment.

H. All references to "SCADA HMI" shall also apply to local "Panel Mounted PC"s.

I. Analytical Measuring and Trending Requirements

1. The analytical "High", "Low" and "Average" values shall be shown "per day" as indicated below.
2. The measured analytical values shall be displayed and / or shown in the following manner:
   a. Instantaneous Analytical Values– Indicates the analytical values as currently being measured by the corresponding analytical transmitter.
   b. Prior Days Analytical Values – Indicates the "High", "Low" and "Average" analytical values from the prior day (the "High" and "Low" values shall be time/date stamped). The analytical values shall be measured over a 24 hour period from 0000:00 to 2359:59 hours (midnight through midnight).
   c. Current Days Analytical Values – Indicates the "High", "Low" and "Average" analytical values from the current day (the "High" and "Low" values shall be time/date stamped). The analytical values shall be measured from 0000:00 to the time the operator requests to view the current day's analytical values (midnight through user requested analytical data display time).
   d. Historic Overall Analytical Values – Indicates the overall "High", "Low" and "Average" analytical values (the "High" and "Low" values shall be time/date stamped) from the last time the measured analytical values were reset to the time the operator requests to view the Historic Overall Analytical Values.
   e. Analytical Value Trending – Indicates the trended analytical values.
3. The measured analytical values (as indicated above) shall be recorded in the SCADA Historical repository. The recorded analytical values and trending shall be displayed on the SCADA HMI upon operator request.
4. The analytical values shall have a dedicated SCADA HMI graphic which shall display all the measured analytical values as indicated above.
5. The measured analytical values may be reset by an operator with the proper authorization (password protected). The SCADA System shall log the user ID, the "Max", "Min.", "Average" and trended values (Prior

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Days, Current Days and Historic Overall Analytical) and time date stamp the event of all analytical values which are reset.

J. Flow Totalizing and Trending Requirements (both SCADA HMI and local Panel Mounted PC):

1. All measured flows shall be totalized in the PLC the signal terminates at.
2. All flows shall be totalized “per day” and “total flow” as indicated below.
3. For each flow measured, the flow shall be displayed and / or totalized and / or trended and shown in the following manner:
    a. Instantaneous Flow – Indicates the flow as currently being measured by the corresponding flow meter.
    b. Prior Days Flow – Indicates the flow as totalized from the prior day. This flow shall be totalized over a 24-hour period from 0000:00 to 2359:59 hours (midnight through midnight).
    c. Current Days Flow – Indicates the flow as totalized from the current day. This flow shall be totalized from 0000:00 to the time the operator requests to view the current days flow (midnight through user requested flow display time).
    d. Total Flow – Indicates the flow as totalized from the last time the totalized flow was reset to the time the operator requests to view the totalized flow.
    e. Flow Trending – Indicates the trended flow of the as measured by the Flow Indicating Transmitter.
4. The totalized flows (as indicated above) shall be recorded in the SCADA Historical repository. The recorded flow values and trending shall be displayed on the SCADA HMI upon operator request.
5. Each Flow Meter shall have a dedicated SCADA HMI graphic which shall display all the flow information as indicated above.
6. The totalized flows may be reset by an operator with the proper authorization (password protected). The SCADA System shall log the user ID, the totalized flow values (Prior Days, Current Days and Total Flow), trending and time date stamp the event of all flows which are reset.
7. Level Measuring and Trending Requirements (SCADA HMI and local Panel Mounted PC):
    a. The measured level “High”, “Low” and “Average” values shall be shown “per day” as indicated below.
    b. The measured level shall be displayed and / or shown in the following manner:
        1) Instantaneous Level – Indicates the level as currently being measured by the corresponding level transmitter.

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2) Prior Days Level – Indicates the “High”, “Low” and “Average” levels from the prior day (the “High” and “Low” values shall be time/date stamped). The average level shall be measured over a 24-hour period from 0000:00 to 2359:59 hours (midnight through midnight).
3) Current Days Level – Indicates the “High”, “Low” and “Average” levels from the current day (the “High” and “Low” values shall be time/date stamped). The level shall be measured from 0000:00 to the time the operator requests to view the current days level (midnight through user requested level display time).
4) Historic Overall Level – Indicates the overall “High”, “Low” and “Average” levels (the “High” and “Low” values shall be time/date stamped) from the last time the measured level was reset to the time the operator requests to view the Historic Overall Level.
5) Measured Level Trending – Indicates the trended measured level.

c. The measured level (as indicated above) shall be recorded in the SCADA Historical repository. The recorded level values and trending shall be displayed on the SCADA HMI upon operator request.
d. The measured level shall have a dedicated SCADA HMI graphic that shall display all the measured levels as indicated above.
e. The measured levels may be reset by an operator with the proper authorization (password protected). The SCADA System shall log the user ID, the ”Max”, “Min.”, “Average” and trended values (Prior Days, Current Days and Historic Overall Level) and time date stamp the event of all level values which are reset.

8. PID Trending Requirements:
a. The measured PID values shall be displayed and / or shown in the following manner:
1) Instantaneous PID Values– Indicates the PID values as currently being measured by the corresponding analytical, flow transmitter, valve actuator and calculated values.
2) Prior Days PID Values – Indicates the trended PID values from the prior day. The PID values shall be measured over a 24-hour period from 0000:00 to 2359:59 hours (midnight through midnight).
3) Current Days PID Values – Indicates the trended PID values from the current day. The PID values shall be measured from 0000:00 to the time the operator requests to view the current day’s PID values (midnight through user requested PID data display time).

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4) Historic PID Values – Indicates the overall trended PID values (the “Alarm State” values shall be time/date stamped) from the last time the measured PID values were reset to the time the operator requests to view the Historic PID Values.
5) Measured PID Value Trending – Indicates the trending of the measured PID values.

b. The measured PID values (as indicated above) shall be recorded in the SCADA Historical repository. The recorded PID values and trending shall be displayed on the SCADA HMI upon operator request.
c. The measured PID values shall have a dedicated SCADA HMI graphic which shall display all the measured PID values as indicated above.
d. The measured PID values may be reset by an operator with the proper authorization (password protected). The SCADA System shall log the user ID, the ”Max”, “Min.”, “Average” and trended values (Prior Days, Current Days and Historic Overall Analytical) and time date stamp the event of all PID values which are reset.

9. Position Measuring and Trending Requirements (SCADA HMI and local Panel Mounted PC):
a. The measured position “High”, “Low” and “Average” values shall be shown “per day” as indicated below.
b. The measured position shall be displayed and / or shown in the following manner:
1) Instantaneous Position – Indicates the position as currently being measured by the corresponding position transmitter.
2) Prior Days Position – Indicates the “High”, “Low” and “Average” positions from the prior day (the “High” and “Low” values shall be time/date stamped). The average position shall be measured over a 24-hour period from 0000:00 to 2359:59 hours (midnight through midnight).
3) Current Days Position – Indicates the “High”, “Low” and “Average” positions from the current day (the “High” and “Low” values shall be time/date stamped). The position shall be measured from 0000:00 to the time the operator requests to view the current days position (midnight through user requested position display time).
4) Historic Overall Position – Indicates the overall “High”, “Low” and “Average” positions (the “High” and “Low” values shall be time/date stamped) from the last time the measured position was reset to the time the operator requests to view the Historic Overall Position.

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5) Measured Position Trending – Indicates the trended measured position.

c. The measured position (as indicated above) shall be recorded in the SCADA Historical repository. The recorded position values and trending shall be displayed on the SCADA HMI upon operator request.

d. The measured position shall have a dedicated SCADA HMI graphic that shall display all the measured positions as indicated above.

e. The measured positions may be reset by an operator with the proper authorization (password protected). The SCADA System shall log the user ID, the ”Max”, “Min.”, “Average” and trended values (Prior Days, Current Days and Historic Overall Position) and time date stamp the event of all position values which are reset.

10. Pressure Measuring and Trending Requirements (SCADA HMI and local Panel Mounted PC):

a. The measured pressure “High”, “Low” and “Average” values shall be shown “per day” as indicated below.

b. The measured pressure shall be displayed and / or shown in the following manner:

1) Instantaneous Pressure – Indicates the pressure as currently being measured by the corresponding pressure transmitter.

2) Prior Days Pressure – Indicates the “High”, “Low” and “Average” pressures from the prior day (the “High” and “Low” values shall be time/date stamped). This pressure shall be measured over a 24-hour period from 0000:00 to 2359:59 hours (midnight through midnight).

3) Current Days Pressure – Indicates the “High”, “Low” and “Average” pressures from the current day (the “High” and “Low” values shall be time/date stamped). The pressure shall be measured from 0000:00 to the time the operator requests to view the current day’s pressure (midnight through user requested pressure display time).

4) Historic Overall Pressure – Indicates the overall “High”, “Low” and “Average” pressures (the “High” and “Low” values shall be time/date stamped) from the last time the measured pressure was reset to the time the operator requests to view the Historic Overall Pressure.

5) Measured Pressure Trending – Indicates the trending of the measured pressure values.

c. The measured pressure (as indicated above) shall be recorded in the SCADA HMI and local Panel Mounted PC Historical repository. The recorded pressure values and trending shall be

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displayed on the SCADA HMI and local Panel Mounted PC upon operator request. Trended data shall be stored on the removable memory card.

d. The measured pressure shall have a dedicated SCADA HMI and local Panel Mounted PC graphic which shall display all the measured pressure as indicated above.

e. The measured pressure may be reset by an operator with the proper authorization (password protected). The SCADA HMI and local Panel Mounted PC shall log the user ID, the ”Max”, “Min.”, “Average” and trended values (Prior Days, Current Days and Historic Overall Pressure) and time date stamp the event of all pressure values which are reset.

11. Temperature Measuring and Trending Requirements (both SCADA HMI and local Panel Mounted PC):

a. The measured temperature “High”, “Low” and “Average” values shall be shown “per day” as indicated below.

b. The measured temperature shall be displayed and / or shown in the following manner:

1) Instantaneous Temperature – Indicates the temperature as currently being measured by the corresponding temperature transmitter.

2) Prior Days Temperature – Indicates the “High”, “Low” and “Average” temperatures from the prior day (the “High” and “Low” values shall be time/date stamped). This temperature shall be measured over a 24-hour period from 0000:00 to 2359:59 hours (midnight through midnight).

3) Current Days Temperature – Indicates the “High”, “Low” and “Average” temperatures from the current day (the “High” and “Low” values shall be time/date stamped). The temperature shall be measured from 0000:00 to the time the operator requests to view the current day’s temperature (midnight through user requested temperature display time).

4) Historic Overall Temperature – Indicates the overall “High”, “Low” and “Average” temperatures (the “High” and “Low” values shall be time/date stamped) from the last time the measured temperature was reset to the time the operator requests to view the Historic Overall Temperature.

5) Measured Temperature Trending – Indicates the trending of the measured temperature.

c. The measured temperature (as indicated above) shall be recorded in the SCADA Historical repository. The recorded temperature values and trending shall be displayed on the SCADA HMI upon operator request.

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d. Each temperature measured shall have a dedicated SCADA HMI graphic which shall display all the measured temperatures as indicated above.
e. The measured temperatures may be reset by an operator with the proper authorization (password protected). The SCADA System shall log the user ID, the ”Max”, “Min.”, “Average” and trended values (Prior Days, Current Days and Historic Overall Temperature) and time date stamp the event of all temperature values which are reset.

12. All discrete status change of states shall be time-date stamped and logged in the SCADA Historical Repository. This recorded data shall be displayed on the SCADA HMI upon operator request.
13. Permissive Indication (both SCADA HMI and local Panel Mounted PC):
    a. If an operator attempts to operate a device in the “Remote – Manual” operation via the SCADA HMI and/or the local Panel Mounted PC and all the permissives to allow that device to operate in this mode of operation are not met, the HMI shall display which permissives need to be met in order to allow the device to operate in the “Remote – Manual” mode of operation.
    b. Gray out the HMI controls if the equipment is not in “Remote” or all permissives are not met to operate the equipment.
14. PLC Diagnostics (indicated on local Panel Mounted PC only):
    a. The Panel Mounted PC shall have a series of screens for PLC diagnostics. These screens shall be accessible by the operator by depressing the “Diagnostics” push button icon located on the main screen.
    b. An overall screen of the PLC, communication module and all I/O cards shall be shown. The operator shall have the ability to select which card they want displayed by depressing the appropriate push button icon.
15. Discrete I/O shall list the PLC points, the tag number of the points, a word description of what that point represents an indication if the point is on or off.
16. Analog I/O shall list all analog signals, the tag number of the analog signal, a word description of what the analog signal represents an indication of the value of signal in Engineering Units.
17. Local Alarm Screen (indicated on local Panel Mounted PC only – independent of the SCADA historian server and Head-End SCADA alarm screen):
    a. The local Panel Mounted PC shall be programmed to have an “Alarm Screen” which shall indicate all alarms present at the control system the control panel is monitoring with a time/date stamp on when the alarm occurred.

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b. The “Alarm Screen” shall have the following push button icons:
   1) Scroll up – This shall scroll up the alarms listed on the screen.
   2) Scroll down – This shall scroll down the alarms listed on the screen.
   3) Alarm Acknowledge – This shall silence the alarm horn if activated.
   4) Alarm Reset – This shall reset any alarm which has locked out any equipment from operation when all alarm conditions have been cleared.
   5) Alarm Historical Screen – This shall take the operator to the “Alarm Historical Screen”.
   6) Back – This shall take the operator back to the previous screen.

c. The local Panel Mounted PC shall be programmed to have an “Alarm Historical Screen” which shall indicate all cleared alarms which occurred over the past two weeks at the control system the control panel is monitoring with a time/date stamp on when the alarm occurred.

d. The “Alarm Historical Screen” shall have the following push button icons:
   1) Scroll up – This shall scroll up the alarms listed on the screen.
   2) Scroll down – This shall scroll down the alarms listed on the screen.
   3) Alarm Acknowledge – This shall silence the alarm horn if activated.
   4) Alarm Reset – This shall reset any alarm which has locked out any equipment from operation when all alarm conditions have been cleared.
   5) Alarm Screen – This shall take the operator to the “Alarm Screen”.
   6) Back – This shall take the operator back to the previous screen.

e. Once an alarm condition has been cleared and the “Alarm Reset” push button icon has been depressed, the alarm shall be removed the “Alarm Screen” and placed in the “Alarm Historical Screen”.

f. If the Panel Mounted PC is in a different screen other than the “Alarm Screen” and an alarm occurs at the control system the control panel is monitoring, a flashing banner indicating the alarm shall be displayed on the bottom of the screen.

g. If the operator touches the banner, the operator shall be taken to the “Alarm Screen”.

18. Setpoints:

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a. All setpoints shall be set during the commissioning process.
b. Each setpoint shall be password protected / operator adjustable.
c. Each setpoint shall have a password protected pushbutton graphic which shall reset the setpoint to its default state (the setpoint as determined during the commissioning process).
d. The setpoints may also be reset globally by a password protected pushbutton graphic which shall reset all setpoints to their default state.
e. The SCADA Historian shall maintain a history of the ten prior setpoints (to include which user made the setpoint change).

19. Alarm Resets:
    a. Alarms generated at the motor control center (MCC); such as motor overloads, seal water failure, hard-wired process interlocks shall be manually reset at the MCC or pump operator interface panel.
    b. Alarms generated at the local control panels, such as pump safety lock-out alarms, package blower alarms, shall be manually reset at the local control panel or Local Control Station.
    c. Alarms generated in the SCADA system such as discrepancy alarms (FAIL TO START, etc.) and SCADA process interlocks shall be manually reset at the SCADA HMI.
20. Power Supply Monitoring Requirements: The “Power Supply OK” contacts of all power supplies and power supply redundancy modules shall be wired in series to an interposing relay. A contact of the interposing relay shall be wired to the PLC housed within the panel to monitor for a power supply fault within the control panel.
21. Additional Programming Requirements:
    a. Cycle Count: This shall be an operator resettable (password protected) indication of how many times a piece of equipment has been turned on and off or how often a valve/gate has been opened and closed.
    b. The following shall be required “Warnings” on all analog PID loops (Note: Warnings do not shut off equipment nor does it shut down a process, it is only for informational purposed only and to be logged by the SCADA Historian):
        1) “Setpoint Deviation” – This warning shall be initiated by the PLC if a process is called to maintain a setpoint and does not reach that setpoint (password protected operator settable deadband) within an allotted amount of time (password protected operator adjustable – time delay to be process dependent).
    c. In the event multiple level transmitters are used (in a wetwell or tank) to monitor and control pump operation, the following

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control options shall be incorporated on the pump station SCADA graphic:

1) The operator may manually select which level transmitter to use for control of the pumps via a push button icon located on the corresponding SCADA graphic for the pump station.
2) The operator may select an averaging mode where the average of all measured levels from the level transmitters is used as the measured level in the wetwell/tank.
3) Alarms: When the measured levels of the level transmitters vary by five percent (operator adjustable) or greater, an "Alarm" shall be generated by the PLC which shall indicate a measured level deviation. The operator shall then manually select which measured level is to be used for control of the pumps at the pump station.

d. PLC control programming of AFD pumps to maintain a level in the wetwell / tank shall use a PI loop to modulate the pumps.

22. Function Definitions:

a. Open Fail: If a valve has been commanded to OPEN by the PLC (in either an automatic sequence of operation or manually commanded via the SCADA system) and is not proven "FULLY OPENED" within 30 seconds (password protected operator adjustable), the valve shall be considered failed by the PLC. Unless otherwise noted, a valve is confirmed "FULLY OPENED" by receiving an Open contact closure from the valve limit switch.

b. Close Fail: If a valve has been commanded to CLOSE by the PLC (in either an automatic sequence of operation or manually commanded via the SCADA system) and is not proven "FULLY CLOSED" within 30 seconds (password protected operator adjustable), the valve shall be considered failed by the PLC. Unless otherwise noted, a valve is confirmed "FULLY CLOSED" by receiving a Closed contact closure from the valve limit switch.

c. Failure to Start / Run: If a pump or piece of mechanical equipment is commanded to RUN by the PLC (in either an automatic sequence of operation or manually commanded via the SCADA system) and has not been proven to be running within 15 seconds or greater (password protected operator adjustable), the pump or piece of mechanical equipment shall be considered failed by the PLC. Unless otherwise noted, a pump or piece of mechanical equipment is confirmed running by receiving the "Pump Running" or "Running" contact closure, by a current switch (monitoring the motor leads) changing states, differential pressure across the pump, AFD speed feedback or any combination of the above.

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d. Failure to Stop: If a pump or piece of mechanical equipment is commanded to STOP by the PLC (in either an automatic sequence of operation or manually commanded via the SCADA system) and has not been proven to be stopped within 15 seconds or greater (password protected operator adjustable), the pump or piece of mechanical equipment shall be considered failed by the PLC. Unless otherwise noted, a pump or piece of mechanical equipment is confirmed stopped by receiving the "Pump Running" or "Running" contact being restored to its normal state, by a current switch (monitoring the motor leads) is restored to its normal state, differential pressure across the pump is restored to its normal state, AFD speed feedback reads a speed of zero (4mADC) or any combination of the above.

e. Analog Setpoint / Speed Deviation Warning: A warning shall be displayed on the SCADA HMI when an analog device (Example: AFD pump) is commanded to a setpoint by the PLC and the device does not achieve that setpoint (within the allowable deadband) within 20 seconds (password protected operator adjustable). This shall only alert the operator and not shut down the associated process.

f. Totalize Flow: Integrate flow rate with respect to time. Unless otherwise noted, operator shall be able to reset totalized value to zero.

g. Cycle Count: Count the number of cycles a piece of equipment undergoes. One cycle is defined as the transition from OFF to ON. For valves, one cycle is defined from one Closed status event to the next.

h. Ramp: Adjust the position of a controlled device; e.g., modulating valve, adjustable speed drive at slow controlled rate.

23. Modulating in Sequence: This describes when multiple adjustable frequency drive (AFD) motors are operating in parallel modulating at the same speed to maintain the process setpoint.

24. Programming Requirements:

a. The "Head-End" SCADA HMI shall have new SCADA graphics programmed to accommodate all work as described on the Drawings and within these Specifications. The existing "Head-End" SCADA software shall be Wonderware. Coordinate with Owner on software version.

1) New HMI screens shall be programmed to monitor and accept operator inputs and log any changes of state; all functions as described within these Contract Documents.

2) The PLC shall be programmed to control the process as described within these Contract Documents.

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b. Data / Alarm Historian shall be reprogrammed to capture all data and alarms as described within these Contract Documents.
c. All programming of existing and new PLCs shall be ladder logic or function blocks.
d. All Package System screens shall be duplicated on the new Plant SCADA system. Screens shall monitor the new package systems and all data shall be added to the new SCADA Historian. Coordinate with the package system control vendors for additional information.

4.01 NEW BELT CONVEYOR CONTROLS

A. New conveyor will replace the existing belt conveyor. Incorporate new conveyor monitoring and control from SCADA and update per the current standards.

4.02 DRY POLYMER CONTROLS

A. Vendor to provide dry polymer control per Section 44 44 63.02, Polymer Feed System, Dry, Article Dry Polymer System Control Package, Paragraph Functional Description.

B. Incorporate SCADA interface to provide all functions for the Dry Polymer System Monitoring and Control from the SCADA system.

4.03 POLYMER TANK LEVEL

A. New Level transmitters will replace the existing transmitters. Confirm new levels are properly displayed and update per the current standards.

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IO LIST

Tag Number	Type	Description	P&ID	Panel Number
LE/LIT-1820-01	AI	RADAR LEVEL ELEMENT AND TRANSMITTER	09-I-4	SLUDGE DEWATERING PLC PANEL
LE/LIT-1820-02	AI	RADAR LEVEL ELEMENT AND TRANSMITTER	09-I-4	SLUDGE DEWATERING PLC PANEL
LE/LIT-1820-03	AI	RADAR LEVEL ELEMENT AND TRANSMITTER	09-I-4	SLUDGE DEWATERING PLC PANEL
LE/LIT-1820-04	AI	RADAR LEVEL ELEMENT AND TRANSMITTER	09-I-4	SLUDGE DEWATERING PLC PANEL

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JACOBS **INSTRUMENT CALIBRATION SHEET** Rev.06.05.92

COMPONENT	MANUFACTURER	PROJECT
Code:	Name:	Number:
Name:	Model:	Name:
	Serial #:	

FUNCTIONS

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? Y / N	CONTROL? Y / N
Indicate? Y / N	Chart:			Describe:	Action? direct / reverse Modes? P / I / D
Record? Y / N	Scale:				SWITCH? Y / N Unit Range: Differential: fixed/adjustable
Transmit/	Input:				
Convert? Y / N	Output:				Reset? automatic / manual

ANALOG CALIBRATIONS

REQUIRED			AS CALIBRATED			
Input	Indicated	Output	Increasing Input		Decreasing Input	
			Indicated	Output	Indicated	Output
CONTROL MODE SETTINGS:			P:	I:	D:	

DISCRETE CALIBRATIONS

	REQUIRED		AS CALIBRATED		**Note No.**
Number	Trip Point (note rising or falling)	Reset Pt.	Trip Point (note rising or falling)	Reset Pt.	
1.					
2.					
3.					
4.					
5.					
6.					
7.					

#	**NOTES:**

Component Calibrated and Ready for Startup
By:
Date:
Tag No.:

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INSTRUMENT CALIBRATION SHEET

EXAMPLE - ANALYZER/TRANSMITTER

Rev.06.05.92

COMPONENT	MANUFACTURER	PROJECT
Code: *A7*	Name: *Leeds & Northrup*	Number: *WDC30715.B2*
Name: *pH Element & Analyzer/Transmitter*	Model: *12429-3-2-1-7*	Name: *UOSA AWT PHASE 3*
	Serial #: *11553322*	

FUNCTIONS

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? N	CONTROL? N
Indicate? Y Record? N	Chart:			Describe:	Action? direct / reverse Modes? P / I / D
	Scale:	*1-14*	*pH units*		SWITCH? N Unit Range:
Transmit/ Convert? Y	Input:	*1-14*	*pH units*		Differential: fixed/adjustable
	Output:	*4-20*	*mA dc*		Reset? automatic / manual

ANALOG CALIBRATIONS

REQUIRED			AS CALIBRATED			
Input	Indicated	Output	Increasing Input		Decreasing Input	
			Indicated	Output	Indicated	Output
1.0	*1.0*	*4.0*	*1.0*	*4.0*	*1.0*	*3.9*
2.3	*2.3*	*5.6*	*2.2*	*5.5*	*2.3*	*5.6*
7.5	*7.5*	*12.0*	*7.5*	*11.9*	*7.5*	*12.0*
12.7	*12.7*	*18.4*	*12.7*	*18.3*	*12.6*	*18.3*
14.0	*14.0*	*20.0*	*14.0*	*20.0*	*14.0*	*20.0*
CONTROL MODE SETTINGS:			P: *N.A.*	I:	D:	

DISCRETE CALIBRATIONS

REQUIRED			AS CALIBRATED		Note
Number	Trip Point (note rising or falling)	Reset Pt.	Trip Point (note rising or falling)	Reset Pt.	**No**
1.	*N.A.*		*N.A.*		
2.					*1.*
3.					
4.					
5.					
6.					
7.					

#	**NOTES:**
	1. Need to recheck low pH calibration solutions.

Component Calibrated and Ready for Startup

By: *J.D. Sewell*

Date: *Jun-6-92*

Tag No.: AIT-12-6[pH]

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JACOBS **I&C VALVE ADJUSTMENT SHEET** Rev.06.05.92

PARTS	Project Name:	Project Number:
Body	Type:	Mfr:
	Size:	Model:
	Line Connection:	Serial #:
Operator	Type:	Mfr:
	Action:	Model:
	Travel:	Serial #:
Positioner	Input Signal:	Mfr:
	Action:	Model:
	Cam:	Serial #:
Pilot Solenoid	Action:	Mfr:
	Rating:	Model:
		Serial #:
I/P Converter	Input:	Mfr:
	Output:	Model:
	Action:	Serial #:
Position Switch	Settings:	Mfr:
	Contacts:	Model:
		Serial #:
Power Supply	Type:	Air Set Mfr:
	Potential:	Model:
		Serial #:

ADJUSTMENTS	Initial	Date	**VERIFICATION**	Initial	Date
Air Set			Valve Action		
Positioner			Installation		
Position Switches			Wire Connection		
I/P Converter			Tube Connection		
Actual Speed					

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REMARKS:	**Valve Ready for Startup**
	By:
	Date:
	Tag No.:

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JACOBS **I&C VALVE ADJUSTMENT SHEET** Rev.06.05.92

EXAMPLE

PARTS	Project Name: *SFO SEWPCP*	Project Number: *SFO10145.G2*
Body	Type: *Vee-Ball*	Mfr: *Fisher Controls*
	Size: *4-inch*	Model: *1049763-2*
	Line Connection: *159 # ANSI Flanges*	Serial #: *1003220*
Operator	Type: *Pneumatic Diaphragm*	Mfr: *Fisher Controls*
	Action: *Linear - Modulated*	Model: *4060D*
	Travel: *3-inch*	Serial #: *2007330*
Positioner	Input Signal: *3-15 psi*	Mfr: *Fisher Controls*
	Action: *Direct - air to open*	Model: *20472T*
	Cam: *Equal percentage*	Serial #: *102010*
Pilot Solenoid	Action:	Mfr:
	Rating: *None*	Model:
		Serial #:
I/P Converter	Input: *4-20 mA dc*	Mfr: *Taylor*
	Output: *3-15 psi*	Model: *10-T-576-3*
	Action: *Direct*	Serial #: *1057-330*
Position Switch	Settings: *Closed / Open 5 deg, rising*	Mfr: *National Switch*
	Contacts: *Close / Close*	Model: *1049-67-3*
		Serial #: *156 &157*
Power Supply	Type: *Pneumatic*	Air Set Mfr: *Air Products*
	Potential: *40 psi*	Model: *3210D*
		Serial #: *1107063*

ADJUSTMENTS	Initial	Date	**VERIFICATION**	Initial	Date
Air Set	*JDS*	*Jun-06-92*	Valve Action	*JDS*	*Jun-03-92*
Positioner	*JDS*	*Jun-06-92*	Installation	*JDS*	*Jun-03-92*
Position Switches	*JDS*	*Jun-06-92*	Wire Connection	*JDS*	*Jun-04-92*
I/P Converter	*JDS*	*Jun-07-92*	Tube Connection	*JDS*	*Jun-04-92*
Actual Speed	*JDS*	*Jun-07-92*			

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REMARKS: *Valve was initially installed backwards.*	**Valve Ready for Startup**
Observed to be correctly installed May-25-92	By: *J.D. Sewell*
	Date: *Jun-07-92*
	Tag No.: *FCV-10-2-1*

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JACOBS **PERFORMANCE ACCEPTANCE TEST SHEET** ***Rev.06.05.92***

Project Name:	Project No.:

Demonstration Test(s): For each functional requirement of the loop:
(a) List and number the requirement. (b) Briefly describe the demonstration test.
(c) Cite the results that will verify the required performance. (d) Provide space for signoff.

Forms/Sheets Verified	By	Date	**Loop Accepted By Owner**
Loop Status Report			By:
Instrument Calibration Sheet			Date:
I&C Valve Calibration Sheet			
Performance Acceptance Test	By	Date	
Performed			
Witnessed			Loop No.:

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JACOBS **PERFORMANCE ACCEPTANCE TEST SHEET** **Rev.06.05.92**

EXAMPLE

Project Name: *SFO SEWPCP Plant Expansion*	Project No.: *SFO12345.C1*

Demonstration Test(s): For each functional requirement of the loop:
(a) List and number the requirement. (b) Briefly describe the demonstration test.
(c) Cite the results that will verify the required performance. (d) Provide space for signoff.

1. MEASURE EFFLUENT FLOW

1.a With no flow, water level over weir should be zero and

FIT indicator should read zero. *Jun-20-92 BDG*

2. FLOW INDICATION AND TRANSMISSION TO LP & CCS

With flow, water level and FIT indicator should be related by expression

*Q(MGD) = 429*H**(2/3) (H = height in inches of water over weir).*

Vary H and observe that following.

2.a Reading of FIT indicator. *Jun-6-92 BDG*

2.b Reading is transmitted to FI on LP-521-1. *Jun-6-92 BDG*

2.c Reading is transmitted and displayed to CCS. *Jun-6-92 BDG*

H(measured)	*0*	*5*	*10*	*15*
Q(computed)	*0*	*47.96*	*135.7*	*251.7*
Q(FIT indicator)	*0*	*48.1*	*137*	*253*
Q(LI on LP-521-1)	*0*	*48.2*	*138*	*254*
Q(display by CCS)	*0*	*48.1*	*136.2*	*252.4*

Forms/Sheets Verified	By	Date	**Loop Accepted By Owner**
Loop Status Report	*J.D. Sewell*	*May-18-92*	By: *J.D. Smith*
Instrument Calibration Sheet	*J.D. Sewell*	*May-18-92*	Date: *Jun-6-92*
I&C Valve Calibration Sheet	*N.A.*		
Performance Acceptance Test	By	Date	
Performed	*J. Blow MPSDC Co.*	*Jun-6-92*	
Witnessed	*B.deGlanville*	*Jun-6-92*	Loop No.: *30-12*

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SECTION 40 99 90
PACKAGE CONTROL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. The Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
2. International Society of Automation (ISA): S50.1, Compatibility of Analog Signals for Electronic Process Instruments.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. AB 1, Molded Case Circuit Breakers and Molded Case Switches.
   c. ICS 2, Industrial Control Devices, Controllers and Assemblies.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. UL: 508A, Standards for Safety, Industrial Control Panels.

1.02 SYSTEM DESCRIPTION

A. Assemble panels and install instruments, plumbing, and wiring in equipment manufacturer’s factories.

B. Test panels and panel assemblies for proper operation prior to shipment from equipment manufacturer’s factory.

1.03 SUBMITTALS

A. Action Submittals:

1. Bill of material, catalog information, descriptive literature, wiring diagrams, and Shop Drawings for components of control system.
2. Catalog information on electrical devices furnished with system.
3. Shop Drawings, catalog material, and dimensional layout drawings for control panels and enclosures.
4. Panel elementary diagrams of prewired panels. Include in diagrams control devices and auxiliary devices, for example, relays, alarms, fuses, lights, fans, and heaters.

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5. Plumbing diagrams of preplumbed panels and interconnecting plumbing diagrams.
6. Interconnection wiring diagrams that include numbered terminal designations showing external interfaces.

B. Informational Submittals:

1. Programmable Controller Submittals:
   a. Complete set of user manuals.
   b. Fully documented ladder logic listings.
   c. Function listing for function blocks not fully documented by ladder logic listings.
   d. Cross-reference listing.
2. Manufacturer's list of proposed spares, expendables, and test equipment.
3. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers and related equipment as recommended by capsule manufacturer.

1.05 EXTRA MATERIALS

A. Spares, Expendables, and Test Equipment:

1. Selector Switch, Pushbutton, and Indicating Light: 20 percent, one minimum, of each type used.
2. Light Bulb: 100 percent, two minimum, of each type used.
3. Fuse: 100 percent, five minimum, of each type used.
4. Surge Suppressors: 20 percent, one minimum, of each type used.

PART 2 PRODUCTS

2.01 GENERAL

A. Section 40 90 01, Instrumentation and Control for Process Systems.

2.02 SIGNAL CHARACTERISTICS

A. Analog Signals:

1. 4 mA dc to 20 mA dc, in accordance with compatibility requirements of ISA S50.1.

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2. Unless otherwise specified or shown, use Type 2, two-wire circuits.
3. Transmitters: Load resistance capability conforming to Class L.
4. Fully isolate input and output signals of transmitters and receivers.

B. Pulse Frequency Signals: dc pulses whose repetition rate is linearly proportional to process variable over 10:1 range. Generate pulses by contact closures or solid-state switches.

1. Power source: Less than 30V dc.

C. Discrete Signals:

1. Two-state logic signals.
2. Utilize 120V ac sources for control and alarm signals.
3. Alarm signals shall be normally open, close to alarm isolated contacts rated for 5-ampere at 120V ac and 2-ampere at 30V dc.

D. As defined in Section 40 90 01, Instrumentation and Control for Process Systems.

2.03 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsule Manufacturers:

1. Northern Instruments; Model Zerust VC.
2. Hoffmann Engineering; Model A-HCI.

2.04 CONTROL PANEL

A. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), UL 508, state and local codes, and applicable sections of NEMA, ANSI, and ICECA.

B. Conform to NEMA ratings as specified in individual equipment sections.

C. Minimum Metal Thickness: 14 gauge.

D. NEMA 250, Type 4X Panels: Type 316 stainless steel construction unless otherwise specified.

E. Doors:

1. Three-point latching mechanisms in accordance with NEMA 250 Type 1 and 12 panels with doors higher than 18 inches.
2. For other doors, stainless steel quick release clamps.

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F. Cutouts shall be cut, punched, or drilled and finished smoothly with rounded edges.

G. Access: Front, suitable for installation with back and sides adjacent to or in contact with other surfaces, unless otherwise specified.

H. Temperature Control:

1. Size panels to adequately dissipate heat generated by equipment mounted on or in the panel.
2. Furnish cooling fans with air filters if required to dissipate heat.
3. For panels outdoors or in unheated areas, furnish thermostatically controlled heaters to maintain temperature above 40 degrees F.

I. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.

J. Lighting: Minimum of one hand switch controlled internal 100-watt incandescent light for panels 12 cubic feet and larger.

K. Minimum of one 120-volt GFCI duplex receptacle for panels 12 cubic feet and larger.

L. Finish:

1. Metallic External Surfaces (excluding aluminum and stainless steel): Manufacturer’s standard gray unless otherwise specified.
2. Internal Surfaces: White enamel.

M. Panel Manufacturers:

1. Hoffman.
2. H.F. Cox.

N. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels.

1. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.

2.05 CONTROL PANEL ELECTRICAL

A. UL Listing Mark for Enclosures: Mark stating “Listed Enclosed Industrial Control Panel” per UL 508A.

B. I&C and electrical components, terminals, wires, and enclosures UL listed.

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C. Control Panels without Motor Starters:

1. Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
2. Locate to provide clear view of and access to breakers when door is open. Group on single subpanel. Provide typed directory.
3. Circuit Breakers:
    a. Coordinate for fault in branch circuit trips, branch breaker, and not main breaker.
    b. Branch Circuit Breakers: 15 amps at 250V ac.
    c. Breaker Manufacturers and Products:
        1) Heineman Electric Co.; Series AM.
        2) Airpax/North American Philips Controls Corp.; Series 205.

D. Control Panels with Three-Phase Power Supplies and Motor Starters:

1. Interlock main circuit breaker with panel door.
    a. Mount logic controls, branch circuit breakers, overload reset switches, and other control circuit devices.
    b. Mount operator controls and indications on front access door.
2. Circuit Breakers:
    a. In accordance with NEMA AB 1.
    b. 18,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified.
    c. Breakers, except Motor Branch Breakers: Molded case thermal magnetic.
    d. 65,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified in package system equipment specification sections.
    e. Tripping: Indicate with operator handle position.
3. Magnetic Motor Starters:
    a. Full voltage, NEMA ICS 2, Class A, Size O minimum.
    b. Include three-pole bimetallic or eutectic alloy thermal overload relays sized for each motor.
    c. Manual reset type with reset button mounted on panel door.
4. Motor Control: 120V ac (except intrinsically safe circuits where applicable).
    a. Power Control Transformer:
        1) Sufficient capacity to serve connected load, including 200VA for duplex outlet plus 100VA (minimum).
        2) Limit voltage variation to 15 percent during contact pickup.
        3) Fuse one side of secondary winding and ground the other.
        4) Furnish primary winding fuses in ungrounded conductors.

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5. Power Monitoring Relay:
   a. Protect three-phase equipment from single phasing, phase imbalance, or phase reversal.
   b. Separate, isolated contact outputs to stop motors and activate alarm light during abnormal conditions.
   c. Transient Voltage Protection: 10,000 volts.
   d. Manufacturer and Product: Furnas; Class 47.
6. Power Distribution Blocks: Furnish to parallel feed tap on branch circuit protective devices. Do not “leap frog” power conductors.
7. Terminations for Power Conductors: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Wiring:

1. ac Circuits:
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current to be carried, but not less than 14 AWG.
2. Analog Signal Circuits:
   a. Type: 300-volt, Type 2 stranded copper, twisted shielded pairs.
   b. Size: 18 AWG, minimum.
3. Other dc Circuits.
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: 18 AWG, minimum.
4. Separate analog and other dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
5. Enclose wiring in sheet metal raceways or plastic wiring ducts.
6. Wire Identification: Numbered and tagged at each termination.
   a. Wire Tags: Machine printed, heat shrink.
   b. Manufacturers:
      1) Brady PermaSleeve.
      2) Tyco Electronics.

F. Wiring Interface:

1. For analog and discrete signal, terminate at numbered terminal blocks.
2. For special signals, terminate power (240 volts or greater) at manufacturer’s standard connectors.
3. For panel, terminate at equipment on/with which it is mounted.

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G. Terminal Blocks:

1. Quantity:
   a. For external connections.
   b. Wire spare or unused panel mounted elements to their panels' terminal blocks.
   c. Spare Terminals: 20 percent of connected terminals, but not less than 10.
2. General: Group to keep 120V ac circuits separate from 24V dc circuits.
   a. Connection Type: Screw connection clamp.
   b. Compression Clamp:
      1) Hardened steel clamp with transversal grooves penetrating wire strands providing a vibration-proof connection.
      2) Guides strands of wire into terminal.
   c. Screws: Hardened steel, captive, and self-locking.
   d. Current Bar: Copper or treated brass.
   e. Insulation:
      1) Thermoplastic rated for minus 55 degrees C to plus 110 degrees C.
      2) Two funnel shaped inputs to facilitate wire entry.
   f. Mounting:
      1) Rail.
      2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
      3) End Stops: One at each end of rail, minimum.
   g. Wire Preparation: Stripping only.
   h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
   i. Marking System:
      1) Terminal number shown on both sides of terminal block.
      2) Allow use of preprinted and field marked tags.
      3) Terminal strip numbers shown on end stops.
      4) Mark terminal block and terminal strip numbers as shown.
3. Terminal Block, 120-Volt Power:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 30 amp.
   c. Wire Size: 22 AWG through 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Spacing: 0.25 inch, maximum.
   g. Manufacturer and Product: Entrelec; Type M4/6.
4. Terminal Block, Ground:
   a. Wire Size: 22 AWG through 12 AWG.
   b. Rated Wire Size: 12 AWG.

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c. Color: Green and yellow body.
d. Spacing: 0.25 inch, maximum.
e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
f. Manufacturer and Product: Entrelec; Type M4/6.P.

5. Terminal Block, Blade Disconnect Switch:
   a. Use: Provide one for each discrete input and output field interface wire.
   b. Rated Voltage: 600V ac.
   c. Rated Current: 10 amp.
   d. Wire Size: 22 AWG through 12 AWG.
   e. Rated Wire Size: 12 AWG.
   f. Color: Gray body, orange switch.
   g. Spacing: 0.25 inch, maximum.
   h. Manufacturer and Product: Entrelec; Type M4/6.SN.
6. Terminal Block, Fused, 24V dc:
   a. Rated Voltage: 600V dc.
   b. Rated Current: 6.3 amp.
   c. Wire Size: 22 AWG through 12 AWG.
   d. Rated Wire Size: 12 AWG.
   e. Color: Gray body.
   f. Fuse: 5 by 20 GMA fuses.
   g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
   h. Indication: LED diode 24V dc.
   i. Leakage Current: 5.2 mA, maximum.
   j. Spacing: 0.32 inch, maximum.
   k. Manufacturer and Product: Entrelec; Type M4/6.SFD.
7. Terminal Block, Fused, 120V ac:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 6.3 amp.
   c. Wire Size: 22 AWG through 12 AWG
   d. Rated Wire Size: 12 AWG.
   e. Color: Gray body.
   f. Fuse: 5 by 20 GMA fuses.
   g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
   h. Indication: Neon lamp 110V ac.
   i. Leakage Current: 1.8 mA, maximum.
   j. Spacing: 0.32 inch, maximum
   k. Manufacturer and Product: Entrelec; Type M4/6.SFL.

H. Grounding: Internal copper grounding bus for ground connections on panels, consoles, racks, and cabinets.

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I. Relays:

1. General:
   a. Relay Mounting: Plug-in type socket.
   b. Relay Enclosure: Provide dust cover.
   c. Socket Type: Screw terminal interface with wiring.
   d. Socket Mounting: Rail.
   e. Furnish holddown clips.
2. Control Circuit Switching Relay, Nonlatching:
   a. Type: Compact general purpose plug-in.
   b. Contact Arrangement: 3 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Push-to-test button.
   k. Manufacturer and Product: Potter and Brumfield; Series KUP.
3. Control Circuit Switching Relay, Latching:
   a. Type: Dual coil mechanical latching relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
   g. Expected Mechanical Life: 500,000 operations.
   h. Expected Electrical Life at Rated Load: 50,000 operations.
   i. Manufacturer and Product: Potter and Brumfield; Series KB/KBP.
4. Control Circuit Switching Relay, Time Delay:
   a. Type: Adjustable time delay relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As specified or shown.
   f. Operating Temperature: Minus 10 degrees C to 55 degrees C.
   g. Repeatability: Plus or minus 2 percent.
   h. Delay Time Range: Select range such that time delay setpoint fall between 20 percent to 80 percent or range.
   i. Time Delay Setpoint: As specified or shown.
   j. Mode of Operation: As specified or shown.
   k. Adjustment Type: Integral potentiometer with knob external to dust cover.

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l. Manufacturer and Products: Potter and Brumfield.
   1) Series CB for 0.1-second to 100-minute delay time ranges.
   2) Series CK for 0.1- to 120-second delay time ranges.

J. Intrinsic Safety Barriers:

1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
   a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.
2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
   a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.

K. Programmable Controllers:

1. Solid state units capable of performing same function as conventional relays, timers, counters, drum sequencers, arithmetic, and other special functions necessary to perform required control functions.
2. Minimum of 64 internal control relays, 16 timer/counters, and four, 16 stop drum sequencers. Furnish minimum of 256 words of nonvolatile memory.
3. Minimum of 12 discrete inputs and 8 discrete outputs, optical isolations rated at 2,500-volt rms. Discrete inputs shall be 120V ac. Discrete outputs shall be rated for 2 amps at 120V ac. Each input and output shall have an LED ON/OFF status indicator.
4. Minimum of 25 percent excess capacity for inputs, outputs, internal coils, registers, and other necessary functions.
5. Capable of operating in a hostile industrial environment (for example, heat, electrical transients, RFI, and vibration) without fans, air conditioning, or electrical filtering. Units operate from 0 degree C to 60 degrees C and up to 95 percent humidity, noncondensing.
6. Furnish with a handheld, CRT, or personal computer programmer that plugs into controller. Program using conventional relay ladder diagram notation and drum sequencer chart notation. Programmer shall provide a force function to set inputs or outputs to a given state regardless of program or input conditions. Programmer shall indicate power flow through internal elements.
7. Manufacturer:
   a. Allen-Bradley.
   b. To maintain the Owner’s current system no equal will be accepted.

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L. Front-of-Panel Devices in Conjunction with NEMA 250, Type 1 and 12 Panels:

1. Potentiometer Units:
   a. Three-terminal, oiltight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
   b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
   c. Include legend plates with service markings.
   d. Manufacturers and Products:
      1) Allen-Bradley; Model 800T.
      2) Eaton/Cutler-Hammer; Model 10250T.
2. Indicating Lights:
   a. Heavy-duty, push-to-test type, oiltight, industrial type with integral transformer for 120V ac applications.
   b. Screwed on prismatic glass lenses in colors noted and factory engraved legend plates for service legend.
   c. Manufacturers and Products:
      1) Eaton/Cutler-Hammer; Type 10250T.
      2) General Electric; CR2940U.
3. Pushbutton, Momentary:
   a. Heavy-duty, oiltight, industrial type with full guard and momentary contacts rated for 10 amperes continuous at 120V ac.
   b. Standard size legend plates with black field and white markings for service legend.
   c. Manufacturers and Products:
      1) Square D; Class 9001, Type K.
      2) Eaton/Cutler-Hammer; Type T.
      3) General Electric; Type CR-2940.
4. Selector Switch:
   a. Heavy-duty, oiltight, industrial type with contacts rated for 120V ac service at 10 amperes continuous.
   b. Standard size, black field, legend plates with white markings, for service legend.
   c. Operators: Black knob type.
   d. Single-hole mounting, accommodating panel thicknesses from 1/16 inch to 1/4 inch.
   e. Manufacturers and Products for Units with up to Four Selection Positions:
      1) Eaton/Cutler-Hammer; Type T.
      2) Square D; Type K.

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f. Manufacturers and Products for Units with up to 12 Selection Positions:
   1) Rundel-Idec; Standard Cam Switch.
   2) Electroswitch; 31.

M. Front-of-Panel Devices Used in Conjunction with NEMA 250, Type 4X Panels:

1. Potentiometer, Watertight:
   a. Three-terminal, heavy-duty NEMA 250, Type 4X watertight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
   b. Single-hole, panel mounting accommodating panel thicknesses between 1/8-inch and 1/4-inch.
   c. Include engraved legend plates with service markings.
   d. Manufacturer and Product: Allen-Bradley; Bulletin 800H.
2. Indicating Lights, Watertight:
   a. Heavy-duty, push-to-test type, NEMA 250, Type 4X watertight, industrial type with integral transformer for 120V ac applications and corrosion-resistant service.
   b. Screwed on prismatic lenses and factory engraved legend plates for service legend.
   c. Manufacturers and Products:
      1) Square D; Type SK.
      2) Allen-Bradley; Type 800H.
3. Pushbutton, Momentary, Watertight:
   a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with momentary contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
   b. Standard size, black field, legend plates with white markings for service legend.
   c. Manufacturers and Products:
      1) Square D; Type SK.
      2) Allen-Bradley; Type 800H.
4. Selector Switch, Watertight:
   a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
   b. Standard size, black field, legend plates with white markings, for service legend.
   c. Operators: Black knob type.
   d. Single-hole mounting, accommodating panel thicknesses from 1/16-inch to 1/4-inch.

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e. Manufacturer and Products:
   1) Square D; Class 9001, Type SK.
   2) Allen-Bradley; Type 800H.

2.06 INSTRUMENT TAG NUMBERS

A. As shown in P&ID's.

2.07 NAMEPLATES, NAMETAGS, AND SERVICE LEGENDS

A. Nametags: Permanently mounted bearing entire ISA tag number.

1. Panel Mounted: Plastic, mounted to instrument behind panel face.
2. Field Mounted: Engraved Type 316 stainless steel, 22-gauge minimum thickness, attached with stainless steel.

B. Service Legends (Integrally Mounted with Instrument) and Nameplates:

1. Engraved, rigid, laminated plastic type with adhesive back. Furnish service legends and nameplates to adequately describe functions of panel face mounted instruments.
2. Color: White with black letters.
3. Letter Height: 3/16 inch.
4. For each panel, face mounted laminated nameplate inscribed with the panel name and tag number. Color shall be white with black letters 1/2 inch high.

C. Standard Light Colors and Inscriptions:

1. Unless otherwise specified in individual equipment specifications, use the following color code and inscriptions:

Tag	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	White

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Tag	Inscription(s)	Color
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow
FORWARD	FORWARD	Red
REVERSE	REVERSE	Blue

2. Lettering: Black on white and amber lenses; white on red and green lenses.
3. Standard Pushbutton Colors and Inscriptions:
   a. Use following unless otherwise shown in the P&ID's or wiring schematics:

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black
MA	MANUAL AUTO	Black Black
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

   b. Lettering Color:
      1) Black on white and yellow buttons.
      2) White on black, red, and green buttons.

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2.08 ELECTRICAL SURGE AND TRANSIENT PROTECTION

A. Equip control panels with surge-arresting devices to protect equipment from damage as a result of electrical transients induced in interconnecting lines from lightning discharges and nearby electrical devices.

B. Suppressor Locations:

1. At point of connection between an equipment item, including ac powered transmitters, and power supply conductor (direct-wired equipment).
2. On analog pairs at each end when the pair travels outside of building.
3. In other locations where equipment sensitivity to surges and transients requires additional protection beyond that inherent to design of equipment.

C. Suppressor Design:

1. Construction: First-stage, high-energy metal oxide varistor and second-stage, bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
2. Response: 5 nanoseconds maximum.
3. Recovery: Automatic.
4. Temperature Range: Minus 20 degrees C to plus 85 degrees C.
5. Enclosure Mounted: Encapsulated inflame retardant epoxy.

D. Suppressors on 120V ac Power Supply Connections:

1. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
2. First-Stage Clamping Voltage: 350 volts or less.
3. Second-Stage Clamping Voltage: 210 volts or less.
4. Power Supplies for Continuous Operation:
   a. Four-Wire Transmitter or Receiver: Minimum 5 amps at 130V ac.
   b. All Other Applications: Minimum 30 amps at 130V ac.

E. Suppressors on Analog Signal Lines:

1. Test Waveform: Linear 8-microsecond rise in current from 0 amp to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.

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2. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
   a. dc Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
   b. dc Clamping Voltage Tolerance: Plus or minus 10 percent.
   c. Maximum Loop Resistance: 18 ohms per conductor.

F. Manufacturers and Products:

1. Analog Signals Lines: Emerson Edco PC-642 or SRA-64 series.
2. 120V ac Lines: Emerson Edco HSP-121.
3. 480-Volt, Three-Phase Power Supplies: Square D Model SDSA3650.
4. Field Mounted at Two-Wire Instruments:
   a. Encapsulated in stainless steel pipe nipples.
   b. Emerson Edco SS64 series.
5. Field Mounted at Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, and 10-ohm resistor on signal line, all in enclosure.
   a. Enclosure:
      1) NEMA 4X Type 316 stainless steel with door.
      2) Maximum Size: 12 inches by 12 inches by 8 inches deep.
   b. Emerson Edco; SLAC series.

G. Grounding:

1. Coordinate surge suppressor grounding in field panels and field instrumentation as specified in Section 26 05 01, Electrical, and suppressor manufacturer’s requirements.
2. Provide control panels with an integral copper grounding bus for connection of suppressors and other required instrumentation.

PART 3 EXECUTION

3.01 ELECTRICAL POWER AND SIGNAL WIRING

A. Restrain control and signal wiring in control panels by plastic ties or ducts. Secure hinge wiring at each end so bending or twisting will occur around the longitudinal axis of wire. Protect bend area with a sleeve.

B. Arrange wiring neatly, cut to proper length, and remove surplus wire. Install abrasion protection for wire bundles passing through holes or across edges of sheet metal.

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C. Use manufacturer's recommended tool with sized anvil for crimp terminations. No more than one wire may be terminated in a single crimp lug. No more than two lugs may be installed on a single screw terminal.

D. Do not splice or tap wiring except at device terminals or terminal blocks.

3.02 PROTECTION

A. Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.

B. During Work, periodically replace capsules in accordance with capsule manufacturer's recommendations. Replace capsules at Substantial Completion.

END OF SECTION

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SECTION 44 44 63.02
POLYMER FEED SYSTEM, DRY

EQUIPMENT AND COMPONENT NUMBER(S)

Polymer Blend Units: ABJ PMU 1815 01 (Anionic) and ABJ PMU 1815 03 (Cationic).
Control Panels: LCP 1815 01 (Anionic) and LCP 1815 03 (Cationic).

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME).
2. National Electrical Manufacturers' Association (NEMA): MG 1, Motors and Generators.

1.02 SUBMITTALS

1. Shop Drawings:
   a. Make, model, and weight of each equipment assembly.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Detailed mechanical drawings showing the equipment location and dimensions, size and locations of connections, weights of associated equipment, and construction details.
   d. Performance specifications of all items of equipment.
   e. Process schematics associated with all items of equipment.
   f. Instrument layout of the control panel.
2. Submittal of Interface Material: The following materials, defining the interface between the system specified herein and the remainder of the plant, plus any additional information called for in these Specifications, shall be submitted to the Engineer within 90 days following execution of Contract, and prior to any construction or fabrication that requires interfacing with the system.
   a. Identification, description, and envelope dimensions for each separately installed subassembly or piece of equipment and the associated connection dimensions to permit incorporation of the system selected into the design of the plant.
   b. Information on field and installation requirements, including mounting requirements, access, and approximate total weight of each piece of equipment.

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c. A detailed description of the instrumentation and control system, including a list of all functions monitored, controlled, and/or alarmed. Describe all automatic shutdown features and interfaces with the plant instrumentation and control systems. The description of the instrumentation and control system shall be in both word and schematic form. Schematics shall be in accordance with the latest edition of NEMA ICS. Clearly document any proposed deviations from the instrumentation and control systems detailed herein, on the Drawings and in Section 40 99 90, Package Control Systems.

d. Electric motor control schematics. Include locations of control stations, and any special control to be provided by others. Coordinate polymer controls with Plant SCADA System per Section 40 90 01, Instrumentation and Control for Process Systems.

e. A complete description of all interface links between the system components and between the system and other plant components. Provide a summary by interface link for the following:
   1) Number, size, and type of all process and auxiliary connections.
   2) Number, size, and type of electronic or electrical signal wires.
   3) Number, size, and type of electrical power wires.

f. Control panel envelope dimensions, mounting requirements, and access requirements (doors, louvers, etc.).

g. Fully commented ladder logic listings, I/O printouts, and cross-reference printouts documenting Programmable Controller software program.

B. Informational Submittals:

1. Field Performance Test Report.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturer’s printed installation instructions.
4. Manufacturer’s Certificate of Proper Installation.
5. Suggested spare parts list to maintain the equipment in service for a period of 1 year. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
6. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
7. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
8. As specified in Section 40 99 90, Package Control Systems.

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1.03 EXTRA MATERIALS

A. Furnish for each system:

1. Water inlet solenoid valve.
2. Feed discharge plug.
3. Spare vacuum conveyor per unit (if vacuum conveyor is provided in packaged system).

1.04 PREPARATION FOR SHIPMENT

A. Insofar as is practical, equipment specified herein shall be factory assembled and tested. Parts and assemblies that are of necessity shipped unassembled shall be packaged and tagged in a manner that will protect equipment from damage and facilitate final assembly in the field. Machined and unpainted parts shall be protected from damage by elements with application of a strippable protective coating.

PART 2 PRODUCTS

2.01 EQUIPMENT MANUFACTURERS AND PRODUCTS

A. Prominent Fluid Controls, Inc.; Model PolyRex 5.4.

B. Excell Feeders; Model 8080-C (240823).

C. Or approved equal.

2.02 POLYMER MIXING SYSTEM DESCRIPTION

A. Design of the dry polymer system is based on Prominent Model PolyRex 5.4.

B. Polymer system shall include, but not be limited to, two dry polymer feeders, rapid fill solenoid valves, disperser water solenoid valves, three-way valve polymer dispersers, level switches, level elements, disperser low-water pressure switches, proximity switches, system control panels, and other accessories as required and as specified herein.

C. Polymer system shall be capable of manually or automatically batching polymer solution in polymer mix/feed tanks from a dry supply source. Control panel shall control dry polymer feeder; control all automatic valves provided under this section and other sections; and control polymer mixers in polymer mixing tanks.

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D. Dry polymer feeder shall be capable of producing a smooth, homogeneous dry polymer feed to disperser unit. Feeder shall have a minimum capacity of 120 pounds of dry polymer per hour attainable under the following conditions:

1. Ambient Temperature Range: 40 degrees F to 100 degrees F.
2. Polymer feeder shall be comprised of main components listed below. Unit shall be supplied complete, ready for operation, and shall be mounted on a cast iron or fabricated steel baseplate.
    a. Polymer storage hopper with minimum of 4-cubic foot storage capacity and low bin level alarm indicator and bag splitter. Hopper shall be equipped with a drop-door conveniently located for ease of polymer input.
        1) Alternatively, the polymer storage hopper can be used in tandem with a vacuum conveyor, such that polymer will be conveyed directly from the polymer bags into the hopper.
    b. Constant-rate screw feeder.
    c. Dry polymer disperser and wetting unit.
    d. Solenoid operated rapid fill valve and disperser valve.

2.03 POLYMER FEEDER

A. Provide a volumetric feeder capable of feeding 2 pounds of dry polymer per minute.

B. Volumetric feeder motor shall be 208V, three-phase, 1/3 hp.

2.04 POLYMER DISPERSER

A. Wetting chamber shall consist of two integrated zones. Initial area, called an acceleration zone, shall be machined Type 316 stainless steel with a tangential water connection and emulsion polymer injection fitting. Water introduced tangentially at 50 feet per second shall produce a deep vortex into the second stage mixer below. Second stage mixer, close-coupled to the first, shall enclose a high shear mixing impeller imparting additional energy to the vortex. Resultant vortex shall produce a suction force of not less than 1 inch of mercury that ensures a vacuum for pulling any airborne dry polymer particles into water vortex. Polymer and water shall flow into the center of impeller and discharge at the perimeter via centrifugal force generated by the rotating impeller. Wetting system volutes shall be constructed of machined Type 316 stainless steel. Entire wetting system shall be enclosed in a single housing.

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B. Alternatively, the polymer disperser may also utilize hydraulic mixing in place of mechanical mixing for polymer dispersion. This system would consist of a stainless steel pre-wetting cone that creates a self-cleaning vortex. The pre-wetting cone sits atop a hydraulic mixing eductor, and the polymer flows by gravity from the pre-wetting cone into the eductor. The eductor creates a vacuum in the wetting cone that pulls the wetting cone water and polymer particles down into the jet eductor nozzle for pre-activation.

2.05 MAKEDOWN WATER BOOSTER PUMP

A. Makedown water booster pumps are not necessary for this application because the washdown water line into the building is well above 50 psi. Pressure requirements must be field verified prior to installing the dry polymer feed systems.

2.06 MAKEDOWN WATER PRESSURE REGULATION

A. Provide a 1-1/2-inch isolation ball valve and pressure safety (regulating) valve upstream of each of the dilution water inlets to the dry polymer blend units. Contractor shall field verify the highest pressure available into the unit as determined by the Owner's chosen makedown water supply line. Manufacturer shall determine maximum pressure limits for the blend unit and provide adequately sized pressure safety valves to protect the unit from high distribution pressures and surges.

2.07 AUTOMATIC VALVES

A. Polymer system supplier shall furnish the rapid fill valves and disperser water valves, complete with all necessary appurtenances such as actuators and limit switches. Disperser water valves and rapid fill valves shall be solenoid operated. Rapid fill valves shall be rated for 19 gpm minimum. Disperser water valves shall be rated for 25 gpm maximum (19 gpm at 50 psi minimum).

2.08 OPTIONAL EQUIPMENT

A. A powder vacuum conveyor system for dust free filling of polymer powder directly from a polymer bag or sack to the storage hopper including:

1. A Type 304 stainless steel vacuum conveyor fitted to the top of the powder hopper with a 10-foot hose and a suction nozzle.
2. A transfer capacity of 22 pounds per minute to 33 pounds per minute of the dry polymer.
3. Control switch and motor starter in the control panel. Motor is 208V, three-phase, 1.75 hp.

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2.09 CONTROL SYSTEMS

A. General: See Section 40 99 90, Package Control Systems, for general instrumentation and control requirements. All instrumentation, control, and electrical components provided under this section shall comply with the requirements of Section 40 99 90, Package Control Systems.

2.10 DRY POLYMER SYSTEM CONTROL PACKAGE

A. Provide a NEMA 4X aluminum panel for each system to house all electrical components, the programmable logic controller, Operator interface LCD Touchscreen and operator controls.

B. Panels:

1. Front of panel devices not available in NEMA 4X construction shall be recessed behind hinged, gasketed, watertight, clear acrylic windows with 1/4-turn quick release lift-and-turn latches.
2. Provide at panel, a control system for manual or automatic batch preparation, mixing, and aging of polymer solution in the polymer dissolution tanks. Control system furnished shall be configured to permit either manual or automatic batching operations according to the batching sequence described hereinafter. Control system provided shall also be designed to monitor for system malfunctions, with a discrete output being provided for remote “polymer system trouble” alarming.
3. Touchscreen on panel shall include ON/OFF/AUTO control and ON status indication of the dry polymer feeder and polymer mixers. It shall also include OPEN/CLOSE/AUTO control of the disperser water valves and rapid fill valves, UNIT 1/UNIT 2/AUTO control and position indication for three-way valve. OPEN/CLOSE/AUTO control and OPEN/CLOSE status indication for dissolution tanks discharge valves. For manual operation, the equipment identified above shall turn ON (or OPEN) and OFF (or CLOSE), when the respective control switches are in the ON (or OPEN) or OFF (or CLOSE) positions. When all of the control switches are in AUTO position, batching operations described below shall be performed automatically.
4. Provide on touchscreen START/STOP manual initiation control of batching operation. The system shall also be capable of being started remotely from SCADA. The programming of the Owner’s SCADA system is not part of this scope.
5. In the event of any system malfunction which shuts down the automatic batching operation, manual RESET shall be required at panel before any operations can resume.

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6. In AUTOMATIC mode, batching operations shall be controlled based on discrete liquid levels in dissolution tanks. Level monitoring systems provided shall detect LOW-LOW, LOW, MEDIUM, HIGH and HIGH-HIGH liquid levels in each dissolution tank. When batching operation has been completed, a BATCH READY light associated with the applicable tank shall be illuminated and remain on until tank level becomes LOW.

C. Functional Description:

1. Provide the following functions:
   a. When a new batch is manually or automatically initiated, disperser and rapid fill valves for the empty tank shall OPEN and water booster pump shall be turned ON (if applicable). Three-way valve position shall be confirmed. When liquid rises to MEDIUM level sufficient to cover the mixer blades, the rapid fill valve shall close and the dry polymer feeder and polymer mixer shall turn ON. Feeder and mixer run times shall be individually adjustable on the touchscreen. When feeder timer times out, the feeder shall be turned OFF and rapid fill valve shall again OPEN. On HIGH level, both the rapid fill valve and the disperser valve shall CLOSE and water booster pump shall STOP (if applicable). Polymer mixer shall continue to run until timer times out, at which time BATCH READY light for that tank shall be illuminated.
   b. If dry polymer feeder is ON and a LOW water pressure condition is present, for a preset but adjustable period of time, interrupt batching cycle and shut down dry polymer feeder, and close disperser water valve. Indicate and alarm the LOW water pressure condition.
   c. Provide on dry polymer feeder discharge piping a proximity type switch to detect a HIGH level condition. When HIGH level is detected, feeder shall pause for 15 seconds to allow dry polymer to clear out of piping. If a HIGH level condition is still present after 15 seconds, automatic batching cycle shall shut down with blower and dry polymer feeder being turned OFF and rapid fill and disperser valves being CLOSED. Indicate and alarm resulting HIGH level condition.

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d. Provide at panel the following discrete output to interface with plant control system:
   1) COMMON TROUBLE to include the following as a minimum:
      a) Low water pressure condition during dry polymer cycle, which after an adjustable time results in batching cycle shutdown.
      b) Batch cycle sequence trouble resulting when a device fails to respond within an adjustable time.
      c) HIGH level in dry polymer feeder discharge.
      d) LOW level in dry polymer feeder discharge.
      e) HIGH pressure in polymer feed pump discharge piping.
   2) Provide a dry contact output to start and stop water booster pump (if applicable).

D. Special Requirements:

1. Programmable Logic Controller System, Small:
   a. Control and monitoring functions required to automatically prepare, mix, and age polymer solution shall be implemented using a programmable logic controller (PLC) system. The specific control system proposed shall be designed such that each individual unit or subsystem of polymer system can be operated manually with PLC processor out-of-service. PLC shall be provided as specified in Section 40 99 90, Package Control Systems.
   b. Programmable logic controller system shall be programmed such that after loss of power and restoration, any batch sequence not completed will resume until completed.
2. Provide and install control and power wiring between components provided with the dry polymer system, including flow valves, disperser unit, mixers, and tanks.
3. Maintain alarm until RESET button is pushed.
4. PLC for each system shall be capable of Ethernet communications to the existing Plant SCADA System. Points shall be available as follows:
   a. System START command.
   b. System RUN status.
   c. System FAULT status.
   d. System AUTO status.
   e. Feeder Level Low alarm.
   f. Hopper Level High alarm.
   g. Batch READY.
   h. Mixer RUN status.

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2.11 POWER SUPPLY

A. Power supply to the polymer disperser system will be a single 208-volt, three-phase, 60-Hz, 20-amp circuit to panels LCP-1815-01 and LCP-1815-03. Available fault current at that point will be 22,000 amps, rms symmetrical.

2.12 MOTOR STARTERS AND DRIVES

A. In the mixing control panel provide combination starters for: Disperser units.

2.13 CONTROLLER

A. Provide a separate variable speed drive or DC-SCR with continuously adjustable stroking speed over a 20:1 range and capable of converting three-phase 208-volt AC to DC power for each motor.

B. NEMA 4X enclosure with meter calibrated from 0 percent to 100 percent of maximum motor speed, selector switch for HAND/OFF/REMOTE, and regulate stroking speed by manual adjustment potentiometer in HAND and by remote 4 mA dc to 20 mA dc signal in REMOTE.

C. Additional Functions where applicable:

1. Constant torque over a controlled speed range of 20:1.
2. Speed regulation-operating deviation band 2 percent of motor base speed due to a 95 percent load change.
3. Adjustable current limit up to 150 percent of rated current.
4. Contactor in motor armature circuit.
5. Adjustable maximum and minimum speed.
6. Full wave rectification.
    a. Circuit breaker or fused switch for protection of motor and SCR control unit and for disconnecting the control unit from the electric supply system.
7. Load capability of 150 percent of rated full load for 1 minute.
8. Dynamic braking.
9. TEFC dc permanent magnet motor for severe, chemical duty application.
10. Motor inverts time thermal overheat protection by motor thermo switch.
11. Provisions to accept a 4 mA to 20 mA speed output signal when in remote mode.
12. ON/OFF pushbuttons for control when in HAND.
13. Provisions to receive remote dry contact to run drive in REMOTE.
14. Dry contact rated 4A at 120V ac to close when drive is running.
15. Dry contact rated 4A at 120V ac to close when drive is in REMOTE.
16. Motor speed indicator.

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D. Variable speed drive shall not cause more than 1 percent harmonic distortion into the power supply voltage waveform, as defined by IEEE Standard 519. Furnish isolation transformers or filtering devices as necessary to meet requirement.

2.14 ACCESSORIES

A. Equipment Identification Plates: A 16-gauge stainless steel identification plate shall be securely mounted on all equipment provided under this section in a readily visible location. Plate shall bear the 3/8-inch engraved and black enamel filled equipment identification number indicated in this specification and/or as shown on the Drawings.

B. Lifting Lugs: Equipment over 100 pounds in weight shall be provided with lifting lugs.

C. Anchor Bolts: Anchor bolts shall be Type 316 stainless steel and at least 1/2 inch in diameter. Coordinate required size with final Shop Drawings.

2.15 FABRICATION

A. Finish of all metalwork shall be of the highest grade and equal to the best practice of modern shops. Exposed surfaces shall have smooth finish and sharp, well defined lines. Methods of fabrication not specified herein shall be adequate for the service encountered, and as reviewed by Engineer.

2.16 FACTORY FINISHING

A. Prepare and prime coat in accordance with Section 09 90 00, Painting and Coating, System No. 5.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in strict conformance with manufacturer’s recommendations.

3.02 FIELD TEST

A. Functional Test: Prior to plant startup, all equipment shall be inspected for proper installation, quiet operation, and proper connection.

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B. Performance Test: Performance will be deemed satisfactory when Contractor has verified, by means of a performance test in the presence of Engineer, that the dry polymer feeder, polymer wetting system, and polymer feed pumps can deliver the capacity specified herein. Contractor shall also verify satisfactory operation of all polymer system controls, including the polymer mixers. Cycle units twice prior to placing in service.

3.03 FIELD FINISHING

A. Equipment as specified in Section 09 90 00, Painting and Coating, System No. 5.

3.04 MANUFACTURER'S SERVICES

A. A manufacturer's representative for the equipment specified herein shall be present at the Job Site and/or classroom designated by Owner for the minimum person-days and trips listed for the services hereinunder, travel time excluded:

1. 5 person-days over three trips for integrating existing systems and onsite startup.

B. Startup services shall be at such times as requested by Contractor and as approved by Owner.

C. Training of Owner's personnel shall be at such times as requested by the Owner.

D. See Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

END OF SECTION

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SECTION 44 46 13.01
BELT CONVEYOR SYSTEM

PART 1 GENERAL

1.01 REFERENCES

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

1. American Bearing Manufacturers' Association (ABMA): 11, Load Ratings and Fatigue Life for Roller Bearings.
2. American Gear Manufacturers Association (AGMA).
3. American Iron and Steel Institute (AISI).
4. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   c. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength Standard.
5. Conveyor Equipment Manufacturers Association (CEMA): Belt Conveyors for Bulk Material.
6. National Electric Manufacturers Association (NEMA): MG 1, Motors and Generators.
7. UL: 674, Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.

1.02 SYSTEM DESCRIPTION

A. Performance Requirements: Design conveyor system to meet service at less than 60 percent of the conveyor's rated capacity. Each conveyor drive unit shall be designed for 100 percent of rated capacity.

B. Material received from Belt Filter Press 1-3 are required to be conveyed approximately 66 feet horizontally and then begin a 27-degree diagonal incline, which conveys residuals until it reaches a vertical height of approximately 22 feet. The belt conveyor incline then flattens again to horizontally convey material a minimum of 9 feet past the retention wall to discharge onto pavement east of the retention wall in the cake discharge area.

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1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Detail drawings and specifications for components of equipment showing all dimensions, parts, construction details, and materials.
   b. Performance specifications of equipment.
   c. Process schematics associated with equipment.
   d. Calculations, including:
      1) Effective conveyor belt tension, Te, pound.
      2) Conveyor belt horsepower.
      3) Maximum conveyor belt unit stress, PIW, pound per inch width.
      4) Shaft slope at pulley hub location, radians.
      5) L-10 bearing life for head, tail, and snub pulleys.
   e. Fabricated items, equipment structural supports, platforms, handrails, and associated items.
   f. Design loadings, for load combinations, to be transmitted to foundations or supports.
   g. Size, length, and spacing of anchor bolts or attachments to the foundations or supports.
   h. Specific details of attachment of bracing members to concrete or steel structures.
   i. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Design calculations for items covered by these Shop Drawings. Calculations shall show design stresses in structural members and connections for loading combinations.
2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Installation instructions.
4. Manufacturer’s test reports.
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
6. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.

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1.04 QUALITY ASSURANCE

A. Qualifications: Shop Drawings for conveyor support structures shall be stamped by a registered engineer of the state in which conveyor will be installed.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: After testing and before dismantling for shipment, matchmark and tag wiring and mechanical connections to ensure proper field assembly.

1.06 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts:

Item	Quantity
Carrying Idlers with Brackets	Two complete sets
Return Idlers with Brackets	One complete set
Belt scraper blade	One
V-belts	One complete set

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 SUPPLEMENTS

A. See supplements to this section for additional product information.

2.02 SERVICE CONDITIONS

A. Material Conveyed: Dewatered Drinking Water Residuals.

B. Bulk Density: 50 pounds to 70 pounds per cubic foot.

C. Moisture, Percent/Weight: 15 percent to 22 percent.

D. Capacity: 3.67 cubic feet per minute.

E. Continuous Use: 7 Days per Week.

F. Running Hours/Day: 12 to 24.

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G. Belt Size: 24 inches.

H. Belt Speed: 50 feet to 100 feet per minute.

I. Location: Inside or outside.

J. Operating Temperature: Minus 10 degrees F to 110 degrees F.

2.03 MANUFACTURERS

A. Schwing-Bioset (Custom Conveyor Division), Elk River, MN.

B. Conveyors 247 (Davis Industrial), Tampa, FL.

C. Or Engineer approved equivalent.

2.04 COMPONENTS

A. Frame:

1. Material: Galvanized steel.
2. Type: Minimum 6-inch formed channel, 3/16 inch thick with heavy pipe dividers and assembled in 10-foot sections.

B. Head Section:

1. Furnish a 12-inch diameter, 26-inch wide welded steel drum type head pulley, complete with lagging.
2. Support pulley shaft in pillow block bearings spaced at minimal distance to clear the running belt.
3. Furnish a belt cleaner at the underside of the head pulley to remove adhering material.
4. Furnish spring loaded, neoprene rubber blade belt cleaner on a channel or truss frame, for connection to the intermediate section of conveyor.

C. Tail Section:

1. Furnish a 12-inch diameter, 26-inch wide welded steel drum type tail pulley.
2. Support pulley shaft in pillow block bearings spaced at minimal distance to clear the running belt.
3. Furnish a belt cleaner-plow at the return belt prior to the tail pulley to prevent objects passing between the pulley and belt.
4. Furnish two feed-point troughing transition idlers, assembled and mounted on a channel or truss frame, for connection to the intermediate section of conveyor.

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D. Idlers:

1. Carrying Idlers: 18-inch, 20-degree, equal length, CEMA C roll diameter, 5-inch steel rolls with factory-sealed bearings.
2. Return Idlers: 10-inch flat conventional, CEMA C roll diameter, 5-inch rolls with factory-sealed bearings.
3. Idlers for Belt Scales: Scale quality, turned and balanced to 0.015 T.I.R (Total Indicated Runout).

E. Belt (Minimum Criteria):

1. Oil-resistant material.
2. 24-inch-wide, multiple ply, rated at 220 piw (pounds per inch width).
3. Top Cover: 1/8 inch.
4. Bottom Cover: 1/16 inch.
5. Service: Conventional, Rated for 40 degrees F to100 degrees F temperature (stress, 75 percent rating).
6. Splice: Mechanical fastener.

F. Skirtboards:

1. Fabricate from 10-gauge minimal thickness ASTM A167 Type 304 stainless steel plate.
2. Seal lower edge with a 60-durometer rubber, rectangular strip, clamped to the exterior of the skirtboard, with provision to adjust for wear.
3. The spacing shall not exceed 2/3 belt width.
4. Set skirtboard length at 2 feet per 100 fpm belt speed, but not less than three times the belt width.
5. Attach to the conveyor support frame and terminate over an idler.

G. Belt Washbox:

1. ASTM A167 Type 304 stainless steel construction box, tensioner, cleaners, and rolls.
2. Two multiple arm belt cleaners with pneumatic bellows tensioners.
3. Minimum three straight flat rollers.
4. Spray bar with nozzles designed to wet entire belt and flush box to drain.
5. Water Tight Access Door:
   a. Manufacturer and Product: Martin Engineering; type “CMTM.”

H. Drive Assembly:

1. Single drive, located at the head end.
2. Furnish OSHA coupling, belt, and chain guards.

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I. Gear Reducer:

1. Shaft mounted, with a V-belt drive.
2. Gear housing shall provide complete protection under service conditions.
3. Gears: Manufactured to meet the requirements of AGMA Standards and rated Class II operation.
4. Lubrication: By splash as a minimum. Furnish with oil heater.
5. Furnish internally located and lubricated backstops.

J. Controlled Acceleration: Accelerate the conveyor belt from rest by wound-rotor motor(s).

1. Applied Torque: Adequate to start a fully loaded belt.

K. Creep Drive:

1. Furnish an independent motor and drive machinery capable of driving the empty conveyor through a clutch arrangement.
2. Install as part of drive assembly.

L. Shafts: Size shafts to ensure a bending deflection at the pulley end disc of no greater than 5 minutes.

1. Drive and Tail Shafts:
   a. AISI Steel Grade Designation: 1040.
   b. Select the heat treatment process (such as, normalize, anneal, 400-degree quench and temper, or 800-degree quench and temper) that will result in a minimum yield tensile strength as required for the calculated shaft loads.
   c. Accurately grind and fit with key seats, as required.
   d. Stepdown diameters will not be acceptable without prior approval.
2. Other Shafts: 65,000 pounds per square inch minimum yield tensile strength, heat-treated, alloy steel.

M. Bearings:

1. Self-aligning, antifriction type, mounted in malleable iron housings, and fitted with taper-locking hubs.
2. Meet ABMA Standards with an L-10 life rating of 100,000 hours.
3. One bearing on each shaft shall float to compensate for shaft expansion.
4. Bearing seals shall prevent the ingress of water, dust, and be washdown duty rated.

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N. Takeup: Tail pulley.

1. Minimum Takeup Length: 3 percent of the total belt length.

O. Walkways:

1. Furnish a side mounted walkway with an antislip deck.
2. Furnish railings and toeplates meeting the requirements of OSHA and local safety codes.
3. Design walkway structural support members to attach to the underside of the conveyor frame and extend to the railing supports.

P. Covers:

1. Furnish galvanized steel 22-gauge weather protection covers for the outside portion of the conveyor.
2. Furnish fixed, three-quarter covers.
3. Furnish hinged covers with retaining brackets of chains when open and quick-release tiedown clips and brackets when closed.
4. Comply with OSHA Standards.

Q. Emergency Stop Switch: Furnish belt conveyors with an emergency stop system consisting of pull cord switches actuated by a cable system running the full length of both sides of the conveyor.

1. Cables and Supports:
   a. Orange-colored, plastic-covered steel aircraft cable.
   b. All cable end fittings and intermediate cable support eyes.
   c. Cable support eyes every 10 feet.
2. Switches:
   a. Limit the required actuating force to OSHA guidelines.
   b. Manually reset after actuation.
   c. Visual indication of operation.
   d. NEMA 250, Type 7 enclosure, with a single-pole, double-throw output contact, rated for switching an inductive load of 5 amps at 120V ac.
3. Manufacturers and Products:
   a. Conveyor Control Components; Model RS.
   b. Crouse-Hinds; Model AFU.

R. Structural Supports:

1. Design conveyor supports, and takeup towers.
2. Connect to building structure.

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3. Conveyor support locations are only shown when the adjoining structure requires that the conveyor support points be limited to specific locations. The absence of defined conveyor support locations or support details on the Drawings shall not relieve the Contractor of the responsibility of providing required conveyor supports.
4. Supports shall not restrict access to other process systems.
5. Design conveyor structures in conformance with the AISC Manual of Steel Construction, AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings.
6. Limit maximum total deflection to less than 1/300 of span. Brace supports adequately to carry horizontal loads.
7. The flange, webs, legs, or wall thickness of conveyor support framing shall not be less than 1/4 inch. Use tubular steel, pipe, flat bar, or other members that provide a clean design that will minimize dust ledges and pockets.

2.05 ACCESSORIES

A. Anchor Bolts: Type 316 stainless steel and as specified in Section 05 50 00, Metal Fabrications. Coat in accordance Section 09 90 00, Painting and Coating.

B. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

C. 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.

2.06 FABRICATION

A. Shop fabricate conveyor structural member and supports from structural carbon steel conforming to ASTM A36/A36M. Steel plate shall conform to ASTM A36/A36M or ASTM A283. Bolts shall conform to ASTM 325.

B. Shop/Factory Finishing:

1. Prepare and prime conveyor steel members, unpainted steel components, and structural supports in accordance with Section 09 90 00, Painting and Coating.
2. Furnish manufacturer’s standard.

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2.07 SOURCE QUALITY CONTROL

A. Inspect conveyor components for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Assemble and perform no-load running tests of the conveyor drive system at manufacturer's plant before shipment.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with the manufacturer's installation instructions.

B. Following installation, protect materials and equipment from corrosion, physical damage, and the effects of moisture.

3.02 FIELD FINISHING

A. Conveyor and Supports: As specified in Section 09 90 00, Painting and Coating.

B. Following installation, touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, and consistency, and type of surface of the original shop/factory finish.

3.03 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each conveyor.

1. Alignment: Prior to facility startup, test complete assemblies for correct rotation, proper alignment and connection, quiet operation, and satisfactory specified performance.

B. Performance Test:

1. Conduct on each conveyor.
2. Perform under actual or approved simulated operating conditions.
3. Test for a continuous 3-hour period without malfunction.

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3.04 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. 1/2 person-day for installation assistance and inspection.
   b. 1/2 person-day for functional testing and completion of Manufacturer's Certificate of Proper Installation.
   c. 1/2 person-day for prestartup classroom or Site training.
   d. 1 person-day for facility startup.
   e. 1/2 person-day for post-startup training of Owner's personnel.

B. See Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

3.05 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this specification:

1. Induction Motor Data Sheet.

END OF SECTION

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INDUCTION MOTOR DATA SHEET

Project: Residuals Improvements Phase 2

Owner: City of Tulsa

Equipment Name: Residuals Conveyor

Equipment Tag Number(s): ABJ-CONV-1710-01

Type: Squirrel-cage induction meeting requirements of NEMA MG 1

Manufacturer: For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.

Hazardous Location: ☐ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.

Motor Horsepower: 5 hp

Voltage: 230/460V

Phase: Three

Frequency: 60 hz

Synchronous Speed: 1,800 rpm

☒ Thermal Protection: Type F insulation

☐ Space Heater: _____ volts, single-phase

Guaranteed Minimum Efficiency at Full Load: _____ percent

Guaranteed Minimum Power Factor at Full Load: _____ percent

Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☒ 1.15

Enclosure Type: _____

☐ Multispeed, Two-Speed: _____ / _____ rpm

Winding: ☐ One ☐ Two

Mounting Type: ☒ Horizontal ☐ Vertical

☐ Vertical Shaft: ☐ Solid ☐ Hollow

☐ Vertical Thrust Capacity (lb): Up ____ Down ____

☐ Adjustable Speed Drive:

Operating Speed Range: _____ to _____% of Rated Speed

☐ Variable Torque

☐ Constant Torque

Additional Motor Requirements: ☒ See Section 26 05 01, Electrical, Motors paragraph.

Special Features:

TEFC, premium efficient motor.

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SECTION 44 46 16
BELT FILTER PRESS DEWATERING EQUIPMENT

EQUIPMENT AND COMPONENT NUMBER(S)

Belt Filter Press(es): ABJ BFP 1705 01, ABJ BFP 1705 02, and ABJ BFP 1705 01.

PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. The Work of this section covers the work necessary to provide a refurbishment of the existing belt filter press(es), and all appurtenances as specified herein.

B. Standardization of Similar Equipment: Provide **refurbished** belt filter presses that are the end product of one responsible system manufacturer or supplier to accommodate standardization of similar equipment operation and maintenance, spare parts, and replacement and manufacturer's services.

1.02 GENERAL

A. Unit Responsibility:

1. Minimum responsibilities of experienced belt filter press manufacturer named in qualification submittal include:
   a. Supply Belt Filter Press (BFP) equipment, complete with all accessories and appurtenances (including, but not necessarily limited to shafting, safety guards, speed reducers, and spare parts).
   b. Design, assembly, delivery, installation supervision, startup, and testing of BFP equipment.
   c. Furnish all components and accessories of the system to enhance compatibility, provide for ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions.

B. Like items of equipment provided hereunder shall be the end products of one manufacturer in order to achieve standardization for operation, maintenance, spare parts, and manufacturers' services.

C. System Interfaces: Coordinate the interfaces between the dewatering belt filter press and Section 44 46 13.01, Belt Conveyor System.

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1.03 REFERENCES

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

1. American Gear Manufacturers Association (AGMA).
2. American National Standards Institute (ANSI).
3. American Society of Mechanical Engineers (ASME): PTC-36, Measurement of Industrial Sound.
4. American Welding Society (AWS).
5. Anti-Friction Bearing Manufacturers Association (AFBMA).
6. ASTM International (ASTM): G65, Procedure A, Standard Practice for Conducting Dry Sand/Rubber Wheel Abrasion Tests.
7. British Standards Institute (BSI): BS 5490.
8. German Industrial Standards (DIN).
9. Institute of Electrical and Electronics Engineers (IEEE).
10. Instrument Society of American (ISA).
11. National Electric Code (NEC).
12. Occupational Safety and Health Act (OSHA).

1.04 SUBMITTALS

A. Informational Submittals:

1. Provide Operation and Maintenance Manual with Maintenance Summary Form in accordance with Section 01 78 23, Operation and Maintenance Data, and the following requirements:
   a. Operation, maintenance, recommended spare parts, and renewal parts information for all equipment furnished under this section.
   b. Set of complete as-reviewed Shop Drawing submittals.
   c. As-built electric and instrumentation and control wiring diagrams and equipment drawings.
   d. Index of all equipment suppliers listing current names, addresses, and telephone numbers of contacts for service, information, and assistance.
   e. Detailed operational procedures including step-by-step startup, normal operation, shutdown, and troubleshooting procedures.
   f. Detailed preventative maintenance requirements and recommended schedule.

1.05 SAFETY REQUIREMENTS

A. Refurbish all equipment specified herein with due regard to safety of operation, accessibility, and durability of parts, in compliance with all applicable OSHA, state, and local safety regulations.

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SECTION 44 46 16
BELT FILTER PRESS DEWATERING EQUIPMENT

EQUIPMENT AND COMPONENT NUMBER(S)

Belt Filter Press(es): ABJ BFP 1705 01, ABJ BFP 1705 02, and ABJ BFP 1705 01.

PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. The Work of this section covers the work necessary to provide a refurbishment of the existing belt filter press(es), and all appurtenances as specified herein.

B. Standardization of Similar Equipment: Provide **refurbished** belt filter presses that are the end product of one responsible system manufacturer or supplier to accommodate standardization of similar equipment operation and maintenance, spare parts, and replacement and manufacturer's services.

1.02 GENERAL

A. Unit Responsibility:

1. Minimum responsibilities of experienced belt filter press manufacturer named in qualification submittal include:
   a. Supply Belt Filter Press (BFP) equipment, complete with all accessories and appurtenances (including, but not necessarily limited to shafting, safety guards, speed reducers, and spare parts).
   b. Design, assembly, delivery, installation supervision, startup, and testing of BFP equipment.
   c. Furnish all components and accessories of the system to enhance compatibility, provide for ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions.

B. Like items of equipment provided hereunder shall be the end products of one manufacturer in order to achieve standardization for operation, maintenance, spare parts, and manufacturers' services.

C. System Interfaces: Coordinate the interfaces between the dewatering belt filter press and Section 44 46 13.01, Belt Conveyor System.

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1.03 REFERENCES

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

1. American Gear Manufacturers Association (AGMA).
2. American National Standards Institute (ANSI).
3. American Society of Mechanical Engineers (ASME): PTC-36, Measurement of Industrial Sound.
4. American Welding Society (AWS).
5. Anti-Friction Bearing Manufacturers Association (AFBMA).
6. ASTM International (ASTM): G65, Procedure A, Standard Practice for Conducting Dry Sand/Rubber Wheel Abrasion Tests.
7. British Standards Institute (BSI): BS 5490.
8. German Industrial Standards (DIN).
9. Institute of Electrical and Electronics Engineers (IEEE).
10. Instrument Society of American (ISA).
11. National Electric Code (NEC).
12. Occupational Safety and Health Act (OSHA).

1.04 SUBMITTALS

A. Informational Submittals:

1. Provide Operation and Maintenance Manual with Maintenance Summary Form in accordance with Section 01 78 23, Operation and Maintenance Data, and the following requirements:
   a. Operation, maintenance, recommended spare parts, and renewal parts information for all equipment furnished under this section.
   b. Set of complete as-reviewed Shop Drawing submittals.
   c. As-built electric and instrumentation and control wiring diagrams and equipment drawings.
   d. Index of all equipment suppliers listing current names, addresses, and telephone numbers of contacts for service, information, and assistance.
   e. Detailed operational procedures including step-by-step startup, normal operation, shutdown, and troubleshooting procedures.
   f. Detailed preventative maintenance requirements and recommended schedule.

1.05 SAFETY REQUIREMENTS

A. Refurbish all equipment specified herein with due regard to safety of operation, accessibility, and durability of parts, in compliance with all applicable OSHA, state, and local safety regulations.

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1.06 BASIS OF DESIGN

A. Design of the refurbishment of the BFP equipment as shown on the Drawings is based on the original equipment manufacturer: Andritz-Ruthner, Inc.; Model CPF 2.0 meter SMX-S8.

1.07 WARRANTY

A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or removal and replacement of Work provided under this specification section (including but not limited to the belt filter press, components) found defective during a warranty period of 2 years. With the exception of warranty period, all other requirements specified in the General Conditions remain in effect. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Andritz-Ruthner, Inc.
2. GSM Engineered Fabrics.
3. Or Engineer approved equivalent.

B. Meet the following BFP Manufacturer Qualifications:

1. Selected manufacturer must have a minimum of 4 years' experience in refurbishing belt presses provided through references.
   a. Provide a list of five projects for complete belt press refurbishment projects of similar scope and complexity.
   b. Submit list of reference installations including model number, location, residuals stream and characteristics, number of units, contract title, reference contact information (name, email, and phone number), project description, scope of work, year completed, and contract value.
   c. Manufacturers not meeting minimum reference installation requirement shall not be acceptable.
2. The successful bidder shall use only new parts (including lubricants) in the repair of the City's equipment.

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3. If the successful bidder plans to use any part other than an OEM-specified part, the successful bidder shall obtain written authorization from the Owner and Engineer for the use of such parts.

2.02 SERVICE CONDITIONS

A. Suitable for installation indoors, for exposure to continuous 100 percent relative humidity conditions, for operation in ambient air temperature from 40 degrees F to 110 degrees F, and for exposure to drinking water residuals, splash, spill, and washdown conditions.

B. Material to be Dewatered:

	Maximum	**Average**	**Minimum**
Residuals Type	**Drinking Water Residuals**		
Feed Solids (%TS)	3.0	2.0	1.0
pH	7.5	7.0	6.8

2.03 PERFORMANCE REQUIREMENTS

A. Continuously receive, flocculate, condition and dewater the feed Residuals specified herein, and neatly discharge the dewatered Residuals cake onto a belt conveyor.

B. Operate continuously or intermittently on demand. Suitable for dewatering the specified Residuals continuously for 24 hours per day, 7 days a week, and shall perform the required dewatering operations at the loading and operating conditions specified herein without side extrusion of Residuals between the belts or spillage of Residuals beyond the BFP envelope.

C. Numeric Performance Requirements:

1. Guarantee to match or exceed by the following numeric performance requirements during performance testing:

BFP Performance Requirements	
Item	**Required**
Minimum cake solids concentration, dry weight, percent total solids	15
Minimum overall solids capture, percent	95

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BFP Performance Requirements	
Item	**Required**
Maximum polymer dose in pounds active polymer per dry ton of feed solids	15
Minimum solids loading, pounds of dry feed solids per hour per BFP (2.0 meter) at 2.0 percent solids	1,600

D. Prior to establishing final performance guarantees, the Contractor shall review, document, and confirm the existing BFP operating conditions including throughput, cake solids, polymer usage, and residuals characteristics. This shall occur after the blend tank decant valve has been installed and before any BFP rehabilitation work begins. The resulting measurements shall be submitted to the Engineer and Owner for review. Only measurements formally accepted by the Engineer shall serve as the baseline conditions for all performance evaluations and guarantees.

E. For the purpose of this specification, "Solids Capture (SC)" will be defined as:

1. Solids Capture:

$$\%\ \text{Capture} = \frac{T}{F}\ x\ \frac{F-C}{T-C}\ x\ 100$$

Where:

T = Cake total solids (TS) (mg/kg).

F = Feed TS (mg/kg) - where feed is defined as the Residuals stream, excluding any dilution due to polymer solution addition.

C = Filtrate TSS (mg/kg) - where filtrate is defined as the stream attributable to the dewatering (all three zones of the BFP) of the Residuals feed only, excluding any dilution due to belt washwater.

2.04 EQUIPMENT

A. Provide the following refurbished parts from the existing units:

1. Clean and inspect shower boxes and other stainless components.
2. Disassemble shower pipes, and provide new nozzles, wire brush and seals installed.

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B. Provide the following new parts listed in the table below (or approved equal) for refurbishment of each of the three the existing units:

New Part	Part Number/ID
Complete set of new rollers and bearing assemblies (supplied for entire BFP)[1]	DMM6753E
30" Dia perforated roll with bearing assembly	DMM6522D-T
24" Dia S-roll with bearing assembly	DMM9714D
18" Dia S-roll with bearing assembly	DMM9718
16" Dia S-roll with bearing assembly	DMM9718
14" Dia S-roll with bearing assembly	DMM9722D
12" Dia S-roll with bearing assembly	DMM9724
10" Dia tension roll with bearing assembly	DMM9706
12" Dia deflection roll with bearing assembly	DMM6497
9.5" Dia drive roll with bearing assembly	DMM6540
9.5" Dia drive roll with (geared) bearing assembly	DMM6541
6.5" Dia tracking roll with bearing assembly	DMM5567D
6" Dia deflection roll with bearing assembly	DMM9707
Side wall seals	60112325
Splash guard seals	DMM6626C (Side seal) DMM9165B (Seal)
Set of dewatering belts	--
Top belt[2]	ID: 13140911
Bottom belt[3]	ID: 131410878
Distribution chute splash guard seal	SK1629 (Seal/chute cover)
Plow chicanes	DMM3525C
Wear strips (gravity and wedge zone)	300036431
Upper shower box seals	DMM10254B DMM10253B

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New Part	Part Number/ID
Lower shower box seals	DMM9254B
Shower bar nozzles	131410772
Shower bar internal brush	131410779
Shower bar seal kit	131684784
Doctor blades[4]	DMM9226C
Doctor blade tensioning Rosta's[5]	RSU27X40
Belt tension bellows[6]	AB-20C-2-6910
Support bushings for tension rods[7]	DMM8305C DMM5587C
Belt tracking bellows (air bellows)	AY-131
Tracking control valves (Automatic control valve)	E260
Tracking sensing arm and paddles	E261 (sensor palm arm) E262 (palm)
Gearbox and bull gears[8]	DMM9239D (gear) ID: 131454291 (bull gear 80 teeth)
Electrical switches and electrical wiring[9]	--
Conduit and wiring[10]	--
Stainless steel terminal box	--
Distribution chute	DMM6747E-T
Gravity Zone cross members	DMM6447D (Cross member #1) DMM6448D (Cross member #2)

1. All rollers bearing housings will be coated to OEM specifications or approved equal.
2. 2.134 m wide by 20.574 m long (clipper seam).
3. 2.134 m wide by 11.760 m long (clipper seam);
   Material: Monofilament polyester;
   Clipper Seams: Style, 8 hooks per inch;
   Seam Width: 3/4" full penetration; applied from both sides;
   Hook and Splice Material: ASTM A167, Type 316L stainless steel, or acceptable equivalent.
4. 1 upper roll and 1 lower roll.
5. Lovejoy-Rosta rubber suspension unit.
6. Upper and lower air bellows.

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New Part	Part Number/ID
7. Upper and lower tension shaft bushings. 8. Interior diameter of the bore should be 2.730 inches. Outside diameter of the gear should be 16.5 inches. 9. 2 limit switches, 2 E-stops. 10. Reference Section 26 05 01, Electrical, for details on conduit and wiring.	

2.05 INSTRUMENTATION AND CONTROLS

A. No additional instrumentation and control work is required on the BFPs as a part of this project scope. The last instrumentation and control upgrades for the BFPs occurred in 2018.

2.06 ACCESSORIES

A. Equipment Bolts: Type 316L stainless steel, A4-70, or equivalent, sized by manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

2.07 MISCELLANEOUS MATERIALS AND ACCESSORIES

A. Piping Connections: Contractor to disassemble all BFP piping connections prior to refurbishment. Contractor to assemble all BFP piping connections after refurbishment is completed.

B. Corrosion Protection:

1. All parts of the equipment in contact with the belts including doctor blade support frames shall be Type 316L stainless steel or coated as specified under Paragraph Drum and Roller Assemblies hereinbefore.
2. Coatings: Suitable for the expected service conditions.
3. Wetted Parts: Suitable for the service conditions specified.
4. Splash Guards: Type 316L stainless steel.
5. Miscellaneous Hardware Including Bolts, Nuts, Washers, and Fastener Clips: Type 316L stainless steel.

C. Dissimilar Metals: Properly electrically insulate any dissimilar metals or connectors in direct contact. Provide 1/8-inch thick continuous neoprene gaskets to isolate aluminum from all steel members.

2.08 FACTORY FINISHING

A. Prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating, System No. 5, unless items are stainless steel or galvanized or are otherwise specified herein.

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PART 3 EXECUTION

3.01 GENERAL

A. Manufacture and test the BFP replacement components in accordance with the applicable trade and industry practices and in compliance with state, OSHA, and other governing code requirements.

B. Install equipment components in conformance with the manufacturer's written instructions, with supervision and inspection performed by manufacturer's representative.

3.02 FIELD QUALITY CONTROL

A. Coordinate timing and schedule test with Owner and be dependent upon quantity of Residuals available for testing.

B. Performance Test:

1. Demonstrate through performance testing actual system operating conditions and verify that BFPs meet or exceed minimum performance requirements specified in Article Performance Requirements, while dewatering the Residuals stream specified in Article Service Conditions.
    a. Conduct testing at the solids loading rates specified in Article Service Conditions.
    b. Establish minimum performance requirements according to item D. of Article Performance Requirements.
2. Notify Owner in writing at least 14 days prior to scheduled performance test.
3. Manufacturer's representative, assisted by installing contractor and Owner, shall startup and operate each BFP on the Residuals stream specified herein, for a period of 4 hours per day for 1-day, with no interruptions allowed during the 4-hour period.
    a. Provide BFP operations and associated manufacturer's field services required to adjust machine settings prior to and exclusive of the above specified performance test duration.
4. Provide qualified manufacturer's representative to supervise each test, analyze data, and certify the BFP's performance during the test.
5. Maintain steady state operation at the specified residuals feed solids rates throughout the test, and all hourly quantities shall be the average during the test period.
    a. Maintain acceptable performance while dewatering feed Residuals with properties within plus or minus 10 percent of the specified criteria listed in Article Service Conditions.

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6. During each performance test, take measurements and collect all required samples for analysis to make the following determinations:
    a. Residuals Feed Rate: gpm.
    b. Residuals Feed Concentration: The total dry solids concentration of the feed Residuals entering the BFP (percent TS).
    c. Dewatered Cake Concentration: The total dry solids concentration of the dewatered Residuals cake discharged from the BFP (percent TS). Take two duplicate samples per sample interval.
    d. Filtrate Concentration: The total suspended solids concentration of the filtrate discharged from the BFP (percent TSS).
    e. Solids Capture: Percent.
    f. Feed Hydraulic Loading Rate (Exclusive of Polymer): gpm.
    g. Feed Solids Loading Rate (Exclusive of Polymer): Pounds per hour of total dry solids.
    h. Polymer Feed Rate: gpm.
    i. Polymer Dose: Pounds active per dry ton of feed solids.
7. Collect samples at approximate 1-hour intervals.
8. Variations in Residuals Feed Characteristics:
    a. Make compensating calculations for the effects if feed Residuals characteristics are not within the ranges specified herein. Provide supporting data to be considered by Engineer in determining conformance with the specified design conditions. Engineer will be sole judge of conformance with performance testing requirements.
    b. If retesting to document compliance is required due solely to feed Residuals characteristics outside of the specified range, Owner may waive retesting or may compensate Contractor for reasonable costs to witness retesting at Owner’s sole option.
9. Performance will be based upon the arithmetic average of the test results obtained during the test period.
    a. Owner reserves the right to discard obviously high or low erroneous test results.
    b. As specified below, laboratory testing will be performed by Owner.
    c. Turnaround time for cake concentration samples are approximately 24 hours.
    d. Laboratory standard methods results will be used for performance evaluation.
10. If a BFP does not meet the requirements of these Specifications during the performance test:
    a. Make changes to equipment and methods of operation as recommended by manufacturer and as approved by Engineer as soon as practical, but within a period not to exceed 30 days.

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b. Following adjustments, perform a second test run similar to the first run.
c. If BFP still does not achieve specified performance during the second test, equipment will be subject to rejection.
d. The BFP manufacturer retains responsibility for the BFPs until the acceptance test has been successfully completed.
e. After initial startup, Owner shall have the right to use the BFP as needed to process Residuals.

11. If, after a maximum of two test runs, in the opinion of Engineer, a BFP meets the performance requirements specified herein, Engineer will recommend acceptance of the BFP. If, in the opinion of Engineer, performance test results do not meet the requirements specified herein, Engineer will notify the BFP manufacturer and Owner of nonacceptable performance.
12. Laboratory tests necessary to confirm the Residuals characteristics for the initial performance test on a BFP will be provided by Owner.
    a. Laboratory tests for performance testing will be performed by Owner in conformance with applicable portions of standard methods.
    b. If retesting is required, BFP manufacturer shall pay Owner for all laboratory tests subsequent to the initial test.
13. Owner will provide power, water, polymer, feed residuals, and disposal for the initial test.

3.03 MANUFACTURER'S FIELD SERVICES

A. For each BFP refurbishment, provide a minimum of two service technicians for the minimum days and trips listed below, travel time excluded:

1. 5 days for BFP disassembly.
2. 10 days for BFP reassembly and start up to check systems for proper operation.
3. Minimum of 15 days total over a minimum of three trips, per each BFP.

B. See Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

END OF SECTION

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