WEBER BASIN WATER CONSERVANCY DISTRICT

GREEN ROAD WELLHOUSE

PROJECT MANUAL

APRIL 2023

HANSEN ALLEN & LUCE INC
ENGINEERS

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WEBER BASIN
WATER CONSERVANCY DISTRICT

GREEN ROAD WELLHOUSE

April 2023

PROJECT MANUAL

Project Engineer

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TABLE OF CONTENTS

SECTION		PAGE(S)
00 00 01	Inside Cover	00 00 01 - 1 to 2
00 00 03	Table of Contents	00 00 03 - 1 to 6

PART 1 - BIDDING REQUIREMENTS

00 11 13	Advertisement for Bid	00 11 13 - 1 to 2
00 21 13	Instructions to Bidders	00 21 13 - 1 to 10
00 41 00	Bid Form	00 41 00 - 1 to 8
00 43 13	Bid Bond	00 43 13 - 1 to 2
00 44 00	Contractor Qualifications	00 44 00 - 1 to 4
00 45 16	List of Subcontractors	00 45 16 - 1 to 2

PART 2 - CONTRACT FORMS

00 51 00	Notice of Award	00 51 00 - 1 to 2
00 52 00	Agreement	00 52 00 - 1 to 8
00 55 00	Notice to Proceed	00 55 00 - 1 to 2
00 61 13	Performance Bond	00 61 00 - 1 to 4
00 61 14	Payment Bond	00 61 50 - 1 to 4
00 63 50	Certificate of Substantial Completion	00 62 50 - 1 to 2
00 63 63	Change Order Form	00 63 63 - 1 to 2

PART 3 - CONTRACT CONDITIONS

00 70 00	General Conditions	00 70 00 - 1 to 70
00 80 00	Supplementary Conditions	00 80 00 - 1 to 12

PART 4 - TECHNICAL SPECIFICATIONS

DIVISION 1 - GENERAL REQUIREMENTS

01 11 00	Summary of Work	01 11 00 - 1 to 2
01 14 00	Work Restrictions	01 14 00 - 1 to 2
01 22 00	Measurement and Payment	01 22 00 - 1 to 8
01 30 00	Administrative Requirements	01 30 00 - 1 to 4
01 32 16	Construction Progress Schedule	01 32 16 - 1 to 8
01 33 00	Submittal Procedures	01 33 00 - 1 to 6
01 41 00	Permits	01 41 00 - 1 to 2
01 42 13	Abbreviations	01 42 13 - 1 to 4
01 42 19	Referenced Standards	01 42 19 - 1 to 2
01 45 00	Quality Control and Materials Testing	01 45 00 - 1 to 6
01 45 23	Testing Agency Services	01 45 23 - 1 to 4
01 50 00	Temporary Construction Utilities and Environmental Controls	01 50 00 - 1 to 6
01 50 30	Protection of Existing Facilities	01 50 30 - 1 to 6
01 55 26	Traffic Control	01 55 26 - 1 to 2
01 56 00	Dust Control	01 56 00 - 1 to 2
01 60 00	Product Requirements	01 60 00 - 1 to 4

TABLE OF CONTENTS

SECTION		PAGE(S)
01 71 13	Mobilization	01 71 13 - 1 to 2
01 78 20	Operation and Maintenance Manuals	01 78 20 - 1 to 4
01 78 50	Project Closeout	01 78 50 - 1 to 10

DIVISION 02 - NOT USED

DIVISION 03 - CONCRETE

03 10 00	Concrete Forming and Accessories	03 10 00 - 1 to 4
03 20 00	Concrete Reinforcement	03 20 00 - 1 to 4
03 25 00	Expansion Joints, Construction Joints and Waterstops	03 25 00 - 1 to 6
03 30 00	Cast-In-Place Concrete	03 30 00 - 1 to 18
03 31 05	CLSM (Flowable Fill)	03 31 05 - 1 to 6
03 60 00	Grout	03 60 00 - 1 to 12

DIVISION 04 – MASONRY

04 22 00	Reinforced Unit Masonry	04 22 00 - 1 to 12

DIVISION 05 – METALS

05 45 00	Mechanical Metal Supports (Pipe Supports)	05 45 00 - 1 to 8
05 50 00	Miscellaneous Specialties	05 50 00 - 1 to 6

DIVISION 06 – WOOD, PLASTICS, AND COMPOSITES

06 10 00	Rough Carpentry	06 10 00 - 1 to 6
06 20 23	Interior Finish Carpentry	06 20 23 - 1 to 10

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

07 11 00	Moisture Protection	07 11 00 - 1 to 4
07 21 00	Insulation	07 21 00 - 1 to 6
07 32 00	Metal Roofing System	07 32 00 - 1 to 6
07 62 00	Sheet Metal Flashing and Trim	07 62 00 - 1 to 8
07 92 00	Joint Sealants	07 92 00 - 1 to 8

DIVISION 08 – OPENINGS

08 10 00	Doors, Frames, and Hardware	08 10 00 - 1 to 10
08 33 23	Overhead Coiling Doors	08 33 23 - 1 to 8
08 62 00	Skylights	08 62 00 - 1 to 4

DIVISION 09 - FINISHES

09 20 00	Gypsum Board	09 20 00 - 1 to 10
09 90 00	Painting and Finishes	09 90 00 - 1 to 22

TABLE OF CONTENTS

SECTION		PAGE(S)
09 98 10	Pipeline Coatings and Linings	09 98 10 - 1 to 14
DIVISION 10 – SPECIALTIES		
10 44 00	Fire Protection Specialties	10 44 00 - 1 to 2
DIVISIONS 11 through 21 - NOT USED		
DIVISION 22 – PLUMBING		
22 10 10	Plumbing, Piping, and Specialties	22 10 10 - 1 to 8
DIVISION 23 – HVAC		
23 05 00	General HVAC Requirements	23 05 00 - 1 to 12
23 05 20	HVAC Identification	23 05 20 - 1 to 2
23 05 30	HVAC Operation and Maintenance Manuals	23 05 30 - 1 to 4
23 05 93	Testing, Adjusting and Balancing	23 05 93 - 1 to 6
23 06 03	Supporting Devices for HVAC	23 06 03 - 1 to 2
23 06 05	Mechanical Sound, Vibration and Seismic Control	23 06 05 - 1 to 4
23 06 07	Motors, Drives & Electrical Requirements	23 06 07 - 1 to 4
23 09 00	HVAC Control Systems	23 09 00 - 1 to 8
23 31 00	Ductwork	23 31 00 - 1 to 6
23 31 10	Ductwork Accessories	23 31 10 - 1 to 4
23 37 00	Air Outlets and Inlets	23 37 00 - 1 to 4
23 76 00	Terminal Electric Heat Transfer Units	23 76 00 - 1 to 4
23 81 26	Split System Air Conditioning Units	23 61 00 - 1 to 2
23 82 00	Power Ventilators	23 82 00 - 1 to 4
23 90 00	Air Filters	23 90 00 - 1 to 4
DIVISIONS 24 through 25 - NOT USED		
DIVISION 26 - ELECTRICAL		
26 05 00	Electrical General Requirements	26 05 00 - 1 to 12
26 05 05	Operation and Maintenance Manuals - Electrical	26 05 05 - 1 to 4
26 05 07	Electrical Power System Studies	26 05 07 - 1 to 16
26 05 09	Electrical Identification	26 05 09 - 1 to 4
26 05 19	Conductors and Cables	26 05 19 - 1 to 4
26 05 22	Wiring Devices	26 05 22 - 1 to 4
26 05 24	Equipment Wiring	26 05 24 - 1 to 4
26 05 26	Grounding and Bonding	26 05 26 - 1 to 4
26 05 30	Conduits	26 05 30 - 1 to 10
26 05 32	Conduit Ductbanks	26 05 32 - 1 to 2
26 05 34	Electrical Boxes and Fittings	26 05 34 - 1 to 2
26 05 74	Electrical Motors	26 05 74 - 1 to 8

TABLE OF CONTENTS

SECTION		PAGE(S)
26 09 13	Control Devices	26 09 13 - 1 to 12
26 16 00	Control Panels and Consoles	26 16 00 - 1 to 12
26 20 00	Service and Distribution Systems	26 20 00 - 1 to 4
26 22 00	Dry Type Transformers	26 22 00 - 1 to 2
26 24 16	Branch Circuit Panelboards	26 24 16 - 1 to 8
26 24 17	Distribution Panelboards	26 24 17 - 1 to 6
26 24 18	Distribution Switchgear	26 24 18 - 1 to 10
26 26 00	Terminal Blocks	26 26 00 - 1 to 2
26 28 13	Fuses	26 28 13 - 1 to 2
26 29 23	Pulse Width Modulated Variable Frequency Drives	26 29 23 - 1 to 10
26 35 53	Surge Protection Devices	26 35 53 - 1 to 8
26 80 10	HVAC Systems Control	26 80 10 - 1 to 2

DIVISIONS 27 through 30 - NOT USED

DIVISION 31 - EARTH WORK

31 05 19	Geosynthetics	31 05 19 - 1 to 6
31 11 00	Clearing and Grubbing	31 11 00 - 1 to 2
31 22 00	Site Grading	31 22 00 - 1 to 4
31 22 16	Fine Grading	31 22 16 - 1 to 2
31 23 15	Excavation and Backfill for Buried Pipelines	31 23 15 - 1 to 10
31 23 19	Dewatering	31 23 19 - 1 to 2
31 23 23	Excavation and Backfill for Structures	31 23 23 - 1 to 6

DIVISION 32 - EXTERIOR IMPROVEMENTS

32 11 23	Road Base - Untreated Base Course	32 11 23 - 1 to 4
32 12 16	Hot-Mix Asphalt Concrete Paving	32 12 16 - 1 to 6
32 31 13	Chain Link Fence and Gates	32 31 13 - 1 to 6

DIVISION 33 - UTILITIES

33 05 03	Copper Pipe	33 05 03 - 1 to 4
33 05 05	Ductile Iron Pipe	33 05 05 - 1 to 12
33 05 07	Polyvinyl Chloride Pressure Pipe, Rubber Joints (AWWA C900)	33 05 07 - 1 to 6
33 05 07.1	PVC Pressure Pipe ASTM D 1785	33 05 07 - 1 to 6
33 05 11	HDPE Pressure Pipe C901, C906	33 05 11 - 1 of 4
33 05 13	Precast Concrete Manholes and Structures	33 05 13 - 1 to 6
33 05 26	Utility Identification	33 05 26 - 1 to 6
33 12 00	Mechanical Appurtenances	33 12 00 - 1 to 8
33 12 30	Deep Well Pump and Motor - Oil Lube	33 12 30 - 1 to 8
33 13 00	Pipeline Testing and Disinfection	33 13 00 - 1 to 4
33 14 13	Drainage System	33 14 13 - 1 to 4
33 92 10	Steel Pipe, Specials, and Fittings (AWWA C200 Modified)	33 92 10 - 1 to 18

TABLE OF CONTENTS

SECTION **PAGE(S)**

DIVISIONS 34 through 39 – NOT USED

DIVISION 40 – PROCESS INTEGRATION

40 05 13.13 Steel Process Piping ..... 40 05 13 - 1 to 6
40 05 13.19 Stainless Steel Process Piping ..... 40 05 19 - 1 to 4
40 10 00 Process Control and Instrumentation System - General ..... 40 10 00 - 1 to 12
40 11 00 Programmable Logic Center (PLC) ..... 40 11 00 - 1 to 4
40 12 50 Pressure Transmitter ..... 40 12 50 - 1 to 2
40 15 10 Process Control Strategies ..... 40 15 10 - 1 to 8
40 20 00 Instruments General ..... 40 20 00 - 1 to 6
40 21 20 Magnetic Flow Meters ..... 40 21 20 - 1 to 2
40 24 10 Ultrasonic Level Measurement ..... 40 24 10 - 1 to 2
40 27 60 Pressure Switches and Seals ..... 40 27 60 - 1 to 4
40 91 20 Pressure Gauges ..... 40 91 20 - 1 to 4
40 91 23 Miscellaneous Properties Measurement Devices ..... 40 91 23 - 1 to 6

DIVISIONS 41 through 45 – NOT USED

DIVISION 46 – WATER AND WASTEWATER EQUIPMENT

46 31 12 Fluoride Chemical Process System ..... 46 31 12 - 1 to 10
46 33 13 On-Site Hypochlorite Generation System ..... 46 33 13 - 1 to 8
46 34 00 Filter Tech Filter System for Green Road Well ..... 46 34 00 - 1 to 4

Appendices (Prepared by Filter Tech)

Proposal Update Summary March 21, 2023 (with Cost and Schedule) ..... 4 pages
Section 1 - Design Criteria Binder ..... 12 pages
Section 2 - Mechanical Drawings Binder ..... 16 pages
Section 3 - Mechanical Equipment Binder ..... 41 pages
Installation Instructions for Equipment and Filter Media ..... 7 pages

DIVISIONS 47 through 49 – NOT USED

PART 5 – DRAWINGS – See Volume II

PART 6 – APPENDICIES

1. AGEC Geotech Report, Green Road Well House (27 pages)

SECTION **PAGE(S)**

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PART 1
BIDDING REQUIREMENTS

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SECTION 00 11 13
ADVERTISEMENT FOR BIDS

NOTICE: Notice is hereby given that the Weber Basin Water Conservancy District (OWNER), will accept bids for the construction of the GREEN ROAD WELLHOUSE Project (Project) according to Contract Drawings and Specifications prepared by HANSEN, ALLEN & LUCE, INC. (ENGINEER), and described in general as:

> *Construct and functionally commission all parts of a 600 gpm drinking water wellhouse system including two buildings (wellhouse and fluoride) of masonry block with pitched roofs; 150 HP vertical turbine pump, motor, piping, valves, onsite hypochlorite generation system, fluoridation system, filtration system with automated backwash system, vault and monitoring, landscaping and irrigation system, HVAC, electrical, controls, paving, C&G, sidewalks, driveways, chain link fence and gates, drainage and water pipelines, and other work.*

BIDS DUE: Separate sealed bids will be received by the OWNER in their office located at 2837 E Highway 193, Layton, UT 84040 until **2:00 p.m. on Thursday, Aug 17, 2023**, and then at said office publicly opened and read aloud. Bids shall be addressed and delivered to the District offices prior to the Bid Opening.

BIDDDER QUALIFICATIONS: 2 Bidders have been prequalified (see Instructions to Bidders in specifications); all others must submit bidder qualifications with their bids. All must use Owner Prequalified Electrical subcontractors**.**

BID DOCUMENTS: Electronic Files (.pdf files) of Bidding Documents may be obtained by emailing Jesse Moreno (Owner project manager) at jmoreno@weberbasin.gov on or after **August 2, 2023**. No paper copies of the Contract Documents will be available for purchase. **Bid security in the amount of 5%** of the base bid will be required to accompany bids.

PRE-BID CONFERENCE: Prospective **Bidders are invited to a non-mandatory Pre-Bid Conference** to be held at District offices at 2837 E Highway 193, Layton, UT 84040 at **2:00 p.m. on Thursday, August 10, 2023** to acquaint Bidders with the site conditions, specifications, and to answer any questions which Bidders may have concerning the project.

QUESTIONS: All communication and questions relative to the project shall be directed to Engineer Nathaniel Jones (phone below) at tjones@halengineers.com at least 2 days before bid opening. Please copy each communication to Jesse Moreno at jmoreno@weberbasin.gov.

Nathaniel Jones, P.E., Project Engineer
at HANSEN, ALLEN & LUCE, INC.
tjones@halengineers.com
Telephone: (801) 556-9887

The OWNER reserves the right to reject any or all bids; or to accept or reject the whole or any part of any bid; or to waive any informality or technicality in any bid in the best interest of the District. Only bids giving a firm quotation properly signed will be accepted.

- END OF DOCUMENT –

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SECTION 00 21 13
INSTRUCTIONS TO BIDDERS

TABLE OF ARTICLES

ARTICLE 1 - DEFINED TERMS

1.01 Terms used in these Instructions to Bidders will have the meanings indicated in the General Conditions and Supplementary Conditions. Additional terms used in these Instructions to Bidders have the meanings indicated below:

A. Issuing Office--The office from which the Bidding Documents are to be issued and where the bidding procedures are to be administered.

ARTICLE 2 - COPIES OF BIDDING DOCUMENTS

2.01 Bidding Documents may be obtained by emailing Jesse Moreno at jmoreno@weberbasin.gov. Complete sets of Bidding Documents will be sent as portable document format (.pdf).

2.02 Complete sets of Bidding Documents must be used in preparing Bids; neither Owner nor Engineer assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.

2.02 Owner and Engineer in making copies of Bidding Documents available on the above terms do so only for the purpose of obtaining Bids for the Work and do not confer a license or grant for any other use.

ARTICLE 3 - QUALIFICATIONS OF BIDDERS

3.01 Contractors are already prequalified to bid the Work: VanCon, Inc and COP Construction. They need not submit qualifications with their bids.

3.02 All other prime contractors must submit with their bid a copy of Spec Section 00 44 00 “Contractor Qualifications”, completely filled out, including at least 3 similar projects they have constructed.

3.03 Prequalified Electrical Subcontractors. All bids must list subcontractors including one of the following Owner Prequalified Electrical Contractors.

1. Freedom Electric
2. Turner Electric
3. Cache Valley Electric
4. S&S Electric
5. Skyline Electric
6. Wood Electric

.

ARTICLE 4 – SITE AND OTHER AREAS; EXISTING SITE CONDITIONS; EXAMINATION OF SITE; OWNER'S SAFETY PROGRAM; OTHER WORK AT THE SITE

4.01 *Site and Other Areas*

A. The Site is identified in the Bidding Documents. By definition, the Site includes rights-of-way, easements, and other lands furnished by OWNER for the use of the CONTRACTOR. Any additional lands required for temporary construction facilities, construction equipment, or storage of materials and equipment, and any access needed for such additional lands, are to be obtained and paid for by CONTRACTOR.

4.02 *Existing Site Conditions*

A. Subsurface and Physical Conditions; Hazardous Environmental Conditions

1. The Supplementary Conditions identify:

a. those reports known to OWNER of explorations and tests of subsurface conditions at or adjacent to the Site.

b. those drawings known to OWNER of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities).

c. reports and drawings known to OWNER relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site.

d. Technical Data contained in such reports and drawings.

2. OWNER will make copies of reports and drawings referenced above available to any Bidder on request. These reports and drawings are not part of the Contract Documents, but the Technical Data contained therein upon whose accuracy Bidder is entitled to rely, as provided in the General Conditions, has been identified and established in the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any Technical Data or any other data, interpretations, opinions, or information contained in such reports or shown or indicated in such drawings.

3. If the Supplementary Conditions do not identify Technical Data, the default definition of Technical Data set forth in Article 1 of the General Conditions will apply.

B. Underground Facilities: Information and data shown or indicated in the Bidding Documents with respect to existing Underground Facilities at or contiguous to the Site are set forth in the Contract Documents and are based upon information and data furnished to OWNER and ENGINEER by OWNERs of such Underground Facilities, including OWNER, or others.

C. Adequacy of Data: Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to subsurface conditions, other physical conditions, and Underground Facilities, and possible changes in the Bidding Documents due to differing or unanticipated subsurface or physical conditions appear in Paragraphs 5.03, 5.04, and 5.05 of the General Conditions. Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to a Hazardous Environmental Condition at the Site, if any, and possible changes in the Contract Documents due to any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in the Contract Drawings or

Specifications or identified in the Contract Documents to be within the scope of the Work, appear in Paragraph 5.06 of the General Conditions.

4.03 *Site Visit and Testing by Bidders*

A. Contractors are invited to visit the project site. Contractors are invited to a non-mandatory Pre-Bid Conference to be held at **2:00 p.m. on Thursday August 10, 2023.** This meeting will start at the District offices located at 2837 E Highway 193, Layton, UT 84040.

B. Bidder is not required to conduct any subsurface testing, or exhaustive investigations of Site conditions.

C. On request, and to the extent OWNER has control over the Site, and schedule permitting, OWNER will provide Bidder access to the Site to conduct such additional examinations, investigations, explorations, tests, and studies as Bidder deems necessary for preparing and submitting a successful Bid. OWNER will not have any obligation to grant such access if doing so is not practical because of existing operations, security or safety concerns, or restraints on OWNER's authority regarding the Site.

D. Bidder shall comply with all applicable Laws and Regulations regarding excavation and location of utilities, obtain all permits, and comply with all terms and conditions established by OWNER or by property OWNERs or other entities controlling the Site with respect to schedule, access, existing operations, security, liability insurance, and applicable safety programs.

E. Bidder shall fill all holes and clean up and restore the Site to its former condition upon completion of such explorations, investigations, tests, and studies.

4.04 *OWNER's Safety Program*

A. Site visits and work at the Site may be governed by an OWNER safety program. As the General Conditions indicate, if an OWNER safety program exists, it will be noted in the Supplementary Conditions.

4.05 *Other Work at the Site*

A. Reference is made to Article 8 of the Supplementary Conditions for the identification of the general nature of other work of which OWNER is aware (if any) that is to be performed at the Site by OWNER or others (such as utilities and other prime CONTRACTORs) and relates to the Work contemplated by these Bidding Documents. If OWNER is party to a written contract for such other work, then on request, OWNER will provide to each Bidder access to examine such contracts (other than portions thereof related to price and other confidential matters), if any.

ARTICLE 5 – BIDDER'S REPRESENTATIONS

5.01 It is the responsibility of each Bidder before submitting a Bid to:

A. examine and carefully study the Bidding Documents, and any data and reference items identified in the Bidding Documents;

B. visit the Site, conduct a thorough, alert visual examination of the Site and adjacent areas, and become familiar with and satisfy itself as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work;

C. become familiar with and satisfy itself as to all Laws and Regulations that may affect cost, progress, and performance of the Work;

D. carefully study all: (1) reports of explorations and tests of subsurface conditions at or adjacent to the Site and all drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings, and (2) reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings;

E. consider the information known to Bidder itself; information commonly known to CONTRACTORS doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the Site-related reports and drawings identified in the Bidding Documents, with respect to the effect of such information, observations, and documents on (1) the cost, progress, and performance of the Work; (2) the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder; and (3) Bidder's safety precautions and programs;

F. agree, based on the information and observations referred to in the preceding paragraph, that at the time of submitting its Bid no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of its Bid for performance of the Work at the price bid and within the times required, and in accordance with the other terms and conditions of the Bidding Documents;

G. become aware of the general nature of the work to be performed by OWNER and others at the Site that relates to the Work as indicated in the Bidding Documents;

H. promptly give ENGINEER written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder discovers in the Bidding Documents and confirm that the written resolution thereof by ENGINEER is acceptable to Bidder;

I. determine that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance and furnishing of the Work; and

J. agree that the submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article, that without exception the Bid and all prices in the Bid are premised upon performing and furnishing the Work required by the Bidding Documents.

ARTICLE 6 – PRE-BID CONFERENCE

6.01 A pre-Bid conference will be held at the time and location stated in the invitation or advertisement to bid. The pre-Bid conference is mandatory. Representatives of OWNER and ENGINEER will be present to discuss the Project. Bidders are encouraged to attend and participate in the conference. ENGINEER will transmit to all prospective Bidders of record such Addenda as ENGINEER considers necessary in response to questions arising at the conference. Oral statements may not be relied upon and will not be binding or legally effective.

ARTICLE 7 – INTERPRETATIONS AND ADDENDA

7.01 All questions about the meaning or intent of the Bidding Documents are to be submitted to ENGINEER in writing. Interpretations or clarifications considered necessary by ENGINEER in response to such questions will be issued by Addenda delivered to all parties recorded as having received the Bidding Documents. Questions received less than seven days prior to the date for opening of Bids may not be answered. Only questions answered by Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

7.02 Addenda may be issued to clarify, correct, supplement, or change the Bidding Documents.

ARTICLE 8 – BID SECURITY

8.01 A Bid must be accompanied by Bid security made payable to OWNER in an amount of 5 percent of Bidder's maximum Bid price (determined by adding the base bid and all alternates) and in the form of a certified check, bank money order, or a Bid bond (on the form included in the Bidding Documents) issued by a surety meeting the requirements of Paragraphs 6.01 and 6.02 of the General Conditions.

8.02 The Bid security of the apparent Successful Bidder will be retained until OWNER awards the contract to such Bidder, and such Bidder has executed the Contract Documents, furnished the required contract security, and met the other conditions of the Notice of Award, whereupon the Bid security will be released. If the Successful Bidder fails to execute and deliver the Contract Documents and furnish the required contract security within 15 days after the Notice of Award, OWNER may consider Bidder to be in default, annul the Notice of Award, and the Bid security of that Bidder will be forfeited. Such forfeiture shall be OWNER's exclusive remedy if Bidder defaults.

8.03 The Bid security of other Bidders that OWNER believes to have a reasonable chance of receiving the award may be retained by OWNER until the earlier of seven days after the Effective Date of the Contract or 61 days after the Bid opening, whereupon Bid security furnished by such Bidders will be released.

8.04 Bid security of other Bidders that OWNER believes do not have a reasonable chance of receiving the award will be released within seven days after the Bid opening.

ARTICLE 9 – CONTRACT TIMES

9.01 The number of days within which, or the dates by which, the Work is to be substantially completed and ready for final payment are set forth in the Agreement.

ARTICLE 10 – LIQUIDATED DAMAGES

10.01 Provisions for liquidated damages, if any, for failure to timely attain a Milestone, Substantial Completion, or completion of the Work in readiness for final payment, are set forth in the Agreement.

ARTICLE 11 – SUBSTITUTE AND "OR-EQUAL" ITEMS

11.01 The Contract for the Work, as awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents without consideration during the bidding

and Contract award process of possible substitute or “or-equal” items. In cases in which the Contract allows the CONTRACTOR to request that ENGINEER authorize the use of a substitute or “or-equal” item of material or equipment, application for such acceptance may not be made to and will not be considered by ENGINEER until after the Effective Date of the Contract.

11.02 All prices that Bidder sets forth in its Bid shall be based on the presumption that the CONTRACTOR will furnish the materials and equipment specified or described in the Bidding Documents, as supplemented by Addenda. Any assumptions regarding the possibility of post-Bid approvals of “or-equal” or substitution requests are made at Bidder’s sole risk.

ARTICLE 12 – SUBCONTRACTORS, SUPPLIERS, AND OTHERS

12.01 A Bidder shall be prepared to retain specific Subcontractors, Suppliers, or other individuals or entities for the performance of the Work if required by the Bidding Documents (most commonly in the Specifications) to do so. If a prospective Bidder objects to retaining any such Subcontractor, Supplier, or other individual or entity, and the concern is not relieved by an Addendum, then the prospective Bidder should refrain from submitting a Bid.

12.02 Subsequent to the submittal of the Bid, OWNER may not require the Successful Bidder or CONTRACTOR to retain any Subcontractor, Supplier, or other individual or entity against which CONTRACTOR has reasonable objection.

12.03 The apparent Successful Bidder, and any other Bidder so requested, shall within five days after Bid opening, submit to OWNER a list of the Subcontractors or Suppliers proposed for the following portions of the Work: pumps and motors, electrical sub-contractor, electrical equipment supplier, meters, and booster pump control valves.

If requested by OWNER, such list shall be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor, Supplier, or other individual or entity. If OWNER or ENGINEER, after due investigation, has reasonable objection to any proposed Subcontractor, Supplier, individual, or entity, OWNER may, before the Notice of Award is given, request apparent Successful Bidder to submit an acceptable substitute, in which case apparent Successful Bidder shall submit a substitute, Bidder’s Bid price will be increased (or decreased) by the difference in cost occasioned by such substitution, and OWNER may consider such price adjustment in evaluating Bids and making the Contract award.

12.04 If apparent Successful Bidder declines to make any such substitution, OWNER may award the Contract to the next lowest Bidder that proposes to use acceptable Subcontractors, Suppliers, or other individuals or entities. Declining to make requested substitutions will not constitute grounds for forfeiture of the Bid security of any Bidder. Any Subcontractor, Supplier, individual, or entity so listed and against which OWNER or ENGINEER makes no written objection prior to the giving of the Notice of Award will be deemed acceptable to OWNER and ENGINEER subject to subsequent revocation of such acceptance as provided in Paragraph 7.06 of the General Conditions.

ARTICLE 13 – PREPARATION OF BID

13.01 The Bid Form is included with the Bidding Documents.

A. All blanks on the Bid Form shall be completed in ink and the Bid Form signed in ink. Erasures or alterations shall be initialed in ink by the person signing the Bid Form. A Bid price shall be indicated for each section, Bid item, alternate, adjustment unit price item, and unit price item listed therein.

B. If the Bid Form expressly indicates that submitting pricing on a specific alternate item is optional, and Bidder elects to not furnish pricing for such optional alternate item, then Bidder may enter the words "No Bid" or "Not Applicable."

13.02 A Bid by a corporation shall be executed in the corporate name by a corporate officer (whose title must appear under the signature), accompanied by evidence of authority to sign. The corporate address and state of incorporation shall be shown. The corporate seal shall be affixed and attested by the corporate secretary or an assistant corporate secretary.

13.03 A Bid by a limited liability company shall be executed in the name of the firm by a member or other authorized person and accompanied by evidence of authority to sign. The state of formation of the firm and the official address of the firm shall be shown.

13.04 A Bid by an individual shall show the Bidder's name and official address.

13.05 A Bid by a joint venture shall be executed by an authorized representative of each joint venturer in the manner indicated on the Bid Form. The official address of the joint venture shall be shown.

13.06 All names shall be printed in ink below the signatures.

13.07 The Bid shall contain an acknowledgment of receipt of all Addenda, the numbers of which shall be filled in on the Bid Form.

13.08 Postal and e-mail addresses and telephone number for communications regarding the Bid shall be shown.

13.09 The Bid shall contain evidence of Bidder's authority and qualification to do business in the state where the Project is located, or Bidder shall covenant in writing to obtain such authority and qualification prior to award of the Contract and attach such covenant to the Bid. Bidder's state contractor license number, if any, shall also be shown on the Bid Form.

ARTICLE 14 – BASIS OF BID

14.01 *Unit Price*

A. Bidders shall submit a Bid on a unit price basis for each item of Work listed in the unit price section of the Bid Form.

B. The "Bid Price" (sometimes referred to as the extended price) for each unit price Bid item will be the product of the "Estimated Quantity" (which OWNER or its representative has set forth in the Bid Form) for the item and the corresponding "Bid Unit Price" offered by the Bidder. The total of all unit price Bid items will be the sum of these "Bid Prices"; such total will be used by OWNER for Bid comparison purposes. The final quantities and Contract Price will be determined in accordance with Paragraph 13.03 of the General Conditions.

C. Discrepancies between the multiplication of units of Work and unit prices will be resolved in favor of the unit prices. Discrepancies between the indicated sum of any

column of figures and the correct sum thereof will be resolved in favor of the correct sum.

14.02 *Allowances*

A. For cash allowances the Bid price shall include such amounts as the Bidder deems proper for CONTRACTOR's overhead, costs, profit, and other expenses on account of cash allowances, if any, named in the Contract Documents, in accordance with Paragraph 13.02.B of the General Conditions.

ARTICLE 15 – SUBMITTAL OF BID

15.01 The Bid Form is to be completed and submitted with all the attachments outlined in Article 7 of the Bid Form.

15.02 A Bid shall be submitted no later than the date and time prescribed and at the place indicated in the advertisement or invitation to bid and shall be enclosed in a plainly marked package with the Project title (and, if applicable, the designated portion of the Project for which the Bid is submitted), the name and address of Bidder, and shall be accompanied by the Bid security and other required documents. If a Bid is sent by mail or other delivery system, the sealed envelope containing the Bid shall be enclosed in a separate package plainly marked on the outside with the notation "BID ENCLOSED." A mailed Bid shall be addressed to OWNER at address in Article 1.01 of Bid Form.

15.03 Bids received after the date and time prescribed for the opening of bids, or not submitted at the correct location or in the designated manner, will not be accepted and will be returned to the Bidder unopened.

15.04 Bidder must also complete and submit the following documents with their Bids:

A. **Bid Form – Section 00 41 43**

B. **Bid Bond – Section 00 43 12**

C. **List of Subcontractors – Section 00 45 30**

D. **Contractor Qualifications – Section 00 44 00** (except for VanCon and COP)

ARTICLE 16 – MODIFICATION AND WITHDRAWAL OF BID

16.01 A Bid may be withdrawn by an appropriate document duly executed in the same manner that a Bid must be executed and delivered to the place where Bids are to be submitted prior to the date and time for the opening of Bids. Upon receipt of such notice, the unopened Bid will be returned to the Bidder.

16.02 If a Bidder wishes to modify its Bid prior to Bid opening, Bidder must withdraw its initial Bid in the manner specified in Paragraph 16.01 and submit a new Bid prior to the date and time for the opening of Bids.

16.03 If within 24 hours after Bids are opened any Bidder files a duly signed written notice with OWNER and promptly thereafter demonstrates to the reasonable satisfaction of OWNER that there was a material and substantial mistake in the preparation of its Bid, that Bidder may withdraw its Bid, and the Bid security will be returned. Thereafter, if the Work is rebid, that Bidder will be disqualified from further bidding on the Work.

ARTICLE 17 – OPENING OF BIDS

17.01 Bids will be opened at the time and place indicated in the advertisement or invitation to bid and, unless obviously non-responsive, read aloud publicly. An abstract of the amounts of the base Bids and major alternates, if any, will be made available to Bidders after the opening of Bids.

ARTICLE 18 – BIDS TO REMAIN SUBJECT TO ACCEPTANCE

18.01 All Bids will remain subject to acceptance for the period of time stated in the Bid Form, but OWNER may, in its sole discretion, release any Bid and return the Bid security prior to the end of this period.

ARTICLE 19 – EVALUATION OF BIDS AND AWARD OF CONTRACT

19.01 OWNER reserves the right to reject any or all Bids, including without limitation, nonconforming, nonresponsive, unbalanced, or conditional Bids. OWNER will reject the Bid of any Bidder that OWNER finds, after reasonable inquiry and evaluation, to not be responsible. If Bidder purports to add terms or conditions to its Bid, takes exception to any provision of the Bidding Documents, or attempts to alter the contents of the Contract Documents for purposes of the Bid, then the OWNER will reject the Bid as nonresponsive; provided that OWNER also reserves the right to waive all minor informalities not involving price, time, or changes in the Work.

19.02 If OWNER awards the contract for the Work, such award shall be to the responsible Bidder submitting the lowest responsive Bid.

19.03 Evaluation of Bids

A. In evaluating Bids, OWNER will consider whether or not the Bids comply with the prescribed requirements, and such alternates, unit prices, and other data, as may be requested in the Bid Form or prior to the Notice of Award.

B. For the determination of the apparent low Bidder when unit price bids are submitted, Bids will be compared on the basis of the total of the products of the estimated quantity of each item and unit price Bid for that item, together with any lump sum items.

19.04 In evaluating whether a Bidder is responsible, OWNER will consider the qualifications of the Bidder and may consider the qualifications and experience of Subcontractors and Suppliers proposed for those portions of the Work for which the identity of Subcontractors and Suppliers must be submitted as provided in the Bidding Documents.

19.05 OWNER may conduct such investigations as OWNER deems necessary to establish the responsibility, qualifications, and financial ability of Bidders and any proposed Subcontractors or Suppliers.

ARTICLE 20 – BONDS AND INSURANCE

20.01 Article 6 of the General Conditions, as may be modified by the Supplementary Conditions, sets forth OWNER's requirements as to performance and payment bonds and insurance. When the Successful Bidder delivers the Agreement (executed by Successful Bidder) to OWNER, it shall be accompanied by required bonds and insurance documentation.

ARTICLE 21 – SIGNING OF AGREEMENT

21.01 When OWNER issues a Notice of Award to the Successful Bidder, it shall be accompanied by the unexecuted counterparts of the Agreement along with the other Contract Documents as identified in the Agreement. Within 15 days thereafter, Successful Bidder shall execute and deliver the required number of counterparts of the Agreement (and any bonds and insurance documentation required to be delivered by the Contract Documents) to OWNER. Within ten days thereafter, OWNER shall deliver one fully executed counterpart of the Agreement to Successful Bidder, together with printed and electronic copies of the Contract Documents as stated in Paragraph 2.02 of the General Conditions.

ARTICLE 22 – ENGINEER/OWNER RESPONSES TO PRE-BID MEETING CONTRACTOR QUESTIONS (FROM MAY 8, 2023 FIRST PRE-BID MEETING)

Responses to Pre Bid Meeting Contractor Questions:

1. *Contractor shall put installation costs for Filter System in Bid Item 20 (not Item 29). See A1.2.*
2. *Contractor shall install filter media per Section 46 34 00, fifth Appendix entitled "Installation Instructions for Equipment and Filter Media, 7 pages."*
3. *WBWCD will provide the chemicals to fill both bulk tanks (Chlorine Salt and Fluoride).*
4. *WBWCD will call Fruit Heights and inform Contractors if they must pay for permit.*
5. *Contractor to perform materials testing per Sections 01 45 00 and 01 45 23.*
6. *There are no Davis-Bacon or "Build American" requirements.*
7. *WBWCD will pay for Rocky Mountain Power fees and to install permanent power facilities.*
8. *Contractor will pay for temporary power during construction, including temporary meter.*
9. *Contractor shall install (per RMP Stds) 4" (not 6") conduit from pole NW of Site to transformer including HDD bore under Green Road. See Elec Plans and Item A1.9.*
10. *The 75Kva transformer with 125A breaker on primary and 300A breaker on secondary with 300A secondary ampacity of wiring - is all correct.*
11. *Q. Will customer-supplied Medium Voltage equipment come with load break elbows? Yes.*
12. *Q. Is it correct Rob Roy is required for part of conduit run? Yes. Tape will not be accepted.*

- END OF SECTION -

SECTION 00 41 00
BID FORM

Project Identification: Weber Basin Water Conservancy District – Green Road Wellhouse

Contract Identification and Number: 254.07.100

ARTICLE 1 - BID RECIPIENT

1.01 This Bid Is Submitted To: **Weber Basin Water Conservancy District, 237 UT-193, Layton UT 84040**

1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with Owner in the form included in the Bidding Documents to perform all Work as specified or indicated in the Bidding Documents for the prices and within the times indicated in the Bid and in accordance with the other terms and conditions of the Bidding Documents.

ARTICLE 2 - BIDDER'S ACKNOWLEDGMENTS

2.01 Bidder accepts all of the terms and conditions of the Advertisement and Instructions to Bidders, including without limitations those dealing with the dispositions of Bid security. The Bid will remain subject to acceptance for 30 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.

ARTICLE 3 - BIDDER'S REPRESENTATIONS

3.01 In submitting this Bid, Bidder represents that:

A. Bidder has examined and carefully studied the Bidding Documents, the other related data identified in the Bidding Documents, and the following Addenda, receipt of which is hereby acknowledged:

Addendum No.	Addendum Date
_____	_____
_____	_____
_____	_____

B. Bidder has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

C. Bidder is familiar with and is satisfied as to all Federal, state, and local Laws and Regulations that may affect cost, progress, and performance of the Work.

D. Bidder has carefully studied all: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) which have been identified in SC-4.02, and (2) reports and drawings of Hazard Environmental Conditions, if any, at the Site that have been identified in SC-4.06 as containing reliable "technical data."

E. Bidder has considered the information known to Bidder; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the Site-related reports and drawings identified in the Bidding Documents, with respect to the effect of such information, observations, and documents on (1) the cost, progress, and performance of the Work; (2) the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, including applying the specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents; and (3) Bidder's safety precautions and programs.

F. Based on the information and observations referred to in Paragraph 3.01.E above, Bidder does not consider that any further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance of the Work at the price(s) bid and within the times and in accordance with the other terms and conditions of the Bidding Documents.

G. Bidder is aware of the general nature of the Work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.

H. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and the written resolution thereof by Engineer is acceptable to Bidder.

I. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work for which this Bid is submitted.

J. Bidder will submit written evidence of its authority to do business in the State or other jurisdiction where the Project is located not later than the date of its execution of the Agreement.

ARTICLE 4 - BIDDER'S CERTIFICATION

4.01 Bidder further represents that:

A. This Bid is genuine and not made in the interest of or on the behalf of any undisclosed individual or entity and is not submitted in conformity with any agreement or rules of any group, association, organization, or corporation;

B. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid;

C. Bidder has not solicited or induced any individual or entity to refrain from bidding; and

D. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this Paragraph 4.01.D:

1. "corrupt practice" means the offering, giving, receiving, or soliciting of any thing of value likely to influence the action of a public official in the bidding process;

2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Owner, (b) to establish bid prices at

artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;

3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish bid prices at artificial, non-competitive levels; and

4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

ARTICLE 5 - BASIS OF BID

5.01 Bidder will complete the Work in accordance with the Contract Documents for the prices identified in the bid schedule on the following page.

A. The completion dates shall be fixed with no additional days or extensions provided for work stoppage including weather delays.

B. Unit Prices have been computed in accordance with paragraph 11.03.B of the General Conditions.

C. Bidder acknowledges that estimated quantities are not guaranteed, and are solely for the purpose of comparison of Bids, and final payment for all Unit Price Bid items will be based on actual quantities, determined as provided in the contract Documents.

BID SCHEDULE

Item No.	Description	Unit	Est Quant.	Bid Unit Price	Bid Price
1	Mobilization / Demobilization	LS	1		
2	Construction Surveying	LS	1		
3	Testing and Testing Agency Services	LS	1		
4	SWPPP and Implementation	LS	1		
5	Owner to Pay RMP to Provide Power to Site (excludes Contractor-installed RMP conduits).	LS	1	**$ 0**	**$0.00**
6	All Earthwork, Haul Off Excess, Finished Grading, Topsoils	LS	1		
8	12-inch Storm Drain	LF	352		
8	Curb Inlet (APWA Plan 315.1)	EA	5		
9	8" DIP Water Pipeline and Fluoride Injection MH	LS	1		
10	Misc Drains Outside BLDGs (2" to 8")	LS	1		

11	Drain MHs: 48”, 60”, 72” and 4” GV	LS	1		
12	Precast Conc Vault (8’x16’x9’)	LS	1		
13	Appurtenances for MHs & Vault: Level Monitors, Valves, Automation, etc	LS	1		
14	Type E Curb & Gutter	LF	710		
15	4’ Wide Waterway	LF	130		
16	Fruit Heights Standard Det CS-04 Driveway with adjacent sidewalk and remove exst C&G and sidewalk.	EA	1		
17	(not used)	LF	0	**$ 0**	**$0.00**
18	PVC Coated Chain Link Fence, Gates	LF	980		
19	AC Paving: 4” AC over 12” UTBC	Sq Ft	16,900		
20	Wellhouse Building Piping Systems **include cost to install and test Filter System**	LS	1		
21	Wellhouse Structure	LS	1		
22	Fluoride Building Structure	LS	1		
23	Deep Well Pump & Motor	LS	1		
24	All Elec & I&C Systems (on- and off-site and in 2 buildings) Complete (except 5, 13, 23, 25, 26, 27, 28, 29)	LS	1		
25	Main Control Panel & Programming	LS	1		
26	HVAC Systems Complete	LS	1		
27	Chlorination System Complete	LS	1		
28	Fluoridation System Complete	LS	1		
29	Well Water Filtration System Complete **This is price for all Filter Tech Work**	LS	1	**$541,179**	**$541,179**
30	Landscaping	LS	1		
Total Bid Schedule				$	

ARTICLE 6 - TIME OF COMPLETION

6.01 Bidder agrees that the Work will be substantially complete and will be completed and ready for final payment in accordance with paragraph 15.06 of the General Conditions on or before the dates or within the number of calendar days indicated in the Agreement.

6.02 Bidder accepts the provisions of the Agreement as to liquidated damage.

ARTICLE 7 - ATTACHEMENTS TO THIS BID

7.01 The following documents are attached to and made a condition of the Bid:

A. Required Bid security in the form of a Bid Bond (EJCDC No. C-430) or Certified Check);

B. Document 00 45 00 - List of Subcontractors;

C. Evidence of authority to do business in the state or jurisdiction of the Project; or a written covenant to obtain such license within the time frame for acceptance of Bids.

ARTICLE 8 - DEFINED TERMS

8.01 The terms used in this Bid with the initial capital letters have the meanings indicated in the Instructions to Bidders, the General Conditions, and the Supplementary Conditions.

ARTICLE 9 - BID SUBMITTAL

9.01 This Bid is submitted by:

If Bidder is:

An Individual

Name (typed or printed): _____ SEAL, if required by State

By: _____

(Individual's signature)

Doing business as:

_____

A Partnership

Partnership Name: _____ SEAL, if required by State

By: _____

(Signature of general partner -- attach evidence of authority to sign)

Name (typed or printed):

_____

A Corporation

Corporation Name:

_____

State or Jurisdiction of Incorporation: _____

Type (General Business, Profession, Service, Limited Liability):

_____

By: _____

(Signature -- attach evidence of authority to sign)

Name (typed or printed):

_____

Title: _____ CORPORATE SEAL, if required by State

Attest _____

(Signature of Corporate Secretary)

Date of Qualification to do business in _____ [State or other jurisdiction where Project is located] is ___/___/_____

A Joint Venture

Name of Joint Venture:
_____

First Joint Venture Name: _____ SEAL, if required by State

By: _____
(Signature of joint venture partner -- attach evidence of authority to sign)

Name (typed or printed):
_____

Title: _____

Second Joint Venture Name: SEAL, if required by State
_____

By: _____
(Signature of joint venture partner -- attach evidence of authority to sign)

Name (typed or printed):
_____

Title: _____

(Each joint venturer must sign. The manner of signing for each individual, partnership, and corporation that is party to the venture should be in the manner indicated above.)

Bidder's Business address: _____

_____

Business Phone No. (_____)_____

Business E-Mail Address
_____

State Contractor License No. _____. (If applicable)

Employer's Tax ID No. _____

Phone Numbers and Address for receipt of official communications, if different from Business contact information:
_____
_____

9.02 Bid submitted on _____, 20___.

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SECTION 00 43 13
BID BOND

Any singular reference to Bidder, Surety, Owner or other party shall be considered plural where applicable.

BIDDER *(Name and Address)*:

SURETY *(Name and Address of Principal Place of Business)*:

OWNER *(Name and Address)*:

BID

Bid Due Date:
Description: **Weber Basin Water Conservancy District – Green Road Wellhouse**

BOND

Bond Number:
Date *(Not earlier than Bid due date)*:
Penal sum _____ $ _____
(Words) (Figures)

Surety and Bidder, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Bid Bond to be duly executed by an authorized officer, agent, or representative.

BIDDER	**SURETY**
_____ (Seal)	_____ (Seal)
Bidder's Name and Corporate Seal	Surety's Name and Corporate Seal
By: _____	By: _____
Signature	Signature (Attach Power of Attorney)
_____	_____
Print Name	Print Name
_____	_____
Title	Title
Attest: _____	Attest: _____
Signature	Signature
_____	_____
Title	Title

Note: Above addresses are to be used for giving any required notice. Provide execution by any additional parties, such as joint venturers, if necessary.

1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to pay to Owner upon default of Bidder the penal sum set forth on the face of this Bond. Payment of the penal sum is the extent of Bidder's and Surety's liability. Recovery of such penal sum under the terms of this Bond shall be Owner's sole and exclusive remedy upon default of Bidder.

2. Default of Bidder shall occur upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents.

3. This obligation shall be null and void if:

3.1 Owner accepts Bidder's Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents, or

3.2 All Bids are rejected by Owner, or

3.3 Owner fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by Paragraph 5 hereof).

4. Payment under this Bond will be due and payable upon default of Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.

5. Surety waives notice of any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions shall not in the aggregate exceed 120 days from Bid due date without Surety's written consent.

6. No suit or action shall be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 4 above is received by Bidder and Surety and in no case later than one year after Bid due date.

7. Any suit or action under this Bond shall be commenced only in a court of competent jurisdiction located in the state in which the Project is located.

8. Notices required hereunder shall be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Registered or Certified Mail, return receipt requested, postage pre-paid, and shall be deemed to be effective upon receipt by the party concerned.

9. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.

10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond shall be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute shall govern and the remainder of this Bond that is not in conflict therewith shall continue in full force and effect.

11. The term "Bid" as used herein includes a Bid, offer, or proposal as applicable.

SECTION 00 44 00

CONTRACTOR QUALIFICATIONS

The Bidder, unless already prequalified for this project, shall furnish the following information. Failure to comply with this requirement will render the Bid non-responsive and may cause its rejection. Additional sheets shall be attached as required.

A. CONTRACTOR's Contact Information:

Name: _____

Address: _____

Telephone Number: _____

Email Address: _____

B. CONTRACTOR's Representative: _____

C. CONTRACTOR's License: Primary Classification _____

Utah State License No. _____

Supplemental Classifications held, if any. _____

D. Number of years as a contractor in Construction Work of this type: _____

E. Names and titles of Principal Officers of CONTRACTOR's Firm:

_____

Name Title

_____

Name Title

_____

Name Title

F. Name of person who inspected site of proposed work for your firm:

Name: _____ Date of Inspection: _____

G. Name, address, and telephone number of surety company and agent who will provide the required bonds on this Contract:

_____

_____

H. A certified copy of financial statement prepared during current fiscal year as prepared for bank or bonding company will not be required with submission of the Bid, but may be required by the OWNER of the apparent successful bidder prior to award as part of the evaluation and review process.

I. List of current jobs now under construction (use additional sheets if necessary):

Client Reference Name	Telephone Number	Dollar Amount	Name, Type of Job

J. List at least three (3) similar projects (regardless of size) completed within the last ten years (use additional sheets if necessary):

Client Reference Name	Telephone Number	Dollar Amount	Name, Type of Job

K. Have you ever failed to complete any work awarded to you? If so, when, where and why? (use additional sheets if necessary)

L. List your major equipment available for this Contract (use additional sheets if necessary):

_____

_____

_____

_____

_____

_____

_____

_____

_____
CONTRACTOR's Signature

- END OF DOCUMENT -

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DOCUMENT 00 45 16
LIST OF SUBCONTRACTORS

The bidder shall list below the names and business address of each subcontractor who will perform Work under this Contract in excess of five percent (0.05) of the total bid price and shall also list the portion of the work which will be done by such subcontractor. After the opening of proposals, no changes or substitutions will be allowed without the written approval of the Owner. NOTE: Attach additional sheets if required.

WORK TO BE PERFORMED	SUBCONTRACTOR'S NAME AND ADDRESS
1.	
2.	
3.	
4.	
5.	
6.	

- END OF DOCUMENT -

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PART 2
CONTRACT FORMS

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SECTION 00 51 00
NOTICE OF AWARD

Date: _____

Project: Weber Basin Water Conservancy District – GREEN ROAD WELLHOUSE	
Owner: Weber Basin Water Conservancy District	Owner's Contract No.: 20016
Contract: GREEN ROAD WELLHOUSE	Engineer's Project No.: 360.39.100
Bidder:	
Bidder's Address:	

You are notified that your Bid dated _____ for the above Contract has been considered. You are the Successful Bidder and are awarded a Contract for **GREEN ROAD WELLHOUSE.**

Total Work

The Contract Price of your Contract is:_____

_____

Three copies of the proposed Contract Documents (except Drawings) accompany this Notice of Award.

Drawings will be delivered separately or otherwise made available to you immediately.

You must comply with the following conditions precedent within 15 days of the date you receive this Notice of Award.

1. Deliver to the Owner three fully executed counterparts of the Contract Documents.
2. Deliver with the executed Contract Documents the Contract security [Bonds] as specified in the Instructions to Bidders (Article 20), General Conditions (Paragraph 5.01), and Supplementary Conditions (Paragraph SC-5.01).
3. Other conditions precedent: N/A

Failure to comply with these conditions within the time specified will entitle Owner to consider you in default, annul this Notice of Award, and declare your Bid security forfeited.

Within ten days after you comply with the above conditions, Owner will return to you one fully executed counterpart of the Contract Documents.

Weber Basin Water Conservancy District
Owner

By:_____
Authorized Signature

_____
Title

Copy to Engineer

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SECTION 00 52 00
AGREEMENT

THIS AGREEMENT is by and between Weber Basin Water Conservancy District ("Owner") and _____ ("Contractor").

Owner and Contractor hereby agree as follows:

ARTICLE 1 – WORK

1.01 Contractor shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described as follows:

Construct and functionally commission all parts of a 600 gpm drinking water wellhouse system including two buildings (wellhouse and fluoride) of masonry block with pitched roofs; 150 HP vertical turbine pump, motor, piping, valves, onsite hypochlorite generation system, fluoridation system, filtration system with automated backwash system, vault and monitoring, landscaping and irrigation system, HVAC, electrical, controls, paving, C&G, sidewalks, driveways, chain link fence and gates, drainage and water pipelines, and other work.

ARTICLE 2 – THE PROJECT

2.01 The Project for which the Work under the Contract Documents may be the whole or only a part is generally described as follows: **Green Road Wellhouse.**

ARTICLE 3 – ENGINEER

3.01 The Project has been designed by Hansen, Allen & Luce, Inc (Engineer), which is to act as Owner's representative, assume all duties and responsibilities, and have the rights and authority assigned to Engineer in the Contract Documents in connection with the completion of the Work in accordance with the Contract Documents.

ARTICLE 4 – CONTRACT TIMES

4.01 Time of the Essence

A. All time limits for Milestones, if any, Substantial Completion, and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

4.02 Dates for Substantial Completion and Final Payment

A. The project shall be substantially completed on or before **May 31, 2025** and completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions on or before **June 30, 2025**.

4.03 Liquidated Damages

A. Contractor and Owner recognize that time is of the essence as stated in Paragraph 4.01 above and that Owner will suffer financial loss if the Work is not completed within the times specified in Paragraph 4.02 and 4.03 above, plus any extensions thereof allowed in accordance with Article 11 of the General Conditions. The parties also recognize the delays, expense, and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty), Contractor shall pay Owner $500.00 for each day that expires after the time specified in Paragraph 4.02 above for Substantial Completion until the Work is substantially complete. After Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Time or any proper extension thereof granted by Owner, Contractor shall pay Owner $500.00 for each day that expires after the time specified in Paragraph 4.02 or 4.03 above for completion and readiness for final payment until the Work is completed and ready for final payment.

ARTICLE 5 – CONTRACT PRICE

5.01 Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents an amount in current funds equal to the sum of the amounts determined pursuant to Paragraphs 5.01.A below:

A. For all Work, at the prices stated in Contractor's Bid, attached hereto as an exhibit.

ARTICLE 6 – PAYMENT PROCEDURES

6.01 *Submittal and Processing of Payments*

A. Contractor shall submit Applications for Payment in accordance with Article 15 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions.

6.02 *Progress Payments; Retainage*

A. Owner shall make progress payments on account of the Contract Price on the basis of Contractor's Applications for Payment on or about the 1st day of each month during performance of the Work as provided in Paragraph 6.02.A.1 below. All such payments will be measured by the schedule of values established as provided in Paragraph 2.03.3 of the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no schedule of values, as provided in the General Requirements.

1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Engineer may determine or Owner may withhold, including but not limited to liquidated damages, in accordance with Paragraph 15.01 of the General Conditions.

a. 95% percent of Work completed (with the balance being retainage). If the Work has been 50 percent completed as determined by Engineer, and if the character and progress of the Work have been satisfactory to Owner and Engineer, then as long as the character and progress of the Work remain satisfactory to Owner and Engineer, there will be no additional retainage; and

b. 95% percent of cost of materials and equipment not incorporated in the Work (with the balance being retainage).

B. Upon Substantial Completion, Owner shall pay an amount sufficient to increase total payments to Contractor to 97.5 percent of the Work completed, less such amounts as Engineer shall determine in accordance with Paragraph 15.01 of the General Conditions and less 100 percent of Engineer's estimate of the value of Work to be completed or corrected as shown on the tentative list of items to be completed or corrected attached to the certificate of Substantial Completion.

6.03 *Final Payment*

A. Upon final completion and acceptance of the Work in accordance with Paragraph 15.05 of the General Conditions, Owner shall pay the remainder of the Contract Price as recommended by Engineer as provided in said Paragraph 15.06.

ARTICLE 7 – INTEREST

7.01 All moneys not paid when due as provided in Article 15 of the General Conditions shall bear interest at the rate of 4% percent per annum.

ARTICLE 8 – CONTRACTOR'S REPRESENTATIONS

8.01 In order to induce Owner to enter into this Agreement, Contractor makes the following representations:

A. Contractor has examined and carefully studied the Contract Documents and the other related data identified in the Bidding Documents.

B. Contractor has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

C. Contractor is familiar with and is satisfied as to all federal, state, and local Laws and Regulations that may affect cost, progress, and performance of the Work.

D. Contractor has carefully studied all: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities), if any and (2) reports and drawings of Hazardous Environmental Conditions, if any.

E. Contractor has considered the information known to Contractor; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Contract Documents; and the Site-related reports and drawings identified in the Contract Documents, with respect to the effect of such information, observations, and documents on (1) the cost, progress, and performance of the Work; (2) the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, including any specific means, methods, techniques, sequences, and procedures of construction expressly required by the Contract Documents; and (3) Contractor's safety precautions and programs.

F. Based on the information and observations referred to in Paragraph 8.01.E above, Contractor does not consider that further examinations, investigations, explorations, tests, studies, or data

are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract Documents.

G. Contractor is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Contract Documents.

H. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.

I. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

ARTICLE 9 – CONTRACT DOCUMENTS

9.01 *Contents*

A. The Contract Documents consist of the following:

1. This Agreement.

2. Performance bond (together with power of attorney).

3. Payment bond (together with power of attorney).

4. General Conditions .

5. Supplementary Conditions.

6. Specifications as listed in the Table of Contents of the Project Manual.

7. Drawings (not attached but incorporated by reference) consisting of all sheets listed in Index of Drawings (see Sheet G-2), each bearing the following general title : **Green Road Wellhouse.**

8. Addenda (numbers __ to____, inclusive).

9. Exhibits to this Agreement (enumerated as follows):

   a. Contractor's Bid

   b. Documentation submitted by Contractor prior to Notice of Award.

10. The following which may be delivered or issued on or after the Effective Date of the Agreement and are not attached hereto:

    a. Notice to Proceed.

    b. Work Change Directives.

    c. Change Orders

d. Field Orders

e. Warranty Bond, if any.

B. The documents listed in Paragraph 9.01.A are attached to this Agreement (except as expressly noted otherwise above).

C. There are no Contract Documents other than those listed above in this Article 9.

D. The Contract Documents may only be amended, modified, or supplemented as provided in Paragraph 3.04 of the General Conditions.

ARTICLE 10 – MISCELLANEOUS

10.01 *Terms*

A. Terms used in this Agreement will have the meanings stated in the General Conditions and the Supplementary Conditions.

10.02 *Assignment of Contract*

A. No assignment by a party hereto of any rights under or interests in the Contract will be binding on another party hereto without the written consent of the party sought to be bound; and, specifically but without limitation, moneys that may become due and moneys that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

10.03 *Successors and Assigns*

A. Owner and Contractor each binds itself, its partners, successors, assigns, and legal representatives to the other party hereto, its partners, successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

10.04 *Severability*

A. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon Owner and Contractor, who agree that the Contract Documents shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

10.05 *Contractor's Certifications*

A. Contractor certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Contract. For the purposes of this Paragraph 10.05:

1. “corrupt practice” means the offering, giving, receiving, or soliciting of any thing of value likely to influence the action of a public official in the bidding process or in the Contract execution;

2. “fraudulent practice” means an intentional misrepresentation of facts made (a) to influence the bidding process or the execution of the Contract to the detriment of Owner, (b) to establish Bid or Contract prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;

3. “collusive practice” means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish Bid prices at artificial, non-competitive levels; and

4. “coercive practice” means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement. Counterparts have been delivered to Owner and Contractor. All portions of the Contract Documents have been signed or have been identified by Owner and Contractor or on their behalf.

This Agreement will be effective on _____(which is the Effective Date of the Agreement).

OWNER:	CONTRACTOR
Weber Basin Water Conservancy District	_____
By: _____	By: _____
Title: _____	Title: _____
	(If Contractor is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.)
Attest: _____	Attest: _____
Title: _____	Title: _____
Address for giving notices:	Address for giving notices:
Weber Basin Water Conservancy District	_____
2837 E Highway 193	_____
Layton, UT 84040	_____
	License No.: _____
	(Where applicable)
(If Owner is a corporation, attach evidence of authority to sign. If Owner is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of this Agreement.)	Agent for service of process:
	_____

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SECTION 00 55 00
NOTICE TO PROCEED

Date: _____

Project: GREEN ROAD WELLHOUSE	
Owner: Weber Basin Water Conservancy District	Owner's Contract No.: N/A
Contract: GREEN ROAD WELLHOUSE	Engineer's Project No.: 254.07.100
Contractor:	
Contractor's Address:	

You are notified that the Contract Times under the above Contract will commence to run _____, 2023. On or before that date, you are to start performing your obligations under the Contract Documents. In accordance with Article 4 of the Agreement, the date of Substantial Completion is _____, and the date of readiness for final payment is _____.

Before you may start any Work at the Site, Paragraph 2.01.B of the General Conditions provides that you and Owner must each deliver to the other (with copies to Engineer and other identified additional insureds and loss payees) certificates of insurance which each is required to purchase and maintain in accordance with the Contract Documents.

Also, before you may start any Work at the Site, you must:

- Execute Contract document provided by the City
- Apply for and receive an approved City Encroachment permit.

_____
Owner: Weber Basin Water Conservancy District

Given by:

_____
Authorized Signature

_____
Title

_____
Date

Copy to Engineer

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SECTION 00 61 13
PERFORMANCE BOND

Contractor Name: **[Full formal name of Contractor]** Address: *(principal place of business)*: **[Address of Contractor's principal place of business]**	**Surety** Name: **[Full formal name of Surety]** Address: *(principal place of business)*: **[Address of Surety's principal place of business]**
Owner Name: **[Full formal name of Owner]** Mailing address *(principal place of business)*: **[Address of Owner's principal place of business]**	**Contract** Description: *(name and location)*: **[Owner's project/contract name, and location of the project]** Contract Price: **[Amount from Contract]** Effective Date of Contract: **[Date from Contract]**

Bond

Bond Amount: **[Amount]**

Date of Bond: **[Date]**
(Date of Bond cannot be earlier than Effective Date of Contract)
Modifications to this Bond form:
☐ None ☐ See Paragraph 16

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth in this Performance Bond, do each cause this Performance Bond to be duly executed by an authorized officer, agent, or representative.

Contractor as Principal	Surety
(Full formal name of Contractor)	*(Full formal name of Surety) (corporate seal)*
By: _____ *(Signature)*	By: _____ *(Signature)(Attach Power of Attorney)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title: _____	Title: _____
Attest: _____ *(Signature)*	Attest: _____ *(Signature)*
Title: _____	Title: _____

Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party is considered plural where applicable.

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner for the performance of the Construction Contract, which is incorporated herein by reference.
2. If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except when applicable to participate in a conference as provided in Paragraph 3.
3. If there is no Owner Default under the Construction Contract, the Surety's obligation under this Bond will arise after:
    3.1. The Owner first provides notice to the Contractor and the Surety that the Owner is considering declaring a Contractor Default. Such notice may indicate whether the Owner is requesting a conference among the Owner, Contractor, and Surety to discuss the Contractor's performance. If the Owner does not request a conference, the Surety may, within five (5) business days after receipt of the Owner's notice, request such a conference. If the Surety timely requests a conference, the Owner shall attend. Unless the Owner agrees otherwise, any conference requested under this Paragraph 3.1 will be held within ten (10) business days of the Surety's receipt of the Owner's notice. If the Owner, the Contractor, and the Surety agree, the Contractor shall be allowed a reasonable time to perform the Construction Contract, but such an agreement does not waive the Owner's right, if any, subsequently to declare a Contractor Default;
    3.2. The Owner declares a Contractor Default, terminates the Construction Contract and notifies the Surety; and
    3.3. The Owner has agreed to pay the Balance of the Contract Price in accordance with the terms of the Construction Contract to the Surety or to a contractor selected to perform the Construction Contract.
4. Failure on the part of the Owner to comply with the notice requirement in Paragraph 3.1 does not constitute a failure to comply with a condition precedent to the Surety's obligations, or release the Surety from its obligations, except to the extent the Surety demonstrates actual prejudice.
5. When the Owner has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:
    5.1. Arrange for the Contractor, with the consent of the Owner, to perform and complete the Construction Contract;
    5.2. Undertake to perform and complete the Construction Contract itself, through its agents or independent contractors;
    5.3. Obtain bids or negotiated proposals from qualified contractors acceptable to the Owner for a contract for performance and completion of the Construction Contract, arrange for a contract to be prepared for execution by the Owner and a contractor selected with the Owners concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract, and pay to the Owner the amount of damages as described in Paragraph 7 in excess of the Balance of the Contract Price incurred by the Owner as a result of the Contractor Default; or
    5.4. Waive its right to perform and complete, arrange for completion, or obtain a new contractor, and with reasonable promptness under the circumstances:
        5.4.1 After investigation, determine the amount for which it may be liable to the Owner and, as soon as practicable after the amount is determined, make payment to the Owner; or
        5.4.2 Deny liability in whole or in part and notify the Owner, citing the reasons for denial.

6. If the Surety does not proceed as provided in Paragraph 5 with reasonable promptness, the Surety shall be deemed to be in default on this Bond seven days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Paragraph 5.4, and the Owner refuses the payment, or the Surety has denied liability, in whole or in part, without further notice, the Owner shall be entitled to enforce any remedy available to the Owner.

7. If the Surety elects to act under Paragraph 5.1, 5.2, or 5.3, then the responsibilities of the Surety to the Owner will not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety will not be greater than those of the Owner under the Construction Contract. Subject to the commitment by the Owner to pay the Balance of the Contract Price, the Surety is obligated, without duplication for:

    7.1. the responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;

    7.2. additional legal, design professional, and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Paragraph 5; and

    7.3. liquidated damages, or if no liquidated damages are specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.

8. If the Surety elects to act under Paragraph 5.1, 5.3, or 5.4, the Surety's liability is limited to the amount of this Bond.

9. The Surety shall not be liable to the Owner or others for obligations of the Contractor that are unrelated to the Construction Contract, and the Balance of the Contract Price will not be reduced or set off on account of any such unrelated obligations. No right of action will accrue on this Bond to any person or entity other than the Owner or its heirs, executors, administrators, successors, and assigns.

10. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.

11. Any proceeding, legal or equitable, under this Bond must be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and must be instituted within two years after a declaration of Contractor Default or within two years after the Contractor ceased working or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum periods of limitations available to sureties as a defense in the jurisdiction of the suit will be applicable.

12. Notice to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears.

13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted therefrom and provisions conforming to such statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.

14. Definitions

    14.1. *Balance of the Contract Price*—The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made including allowance for the Contractor for any amounts received or to be received by the Owner in settlement of insurance or other claims for damages to which the Contractor is entitled,

reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.

14.2. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and changes made to the agreement and the Contract Documents.

14.3. *Contractor Default*—Failure of the Contractor, which has not been remedied or waived, to perform or otherwise to comply with a material term of the Construction Contract.

14.4. *Owner Default*—Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

14.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.

15. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond will be deemed to be Subcontractor and the term Owner will be deemed to be Contractor.

16. Modifications to this Bond are as follows: **[Describe modification or enter "None"]**

SECTION 00 61 14
PAYMENT BOND

Contractor Name: **[Full formal name of Contractor]** Address: *(principal place of business)*: **[Address of Contractor's principal place of business]**	**Surety** Name: **[Full formal name of Surety]** Address: *(principal place of business)*: **[Address of Surety's principal place of business]**
Owner Name: Address: *(principal place of business)*:	**Contract** Description: *(name and location)*: **[Owner's project /contract name, and location of the project]** Contract Price: **[Amount, from Contract]** Effective Date of Contract: **[Date, from Contract]**

Bond

Bond Amount: **[Amount]**

Date of Bond: **[Date]**

(Date of Bond cannot be earlier than Effective Date of Contract)

Modifications to this Bond form:

☐ None ☐ See Paragraph 18

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth in this Payment Bond, do each cause this Payment Bond to be duly executed by an authorized officer, agent, or representative.

Contractor as Principal	Surety
_____ *(Full formal name of Contractor)*	_____ *(Full formal name of Surety) (corporate seal)*
By: _____ *(Signature)*	By: _____ *(Signature)(Attach Power of Attorney)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title: _____	Title: _____
Attest: _____ *(Signature)*	Attest: _____ *(Signature)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title: _____	Title: _____

Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party is considered plural where applicable.

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner to pay for labor, materials, and equipment furnished for use in the performance of the Construction Contract, which is incorporated herein by reference, subject to the following terms.
2. If the Contractor promptly makes payment of all sums due to Claimants, and defends, indemnifies, and holds harmless the Owner from claims, demands, liens, or suits by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, then the Surety and the Contractor shall have no obligation under this Bond.
3. If there is no Owner Default under the Construction Contract, the Surety's obligation to the Owner under this Bond will arise after the Owner has promptly notified the Contractor and the Surety (at the address described in Paragraph 13) of claims, demands, liens, or suits against the Owner or the Owner's property by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, and tendered defense of such claims, demands, liens, or suits to the Contractor and the Surety.
4. When the Owner has satisfied the conditions in Paragraph 3, the Surety shall promptly and at the Surety's expense defend, indemnify, and hold harmless the Owner against a duly tendered claim, demand, lien, or suit.
5. The Surety's obligations to a Claimant under this Bond will arise after the following:
    5.1. Claimants who do not have a direct contract with the Contractor
        5.1.1. have furnished a written notice of non-payment to the Contractor, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were, or equipment was, furnished or supplied or for whom the labor was done or performed, within ninety (90) days after having last performed labor or last furnished materials or equipment included in the Claim; and
        5.1.2. have sent a Claim to the Surety (at the address described in Paragraph 13).
    5.2. Claimants who are employed by or have a direct contract with the Contractor have sent a Claim to the Surety (at the address described in Paragraph 13).
6. If a notice of non-payment required by Paragraph 5.1.1 is given by the Owner to the Contractor, that is sufficient to satisfy a Claimant's obligation to furnish a written notice of non-payment under Paragraph 5.1.1.
7. When a Claimant has satisfied the conditions of Paragraph 5.1 or 5.2, whichever is applicable, the Surety shall promptly and at the Surety's expense take the following actions:
    7.1. Send an answer to the Claimant, with a copy to the Owner, within sixty (60) days after receipt of the Claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed; and
    7.2. Pay or arrange for payment of any undisputed amounts.
    7.3. The Surety's failure to discharge its obligations under Paragraph 7.1 or 7.2 will not be deemed to constitute a waiver of defenses the Surety or Contractor may have or acquire as to a Claim, except as to undisputed amounts for which the Surety and Claimant have reached agreement. If, however, the Surety fails to discharge its obligations under Paragraph 7.1 or 7.2, the Surety shall indemnify the Claimant for the reasonable attorney's fees the Claimant incurs thereafter to recover any sums found to be due and owing to the Claimant.
8. The Surety's total obligation will not exceed the amount of this Bond, plus the amount of reasonable attorney's fees provided under Paragraph 7.3, and the amount of this Bond will be credited for any payments made in good faith by the Surety.

9. Amounts owed by the Owner to the Contractor under the Construction Contract will be used for the performance of the Construction Contract and to satisfy claims, if any, under any construction performance bond. By the Contractor furnishing and the Owner accepting this Bond, they agree that all funds earned by the Contractor in the performance of the Construction Contract are dedicated to satisfying obligations of the Contractor and Surety under this Bond, subject to the Owner's priority to use the funds for the completion of the work.

10. The Surety shall not be liable to the Owner, Claimants, or others for obligations of the Contractor that are unrelated to the Construction Contract. The Owner shall not be liable for the payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligation to make payments to or give notice on behalf of Claimants, or otherwise have any obligations to Claimants under this Bond.

11. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.

12. No suit or action will be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the state in which the project that is the subject of the Construction Contract is located or after the expiration of one year from the date (1) on which the Claimant sent a Claim to the Surety pursuant to Paragraph 5.1.2 or 5.2, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit will be applicable.

13. Notice and Claims to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears. Actual receipt of notice or Claims, however accomplished, will be sufficient compliance as of the date received.

14. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted here from and provisions conforming to such statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.

15. Upon requests by any person or entity appearing to be a potential beneficiary of this Bond, the Contractor and Owner shall promptly furnish a copy of this Bond or shall permit a copy to be made.

16. Definitions

    16.1. *Claim*—A written statement by the Claimant including at a minimum:

        16.1.1. The name of the Claimant;

        16.1.2. The name of the person for whom the labor was done, or materials or equipment furnished;

        16.1.3. A copy of the agreement or purchase order pursuant to which labor, materials, or equipment was furnished for use in the performance of the Construction Contract;

        16.1.4. A brief description of the labor, materials, or equipment furnished;

        16.1.5. The date on which the Claimant last performed labor or last furnished materials or equipment for use in the performance of the Construction Contract;

        16.1.6. The total amount earned by the Claimant for labor, materials, or equipment furnished as of the date of the Claim;

        16.1.7. The total amount of previous payments received by the Claimant; and

16.1.8. The total amount due and unpaid to the Claimant for labor, materials, or equipment furnished as of the date of the Claim.

16.2. *Claimant*—An individual or entity having a direct contract with the Contractor or with a subcontractor of the Contractor to furnish labor, materials, or equipment for use in the performance of the Construction Contract. The term Claimant also includes any individual or entity that has rightfully asserted a claim under an applicable mechanic's lien or similar statute against the real property upon which the Project is located. The intent of this Bond is to include without limitation in the terms of "labor, materials, or equipment" that part of the water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Construction Contract, architectural and engineering services required for performance of the work of the Contractor and the Contractor's subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.

16.3. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and all changes made to the agreement and the Contract Documents.

16.4. *Owner Default*—Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

16.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.

17. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond will be deemed to be Subcontractor and the term Owner will be deemed to be Contractor.

18. Modifications to this Bond are as follows: **[Describe modification or enter "None"]**

SECTION 00 62 50
CERTIFICATE OF SUBSTANTIAL COMPLETION

Owner: Weber Basin Water Conservancy District
Engineer: Hansen, Allen & Luce
Contractor:
Project: WBWCD – GREEN ROAD WELLHOUSE
Contract:

Owner Project No: 20016
Engineer's Project No.: 254.07.100
Contractor's Project No.:

This ☐ Preliminary ☐ Final Certificate of Substantial Completion applies to:

☒ All Work ☐ The following specified portions of the Work:

_____

_____

_____

Date of Substantial Completion: _____

The Work to which this Certificate applies has been inspected by authorized representatives of Owner, Contractor, and Engineer, and found to be substantially complete. The Date of Substantial Completion of the Work or portion thereof designated above is hereby established, subject to the provisions of the Contract pertaining to Substantial Completion. The date of Substantial Completion in the final Certificate of Substantial Completion marks the commencement of the contractual correction period and applicable warranties required by the Contract.

A punch list of items to be completed or corrected is attached to this Certificate. This list may not be all-inclusive, and the failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

Amendments of contractual responsibilities recorded in this Certificate should be the product of mutual agreement of Owner and Contractor; see Paragraph 15.03.D of the General Conditions.

The responsibilities between Owner and Contractor for security, operation, safety, maintenance, heat, utilities, insurance, and warranties upon Owner's use or occupancy of the Work must be as provided in the Contract, except as amended as follows:

Owner's Amended Responsibilities: ☐ None ☐ As follows:

_____

_____

_____

Contractor's Amended Responsibilities: ☐ None ☐ As follows:

_____

_____

_____

The following documents are attached to and made a part of this Certificate:

_____

_____

_____

This Certificate does not constitute an acceptance of Work not in accordance with the Contract Documents, nor is it a release of Contractor's obligation to complete the Work in accordance with the Contract Documents.

Executed by Engineer	Date
Accepted by Contractor	Date
Accepted by Owner	Date

SECTION 00 63 63
CHANGE ORDER FORM

Change Order No. _____

Date of Issuance:	Effective Date:
Owner:	Owner's Contract No.: 20016
Contractor:	Contractor's Project No.:
Engineer:	Engineer's Project No.: 254.07.100
Project:	Contract Name:

The Contract is modified as follows upon execution of this Change Order:

Description:

Attachments: *[List documents supporting change]*

CHANGE IN CONTRACT PRICE	**CHANGE IN CONTRACT TIMES** *[note changes in Milestones if applicable]*
Original Contract Price: $_____	Original Contract Times: Substantial Completion: _____ Ready for Final Payment: _____ days or dates
[Increase] [Decrease] from previously approved Change Orders No. ___ to No. ___: $_____	[Increase] [Decrease] from previously approved Change Orders No. ___ to No. ___: Substantial Completion: _____ Ready for Final Payment: _____ days
Contract Price prior to this Change Order: $_____	Contract Times prior to this Change Order: Substantial Completion: _____ Ready for Final Payment: _____ days or dates
[Increase] [Decrease] of this Change Order: $_____	[Increase] [Decrease] of this Change Order: Substantial Completion: _____ Ready for Final Payment: _____ days or dates
Contract Price incorporating this Change Order: $_____	Contract Times with all approved Change Orders: Substantial Completion: _____ Ready for Final Payment: _____ days or dates

RECOMMENDED:	ACCEPTED:	ACCEPTED:
By: _____	By: _____	By: _____
Engineer (if required)	Owner (Authorized Signature)	Contractor (Authorized Signature)
Title: _____	Title _____	Title _____
Date: _____	Date _____	Date _____

Approved by Funding Agency (if applicable)

By: _____ Date:

Title: _____

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PART 3
CONTRACT CONDITIONS

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SECTION 00 72 00
GENERAL CONDITIONS

The General Conditions to be used for the Project are the Standard General Conditions of the Construction Contract prepared by Engineers Joint Contract Documents Council (No. EJCDC C-700, 2018 Edition) as included in this Section.

This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the controlling Laws and Regulations.

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared By

EJCDC®
ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

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STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

TABLE OF CONTENTS

Page

Article 1—Definitions and Terminology 1
1.01 Defined Terms 1
1.02 Terminology 6
Article 2—Preliminary Matters 7
2.01 Delivery of Performance and Payment Bonds; Evidence of Insurance 7
2.02 Copies of Documents 7
2.03 Before Starting Construction 7
2.04 Preconstruction Conference; Designation of Authorized Representatives 8
2.05 Acceptance of Schedules 8
2.06 Electronic Transmittals 8
Article 3—Contract Documents: Intent, Requirements, Reuse 9
3.01 Intent 9
3.02 Reference Standards 9
3.03 Reporting and Resolving Discrepancies 10
3.04 Requirements of the Contract Documents 10
3.05 Reuse of Documents 11
Article 4—Commencement and Progress of the Work 11
4.01 Commencement of Contract Times; Notice to Proceed 11
4.02 Starting the Work 11
4.03 Reference Points 11
4.04 Progress Schedule 12
4.05 Delays in Contractor's Progress 12
Article 5—Site; Subsurface and Physical Conditions; Hazardous Environmental Conditions 13
5.01 Availability of Lands 13
5.02 Use of Site and Other Areas 14
5.03 Subsurface and Physical Conditions 15
5.04 Differing Subsurface or Physical Conditions 16

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5.05 Underground Facilities 17
5.06 Hazardous Environmental Conditions at Site 19
Article 6—Bonds and Insurance 21
6.01 Performance, Payment, and Other Bonds 21
6.02 Insurance—General Provisions 22
6.03 Contractor's Insurance 24
6.04 Builder's Risk and Other Property Insurance 25
6.05 Property Losses; Subrogation 25
6.06 Receipt and Application of Property Insurance Proceeds 27
Article 7—Contractor's Responsibilities 27
7.01 Contractor's Means and Methods of Construction 27
7.02 Supervision and Superintendence 27
7.03 Labor; Working Hours 27
7.04 Services, Materials, and Equipment 28
7.05 "Or Equals" 28
7.06 Substitutes 29
7.07 Concerning Subcontractors and Suppliers 31
7.08 Patent Fees and Royalties 32
7.09 Permits 33
7.10 Taxes 33
7.11 Laws and Regulations 33
7.12 Record Documents 33
7.13 Safety and Protection 34
7.14 Hazard Communication Programs 35
7.15 Emergencies 35
7.16 Submittals 35
7.17 Contractor's General Warranty and Guarantee 38
7.18 Indemnification 39
7.19 Delegation of Professional Design Services 39
Article 8—Other Work at the Site 40
8.01 Other Work 40
8.02 Coordination 41
8.03 Legal Relationships 41

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Article 9—Owner's Responsibilities 42
9.01 Communications to Contractor 42
9.02 Replacement of Engineer 42
9.03 Furnish Data 42
9.04 Pay When Due 42
9.05 Lands and Easements; Reports, Tests, and Drawings 43
9.06 Insurance 43
9.07 Change Orders 43
9.08 Inspections, Tests, and Approvals 43
9.09 Limitations on Owner's Responsibilities 43
9.10 Undisclosed Hazardous Environmental Condition 43
9.11 Evidence of Financial Arrangements 43
9.12 Safety Programs 43
Article 10—Engineer's Status During Construction 44
10.01 Owner's Representative 44
10.02 Visits to Site 44
10.03 Resident Project Representative 44
10.04 Engineer's Authority 44
10.05 Determinations for Unit Price Work 45
10.06 Decisions on Requirements of Contract Documents and Acceptability of Work 45
10.07 Limitations on Engineer's Authority and Responsibilities 45
10.08 Compliance with Safety Program 45
Article 11—Changes to the Contract 46
11.01 Amending and Supplementing the Contract 46
11.02 Change Orders 46
11.03 Work Change Directives 46
11.04 Field Orders 47
11.05 Owner-Authorized Changes in the Work 47
11.06 Unauthorized Changes in the Work 47
11.07 Change of Contract Price 47
11.08 Change of Contract Times 49
11.09 Change Proposals 49
11.10 Notification to Surety 50

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Article 12—Claims 50
12.01 Claims 50
Article 13—Cost of the Work; Allowances; Unit Price Work 51
13.01 Cost of the Work 51
13.02 Allowances 55
13.03 Unit Price Work 55
Article 14—Tests and Inspections; Correction, Removal, or Acceptance of Defective Work 56
14.01 Access to Work 56
14.02 Tests, Inspections, and Approvals 56
14.03 Defective Work 57
14.04 Acceptance of Defective Work 58
14.05 Uncovering Work 58
14.06 Owner May Stop the Work 58
14.07 Owner May Correct Defective Work 59
Article 15—Payments to Contractor; Set-Offs; Completion; Correction Period 59
15.01 Progress Payments 59
15.02 Contractor's Warranty of Title 62
15.03 Substantial Completion 62
15.04 Partial Use or Occupancy 63
15.05 Final Inspection 64
15.06 Final Payment 64
15.07 Waiver of Claims 65
15.08 Correction Period 66
Article 16—Suspension of Work and Termination 67
16.01 Owner May Suspend Work 67
16.02 Owner May Terminate for Cause 67
16.03 Owner May Terminate for Convenience 68
16.04 Contractor May Stop Work or Terminate 68
Article 17—Final Resolution of Disputes 69
17.01 Methods and Procedures 69
Article 18—Miscellaneous 69
18.01 Giving Notice 69
18.02 Computation of Times 69

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18.03 Cumulative Remedies 70
18.04 Limitation of Damages 70
18.05 No Waiver 70
18.06 Survival of Obligations 70
18.07 Controlling Law 70
18.08 Assignment of Contract 70
18.09 Successors and Assigns 70
18.10 Headings 70

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STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

ARTICLE 1—DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

A. Wherever used in the Bidding Requirements or Contract Documents, a term printed with initial capital letters, including the term's singular and plural forms, will have the meaning indicated in the definitions below. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.

2. *Agreement*—The written instrument, executed by Owner and Contractor, that sets forth the Contract Price and Contract Times, identifies the parties and the Engineer, and designates the specific items that are Contract Documents.

3. *Application for Payment*—The document prepared by Contractor, in a form acceptable to Engineer, to request progress or final payments, and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

4. *Bid*—The offer of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

5. *Bidder*—An individual or entity that submits a Bid to Owner.

6. *Bidding Documents*—The Bidding Requirements, the proposed Contract Documents, and all Addenda.

7. *Bidding Requirements*—The Advertisement or invitation to bid, Instructions to Bidders, Bid Bond or other Bid security, if any, the Bid Form, and the Bid with any attachments.

8. *Change Order*—A document which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, or other revision to the Contract, issued on or after the Effective Date of the Contract.

9. *Change Proposal*—A written request by Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment in Contract Price or Contract Times; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; challenging a set-off against payments due; or seeking other relief with respect to the terms of the Contract.

10. *Claim*

a. A demand or assertion by Owner directly to Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment of Contract Price or Contract Times; contesting an initial decision by Engineer concerning the

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requirements of the Contract Documents or the acceptability of Work under the Contract Documents; contesting Engineer's decision regarding a Change Proposal; seeking resolution of a contractual issue that Engineer has declined to address; or seeking other relief with respect to the terms of the Contract.

b. A demand or assertion by Contractor directly to Owner, duly submitted in compliance with the procedural requirements set forth herein, contesting Engineer's decision regarding a Change Proposal, or seeking resolution of a contractual issue that Engineer has declined to address.

c. A demand or assertion by Owner or Contractor, duly submitted in compliance with the procedural requirements set forth herein, made pursuant to Paragraph 12.01.A.4, concerning disputes arising after Engineer has issued a recommendation of final payment.

d. A demand for money or services by a third party is not a Claim.

11. *Constituent of Concern*—Asbestos, petroleum, radioactive materials, polychlorinated biphenyls (PCBs), lead-based paint (as defined by the HUD/EPA standard), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to Laws and Regulations regulating, relating to, or imposing liability or standards of conduct concerning, any hazardous, toxic, or dangerous waste, substance, or material.

12. *Contract*—The entire and integrated written contract between Owner and Contractor concerning the Work.

13. *Contract Documents*—Those items so designated in the Agreement, and which together comprise the Contract.

14. *Contract Price*—The money that Owner has agreed to pay Contractor for completion of the Work in accordance with the Contract Documents.

15. *Contract Times*—The number of days or the dates by which Contractor shall: (a) achieve Milestones, if any; (b) achieve Substantial Completion; and (c) complete the Work.

16. *Contractor*—The individual or entity with which Owner has contracted for performance of the Work.

17. *Cost of the Work*—See Paragraph 13.01 for definition.

18. *Drawings*—The part of the Contract that graphically shows the scope, extent, and character of the Work to be performed by Contractor.

19. *Effective Date of the Contract*—The date, indicated in the Agreement, on which the Contract becomes effective.

20. *Electronic Document*—Any Project-related correspondence, attachments to correspondence, data, documents, drawings, information, or graphics, including but not limited to Shop Drawings and other Submittals, that are in an electronic or digital format.

21. *Electronic Means*—Electronic mail (email), upload/download from a secure Project website, or other communications methods that allow: (a) the transmission or communication of Electronic Documents; (b) the documentation of transmissions, including sending and receipt; (c) printing of the transmitted Electronic Document by the

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recipient; (d) the storage and archiving of the Electronic Document by sender and recipient; and (e) the use by recipient of the Electronic Document for purposes permitted by this Contract. Electronic Means does not include the use of text messaging, or of Facebook, Twitter, Instagram, or similar social media services for transmission of Electronic Documents.

22. *Engineer*—The individual or entity named as such in the Agreement.

23. *Field Order*—A written order issued by Engineer which requires minor changes in the Work but does not change the Contract Price or the Contract Times.

24. *Hazardous Environmental Condition*—The presence at the Site of Constituents of Concern in such quantities or circumstances that may present a danger to persons or property exposed thereto.

    a. The presence at the Site of materials that are necessary for the execution of the Work, or that are to be incorporated into the Work, and that are controlled and contained pursuant to industry practices, Laws and Regulations, and the requirements of the Contract, is not a Hazardous Environmental Condition.

    b. The presence of Constituents of Concern that are to be removed or remediated as part of the Work is not a Hazardous Environmental Condition.

    c. The presence of Constituents of Concern as part of the routine, anticipated, and obvious working conditions at the Site, is not a Hazardous Environmental Condition.

25. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, statutes, rules, regulations, ordinances, codes, and binding decrees, resolutions, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

26. *Liens*—Charges, security interests, or encumbrances upon Contract-related funds, real property, or personal property.

27. *Milestone*—A principal event in the performance of the Work that the Contract requires Contractor to achieve by an intermediate completion date, or by a time prior to Substantial Completion of all the Work.

28. *Notice of Award*—The written notice by Owner to a Bidder of Owner's acceptance of the Bid.

29. *Notice to Proceed*—A written notice by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work.

30. *Owner*—The individual or entity with which Contractor has contracted regarding the Work, and which has agreed to pay Contractor for the performance of the Work, pursuant to the terms of the Contract.

31. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising Contractor's plan to accomplish the Work within the Contract Times.

32. *Project*—The total undertaking to be accomplished for Owner by engineers, contractors, and others, including planning, study, design, construction, testing, commissioning, and start-up, and of which the Work to be performed under the Contract Documents is a part.

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33. *Resident Project Representative*—The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative (RPR) includes any assistants or field staff of Resident Project Representative.

34. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and that establish the standards by which such portion of the Work will be judged.

35. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements for Engineer's review of the submittals.

36. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

37. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information that are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work. Shop Drawings, whether approved or not, are not Drawings and are not Contract Documents.

38. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements, and such other lands or areas furnished by Owner which are designated for the use of Contractor.

39. *Specifications*—The part of the Contract that consists of written requirements for materials, equipment, systems, standards, and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable to the Work.

40. *Subcontractor*—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work.

41. *Submittal*—A written or graphic document, prepared by or for Contractor, which the Contract Documents require Contractor to submit to Engineer, or that is indicated as a Submittal in the Schedule of Submittals accepted by Engineer. Submittals may include Shop Drawings and Samples; schedules; product data; Owner-delegated designs; sustainable design information; information on special procedures; testing plans; results of tests and evaluations, source quality-control testing and inspections, and field or Site quality-control testing and inspections; warranties and certifications; Suppliers' instructions and reports; records of delivery of spare parts and tools; operations and maintenance data; Project photographic documentation; record documents; and other such documents required by the Contract Documents. Submittals, whether or not approved or accepted by Engineer, are not Contract Documents. Change Proposals, Change Orders, Claims, notices, Applications for Payment, and requests for interpretation or clarification are not Submittals.

42. *Substantial Completion*—The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion of such Work.

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43. *Successful Bidder*—The Bidder to which the Owner makes an award of contract.

44. *Supplementary Conditions*—The part of the Contract that amends or supplements these General Conditions.

45. *Supplier*—A manufacturer, fabricator, supplier, distributor, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or a Subcontractor.

46. *Technical Data*

    a. Those items expressly identified as Technical Data in the Supplementary Conditions, with respect to either (1) existing subsurface conditions at or adjacent to the Site, or existing physical conditions at or adjacent to the Site including existing surface or subsurface structures (except Underground Facilities) or (2) Hazardous Environmental Conditions at the Site.

    b. If no such express identifications of Technical Data have been made with respect to conditions at the Site, then Technical Data is defined, with respect to conditions at the Site under Paragraphs 5.03, 5.04, and 5.06, as the data contained in boring logs, recorded measurements of subsurface water levels, assessments of the condition of subsurface facilities, laboratory test results, and other factual, objective information regarding conditions at the Site that are set forth in any geotechnical, environmental, or other Site or facilities conditions report prepared for the Project and made available to Contractor.

    c. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data, and instead Underground Facilities are shown or indicated on the Drawings.

47. *Underground Facilities*—All active or not-in-service underground lines, pipelines, conduits, ducts, encasements, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or systems at the Site, including but not limited to those facilities or systems that produce, transmit, distribute, or convey telephone or other communications, cable television, fiber optic transmissions, power, electricity, light, heat, gases, oil, crude oil products, liquid petroleum products, water, steam, waste, wastewater, storm water, other liquids or chemicals, or traffic or other control systems. An abandoned facility or system is not an Underground Facility.

48. *Unit Price Work*—Work to be paid for on the basis of unit prices.

49. *Work*—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction; furnishing, installing, and incorporating all materials and equipment into such construction; and may include related services such as testing, start-up, and commissioning, all as required by the Contract Documents.

50. *Work Change Directive*—A written directive to Contractor issued on or after the Effective Date of the Contract, signed by Owner and recommended by Engineer, ordering an addition, deletion, or revision in the Work.

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1.02 *Terminology*

A. The words and terms discussed in Paragraphs 1.02.B, C, D, and E are not defined terms that require initial capital letters, but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.

B. *Intent of Certain Terms or Adjectives*: The Contract Documents include the terms "as allowed," "as approved," "as ordered," "as directed" or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives "reasonable," "suitable," "acceptable," "proper," "satisfactory," or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Article 10 or any other provision of the Contract Documents.

C. *Day*: The word "day" means a calendar day of 24 hours measured from midnight to the next midnight.

D. *Defective*: The word "defective," when modifying the word "Work," refers to Work that is unsatisfactory, faulty, or deficient in that it:

1. does not conform to the Contract Documents;

2. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or

3. has been damaged prior to Engineer's recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 15.03 or Paragraph 15.04).

E. *Furnish, Install, Perform, Provide*

1. The word "furnish," when used in connection with services, materials, or equipment, means to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.

2. The word "install," when used in connection with services, materials, or equipment, means to put into use or place in final position said services, materials, or equipment complete and ready for intended use.

3. The words "perform" or "provide," when used in connection with services, materials, or equipment, means to furnish and install said services, materials, or equipment complete and ready for intended use.

4. If the Contract Documents establish an obligation of Contractor with respect to specific services, materials, or equipment, but do not expressly use any of the four words "furnish," "install," "perform," or "provide," then Contractor shall furnish and install said services, materials, or equipment complete and ready for intended use.

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F. *Contract Price or Contract Times*: References to a change in "Contract Price or Contract Times" or "Contract Times or Contract Price" or similar, indicate that such change applies to (1) Contract Price, (2) Contract Times, or (3) both Contract Price and Contract Times, as warranted, even if the term "or both" is not expressed.

G. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2—PRELIMINARY MATTERS

2.01 *Delivery of Performance and Payment Bonds; Evidence of Insurance*

A. *Performance and Payment Bonds*: When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner the performance bond and payment bond (if the Contract requires Contractor to furnish such bonds).

B. *Evidence of Contractor's Insurance*: When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner, with copies to each additional insured (as identified in the Contract), the certificates, endorsements, and other evidence of insurance required to be provided by Contractor in accordance with Article 6, except to the extent the Supplementary Conditions expressly establish other dates for delivery of specific insurance policies.

C. *Evidence of Owner's Insurance*: After receipt of the signed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor, with copies to each additional insured (as identified in the Contract), the certificates and other evidence of insurance required to be provided by Owner under Article 6.

2.02 *Copies of Documents*

A. Owner shall furnish to Contractor four printed copies of the Contract (including one fully signed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction.

B. Owner shall maintain and safeguard at least one original printed record version of the Contract, including Drawings and Specifications signed and sealed by Engineer and other design professionals. Owner shall make such original printed record version of the Contract available to Contractor for review. Owner may delegate the responsibilities under this provision to Engineer.

2.03 *Before Starting Construction*

A. *Preliminary Schedules*: Within 10 days after the Effective Date of the Contract (or as otherwise required by the Contract Documents), Contractor shall submit to Engineer for timely review:

1. a preliminary Progress Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract;

2. a preliminary Schedule of Submittals; and

3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work

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into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.04 *Preconstruction Conference; Designation of Authorized Representatives*

A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work, and to discuss the schedules referred to in Paragraph 2.03.A, procedures for handling Shop Drawings, Samples, and other Submittals, processing Applications for Payment, electronic or digital transmittals, and maintaining required records.

B. At this conference Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.05 *Acceptance of Schedules*

A. At least 10 days before submission of the first Application for Payment a conference, attended by Contractor, Engineer, and others as appropriate, will be held to review the schedules submitted in accordance with Paragraph 2.03.A. No progress payment will be made to Contractor until acceptable schedules are submitted to Engineer.

1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.

2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.

3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to the component parts of the Work.

4. If a schedule is not acceptable, Contractor will have an additional 10 days to revise and resubmit the schedule.

2.06 *Electronic Transmittals*

A. Except as otherwise stated elsewhere in the Contract, the Owner, Engineer, and Contractor may send, and shall accept, Electronic Documents transmitted by Electronic Means.

B. If the Contract does not establish protocols for Electronic Means, then Owner, Engineer, and Contractor shall jointly develop such protocols.

C. Subject to any governing protocols for Electronic Means, when transmitting Electronic Documents by Electronic Means, the transmitting party makes no representations as to long-term compatibility, usability, or readability of the Electronic Documents resulting from the recipient's use of software application packages, operating systems, or computer hardware differing from those used in the drafting or transmittal of the Electronic Documents.

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ARTICLE 3—CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 *Intent*

A. The Contract Documents are complementary; what is required by one Contract Document is as binding as if required by all.

B. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents.

C. Unless otherwise stated in the Contract Documents, if there is a discrepancy between the electronic versions of the Contract Documents (including any printed copies derived from such electronic versions) and the printed record version, the printed record version will govern.

D. The Contract supersedes prior negotiations, representations, and agreements, whether written or oral.

E. Engineer will issue clarifications and interpretations of the Contract Documents as provided herein.

F. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation will be deemed stricken, and all remaining provisions will continue to be valid and binding upon Owner and Contractor, which agree that the Contract Documents will be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

G. Nothing in the Contract Documents creates:

1. any contractual relationship between Owner or Engineer and any Subcontractor, Supplier, or other individual or entity performing or furnishing any of the Work, for the benefit of such Subcontractor, Supplier, or other individual or entity; or

2. any obligation on the part of Owner or Engineer to pay or to see to the payment of any money due any such Subcontractor, Supplier, or other individual or entity, except as may otherwise be required by Laws and Regulations.

3.02 *Reference Standards*

A. *Standards Specifications, Codes, Laws and Regulations*

1. Reference in the Contract Documents to standard specifications, manuals, reference standards, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, means the standard specification, manual, reference standard, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Contract if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

2. No provision of any such standard specification, manual, reference standard, or code, and no instruction of a Supplier, will be effective to change the duties or responsibilities of Owner, Contractor, or Engineer from those set forth in the part of the Contract Documents prepared by or for Engineer. No such provision or instruction shall be effective to assign to Owner or Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility

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inconsistent with the provisions of the part of the Contract Documents prepared by or for Engineer.

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies*

1. *Contractor's Verification of Figures and Field Measurements*: Before undertaking each part of the Work, Contractor shall carefully study the Contract Documents, and check and verify pertinent figures and dimensions therein, particularly with respect to applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy that Contractor discovers, or has actual knowledge of, and shall not proceed with any Work affected thereby until the conflict, error, ambiguity, or discrepancy is resolved by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract issued pursuant to Paragraph 11.01.

2. *Contractor's Review of Contract Documents*: If, before or during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation, (b) actual field conditions, (c) any standard specification, manual, reference standard, or code, or (d) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 7.15) until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract issued pursuant to Paragraph 11.01.

3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

B. *Resolving Discrepancies*

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the part of the Contract Documents prepared by or for Engineer take precedence in resolving any conflict, error, ambiguity, or discrepancy between such provisions of the Contract Documents and:

a. the provisions of any standard specification, manual, reference standard, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference as a Contract Document); or

b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 *Requirements of the Contract Documents*

A. During the performance of the Work and until final payment, Contractor and Owner shall submit to the Engineer in writing all matters in question concerning the requirements of the Contract Documents (sometimes referred to as requests for information or interpretation—RFIs), or relating to the acceptability of the Work under the Contract Documents, as soon as possible after such matters arise. Engineer will be the initial interpreter of the requirements of the Contract Documents, and judge of the acceptability of the Work.

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B. Engineer will, with reasonable promptness, render a written clarification, interpretation, or decision on the issue submitted, or initiate an amendment or supplement to the Contract Documents. Engineer's written clarification, interpretation, or decision will be final and binding on Contractor, unless it appeals by submitting a Change Proposal, and on Owner, unless it appeals by filing a Claim.

C. If a submitted matter in question concerns terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work under the Contract Documents, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, then Engineer will promptly notify Owner and Contractor in writing that Engineer is unable to provide a decision or interpretation. If Owner and Contractor are unable to agree on resolution of such a matter in question, either party may pursue resolution as provided in Article 12.

3.05 *Reuse of Documents*

A. Contractor and its Subcontractors and Suppliers shall not:

1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media versions, or reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer; or

2. have or acquire any title or ownership rights in any other Contract Documents, reuse any such Contract Documents for any purpose without Owner's express written consent, or violate any copyrights pertaining to such Contract Documents.

B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein precludes Contractor from retaining copies of the Contract Documents for record purposes.

ARTICLE 4—COMMENCEMENT AND PROGRESS OF THE WORK

4.01 *Commencement of Contract Times; Notice to Proceed*

A. The Contract Times will commence to run on the 30th day after the Effective Date of the Contract or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Contract. In no event will the Contract Times commence to run later than the 60th day after the day of Bid opening or the 30th day after the Effective Date of the Contract, whichever date is earlier.

4.02 *Starting the Work*

A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work may be done at the Site prior to such date.

4.03 *Reference Points*

A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the

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established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.04 *Progress Schedule*

A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.05 as it may be adjusted from time to time as provided below.

1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.05) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times.

2. Proposed adjustments in the Progress Schedule that will change the Contract Times must be submitted in accordance with the requirements of Article 11.

B. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work will be delayed or postponed pending resolution of any disputes or disagreements, or during any appeal process, except as permitted by Paragraph 16.04, or as Owner and Contractor may otherwise agree in writing.

4.05 *Delays in Contractor's Progress*

A. If Owner, Engineer, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times.

B. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delay, disruption, or interference caused by or within the control of Contractor. Delay, disruption, and interference attributable to and within the control of a Subcontractor or Supplier shall be deemed to be within the control of Contractor.

C. If Contractor's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of Owner, Contractor, and those for which they are responsible, then Contractor shall be entitled to an equitable adjustment in Contract Times. Such an adjustment will be Contractor's sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. Causes of delay, disruption, or interference that may give rise to an adjustment in Contract Times under this paragraph include but are not limited to the following:

1. Severe and unavoidable natural catastrophes such as fires, floods, epidemics, and earthquakes;

2. Abnormal weather conditions;

3. Acts or failures to act of third-party utility owners or other third-party entities (other than those third-party utility owners or other third-party entities performing other work at or adjacent to the Site as arranged by or under contract with Owner, as contemplated in Article 8); and

4. Acts of war or terrorism.

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D. Contractor's entitlement to an adjustment of Contract Times or Contract Price is limited as follows:

1. Contractor's entitlement to an adjustment of the Contract Times is conditioned on the delay, disruption, or interference adversely affecting an activity on the critical path to completion of the Work, as of the time of the delay, disruption, or interference.

2. Contractor shall not be entitled to an adjustment in Contract Price for any delay, disruption, or interference if such delay is concurrent with a delay, disruption, or interference caused by or within the control of Contractor. Such a concurrent delay by Contractor shall not preclude an adjustment of Contract Times to which Contractor is otherwise entitled.

3. Adjustments of Contract Times or Contract Price are subject to the provisions of Article 11.

E. Each Contractor request or Change Proposal seeking an increase in Contract Times or Contract Price must be supplemented by supporting data that sets forth in detail the following:

1. The circumstances that form the basis for the requested adjustment;

2. The date upon which each cause of delay, disruption, or interference began to affect the progress of the Work;

3. The date upon which each cause of delay, disruption, or interference ceased to affect the progress of the Work;

4. The number of days' increase in Contract Times claimed as a consequence of each such cause of delay, disruption, or interference; and

5. The impact on Contract Price, in accordance with the provisions of Paragraph 11.07.

Contractor shall also furnish such additional supporting documentation as Owner or Engineer may require including, where appropriate, a revised progress schedule indicating all the activities affected by the delay, disruption, or interference, and an explanation of the effect of the delay, disruption, or interference on the critical path to completion of the Work.

F. Delays, disruption, and interference to the performance or progress of the Work resulting from the existence of a differing subsurface or physical condition, an Underground Facility that was not shown or indicated by the Contract Documents, or not shown or indicated with reasonable accuracy, and those resulting from Hazardous Environmental Conditions, are governed by Article 5, together with the provisions of Paragraphs 4.05.D and 4.05.E.

G. Paragraph 8.03 addresses delays, disruption, and interference to the performance or progress of the Work resulting from the performance of certain other work at or adjacent to the Site.

ARTICLE 5—SITE; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

5.01 *Availability of Lands*

A. Owner shall furnish the Site. Owner shall notify Contractor in writing of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work.

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B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which permanent improvements are to be made and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.

C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

5.02 *Use of Site and Other Areas*

A. *Limitation on Use of Site and Other Areas*

1. Contractor shall confine construction equipment, temporary construction facilities, the storage of materials and equipment, and the operations of workers to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and such other adjacent areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for (a) damage to the Site; (b) damage to any such other adjacent areas used for Contractor's operations; (c) damage to any other adjacent land or areas, or to improvements, structures, utilities, or similar facilities located at such adjacent lands or areas; and (d) for injuries and losses sustained by the owners or occupants of any such land or areas; provided that such damage or injuries result from the performance of the Work or from other actions or conduct of the Contractor or those for which Contractor is responsible.

2. If a damage or injury claim is made by the owner or occupant of any such land or area because of the performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible, Contractor shall (a) take immediate corrective or remedial action as required by Paragraph 7.13, or otherwise; (b) promptly attempt to settle the claim as to all parties through negotiations with such owner or occupant, or otherwise resolve the claim by arbitration or other dispute resolution proceeding, or in a court of competent jurisdiction; and (c) to the fullest extent permitted by Laws and Regulations, indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from and against any such claim, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused directly or indirectly, in whole or in part by, or based upon, Contractor's performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible.

B. *Removal of Debris During Performance of the Work*: During the progress of the Work the Contractor shall keep the Site and other adjacent areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris will conform to applicable Laws and Regulations.

C. *Cleaning*: Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site and adjacent areas all tools, appliances, construction equipment

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and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

D. *Loading of Structures*: Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent structures or land to stresses or pressures that will endanger them.

5.03 *Subsurface and Physical Conditions*

A. *Reports and Drawings*: The Supplementary Conditions identify:

1. Those reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data;

2. Those drawings of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data; and

3. Technical Data contained in such reports and drawings.

B. *Underground Facilities*: Underground Facilities are shown or indicated on the Drawings, pursuant to Paragraph 5.05, and not in the drawings referred to in Paragraph 5.03.A. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data.

C. *Reliance by Contractor on Technical Data*: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely upon the accuracy of the Technical Data as defined in Paragraph 1.01.A.46.b.

D. *Limitations of Other Data and Documents*: Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto;

2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings;

3. the contents of other Site-related documents made available to Contractor, such as record drawings from other projects at or adjacent to the Site, or Owner's archival documents concerning the Site; or

4. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions, or information.

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5.04 *Differing Subsurface or Physical Conditions*

A. *Notice by Contractor*: If Contractor believes that any subsurface or physical condition that is uncovered or revealed at the Site:

1. is of such a nature as to establish that any Technical Data on which Contractor is entitled to rely as provided in Paragraph 5.03 is materially inaccurate;

2. is of such a nature as to require a change in the Drawings or Specifications;

3. differs materially from that shown or indicated in the Contract Documents; or

4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except with respect to an emergency) until receipt of a written statement permitting Contractor to do so.

B. *Engineer's Review*: After receipt of written notice as required by the preceding paragraph, Engineer will promptly review the subsurface or physical condition in question; determine whether it is necessary for Owner to obtain additional exploration or tests with respect to the condition; conclude whether the condition falls within any one or more of the differing site condition categories in Paragraph 5.04.A; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the subsurface or physical condition in question and the need for any change in the Drawings or Specifications; and advise Owner in writing of Engineer's findings, conclusions, and recommendations.

C. *Owner's Statement to Contractor Regarding Site Condition*: After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the subsurface or physical condition in question, addressing the resumption of Work in connection with such condition, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations, in whole or in part.

D. *Early Resumption of Work*: If at any time Engineer determines that Work in connection with the subsurface or physical condition in question may resume prior to completion of Engineer's review or Owner's issuance of its statement to Contractor, because the condition in question has been adequately documented, and analyzed on a preliminary basis, then the Engineer may at its discretion instruct Contractor to resume such Work.

E. *Possible Price and Times Adjustments*

1. Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times, to the extent that the existence of a differing subsurface or physical condition, or any related delay, disruption, or interference, causes an increase or decrease in

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Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

a. Such condition must fall within any one or more of the categories described in Paragraph 5.04.A;

b. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03; and,

c. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E.

2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times with respect to a subsurface or physical condition if:

a. Contractor knew of the existence of such condition at the time Contractor made a commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract, or otherwise;

b. The existence of such condition reasonably could have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas expressly required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such commitment; or

c. Contractor failed to give the written notice required by Paragraph 5.04.A.

3. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment will be set forth in a Change Order.

4. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the subsurface or physical condition in question.

F. *Underground Facilities; Hazardous Environmental Conditions*: Paragraph 5.05 governs rights and responsibilities regarding the presence or location of Underground Facilities. Paragraph 5.06 governs rights and responsibilities regarding Hazardous Environmental Conditions. The provisions of Paragraphs 5.03 and 5.04 are not applicable to the presence or location of Underground Facilities, or to Hazardous Environmental Conditions.

5.05 *Underground Facilities*

A. *Contractor's Responsibilities*: Unless it is otherwise expressly provided in the Supplementary Conditions, the cost of all of the following are included in the Contract Price, and Contractor shall have full responsibility for:

1. reviewing and checking all information and data regarding existing Underground Facilities at the Site;

2. complying with applicable state and local utility damage prevention Laws and Regulations;

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3. verifying the actual location of those Underground Facilities shown or indicated in the Contract Documents as being within the area affected by the Work, by exposing such Underground Facilities during the course of construction;

4. coordination of the Work with the owners (including Owner) of such Underground Facilities, during construction; and

5. the safety and protection of all existing Underground Facilities at the Site, and repairing any damage thereto resulting from the Work.

B. *Notice by Contractor*: If Contractor believes that an Underground Facility that is uncovered or revealed at the Site was not shown or indicated on the Drawings, or was not shown or indicated on the Drawings with reasonable accuracy, then Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing regarding such Underground Facility.

C. *Engineer's Review*: Engineer will:

1. promptly review the Underground Facility and conclude whether such Underground Facility was not shown or indicated on the Drawings, or was not shown or indicated with reasonable accuracy;

2. identify and communicate with the owner of the Underground Facility; prepare recommendations to Owner (and if necessary issue any preliminary instructions to Contractor) regarding the Contractor's resumption of Work in connection with the Underground Facility in question;

3. obtain any pertinent cost or schedule information from Contractor; determine the extent, if any, to which a change is required in the Drawings or Specifications to reflect and document the consequences of the existence or location of the Underground Facility; and

4. advise Owner in writing of Engineer's findings, conclusions, and recommendations.

During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

D. *Owner's Statement to Contractor Regarding Underground Facility*: After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the Underground Facility in question addressing the resumption of Work in connection with such Underground Facility, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations in whole or in part.

E. *Early Resumption of Work*: If at any time Engineer determines that Work in connection with the Underground Facility may resume prior to completion of Engineer's review or Owner's issuance of its statement to Contractor, because the Underground Facility in question and conditions affected by its presence have been adequately documented, and analyzed on a preliminary basis, then the Engineer may at its discretion instruct Contractor to resume such Work.

F. *Possible Price and Times Adjustments*

1. Contractor shall be entitled to an equitable adjustment in the Contract Price or Contract Times, to the extent that any existing Underground Facility at the Site that was not shown

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or indicated on the Drawings, or was not shown or indicated with reasonable accuracy, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

a. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03;

b. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E; and

c. Contractor gave the notice required in Paragraph 5.05.B.

2. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment will be set forth in a Change Order.

3. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the Underground Facility in question.

4. The information and data shown or indicated on the Drawings with respect to existing Underground Facilities at the Site is based on information and data (a) furnished by the owners of such Underground Facilities, or by others, (b) obtained from available records, or (c) gathered in an investigation conducted in accordance with the current edition of ASCE 38, Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, by the American Society of Civil Engineers. If such information or data is incorrect or incomplete, Contractor's remedies are limited to those set forth in this Paragraph 5.05.F.

5.06 *Hazardous Environmental Conditions at Site*

A. *Reports and Drawings*: The Supplementary Conditions identify:

1. those reports known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site;

2. drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site; and

3. Technical Data contained in such reports and drawings.

B. *Reliance by Contractor on Technical Data Authorized*: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely on the accuracy of the Technical Data as defined in Paragraph 1.01.A.46.b. Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures

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of construction to be employed by Contractor, and safety precautions and programs incident thereto;

2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions or information.

C. Contractor shall not be responsible for removing or remediating any Hazardous Environmental Condition encountered, uncovered, or revealed at the Site unless such removal or remediation is expressly identified in the Contract Documents to be within the scope of the Work.

D. Contractor shall be responsible for controlling, containing, and duly removing all Constituents of Concern brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible, and for any associated costs; and for the costs of removing and remediating any Hazardous Environmental Condition created by the presence of any such Constituents of Concern.

E. If Contractor encounters, uncovers, or reveals a Hazardous Environmental Condition whose removal or remediation is not expressly identified in the Contract Documents as being within the scope of the Work, or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, then Contractor shall immediately: (1) secure or otherwise isolate such condition; (2) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 7.15); and (3) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 5.06.F. If Contractor or anyone for whom Contractor is responsible created the Hazardous Environmental Condition in question, then Owner may remove and remediate the Hazardous Environmental Condition, and impose a set-off against payments to account for the associated costs.

F. Contractor shall not resume Work in connection with such Hazardous Environmental Condition or in any affected area until after Owner has obtained any required permits related thereto, and delivered written notice to Contractor either (1) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work, or (2) specifying any special conditions under which such Work may be resumed safely.

G. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, as a result of such Work stoppage, such special conditions under which Work is agreed to be resumed by Contractor, or any costs or expenses incurred in response to the Hazardous Environmental Condition, then within 30 days of Owner's written notice regarding the resumption of Work, Contractor may submit a Change Proposal, or Owner may impose a set-off. Entitlement to any such adjustment is subject to the provisions of Paragraphs 4.05.D, 4.05.E, 11.07, and 11.08.

H. If, after receipt of such written notice, Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special

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conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work, following the contractual change procedures in Article 11. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 8.

I. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court, arbitration, or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition (1) was not shown or indicated in the Drawings, Specifications, or other Contract Documents, identified as Technical Data entitled to limited reliance pursuant to Paragraph 5.06.B, or identified in the Contract Documents to be included within the scope of the Work, and (2) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.I obligates Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

J. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the failure to control, contain, or remove a Constituent of Concern brought to the Site by Contractor or by anyone for whom Contractor is responsible, or to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.J obligates Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

K. The provisions of Paragraphs 5.03, 5.04, and 5.05 do not apply to the presence of Constituents of Concern or to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 6—BONDS AND INSURANCE

6.01 *Performance, Payment, and Other Bonds*

A. Contractor shall furnish a performance bond and a payment bond, each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of Contractor's obligations under the Contract. These bonds must remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 15.08, whichever is later, except as provided otherwise by Laws or Regulations, the terms of a prescribed bond form, the Supplementary Conditions, or other provisions of the Contract.

B. Contractor shall also furnish such other bonds (if any) as are required by the Supplementary Conditions or other provisions of the Contract.

C. All bonds must be in the form included in the Bidding Documents or otherwise specified by Owner prior to execution of the Contract, except as provided otherwise by Laws or

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Regulations, and must be issued and signed by a surety named in "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Department Circular 570 (as amended and supplemented) by the Bureau of the Fiscal Service, U.S. Department of the Treasury. A bond signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual's authority to bind the surety. The evidence of authority must show that it is effective on the date the agent or attorney-in-fact signed the accompanying bond.

D. Contractor shall obtain the required bonds from surety companies that are duly licensed or authorized, in the state or jurisdiction in which the Project is located, to issue bonds in the required amounts.

E. If the surety on a bond furnished by Contractor is declared bankrupt or becomes insolvent, or the surety ceases to meet the requirements above, then Contractor shall promptly notify Owner and Engineer in writing and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which must comply with the bond and surety requirements above.

F. If Contractor has failed to obtain a required bond, Owner may exclude the Contractor from the Site and exercise Owner's termination rights under Article 16.

G. Upon request to Owner from any Subcontractor, Supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of the Work, Owner shall provide a copy of the payment bond to such person or entity.

H. Upon request to Contractor from any Subcontractor, Supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of the Work, Contractor shall provide a copy of the payment bond to such person or entity.

6.02 *Insurance—General Provisions*

A. Owner and Contractor shall obtain and maintain insurance as required in this article and in the Supplementary Conditions.

B. All insurance required by the Contract to be purchased and maintained by Owner or Contractor shall be obtained from insurance companies that are duly licensed or authorized in the state or jurisdiction in which the Project is located to issue insurance policies for the required limits and coverages. Unless a different standard is indicated in the Supplementary Conditions, all companies that provide insurance policies required under this Contract shall have an A.M. Best rating of A-VII or better.

C. Alternative forms of insurance coverage, including but not limited to self-insurance and "Occupational Accident and Excess Employer's Indemnity Policies," are not sufficient to meet the insurance requirements of this Contract, unless expressly allowed in the Supplementary Conditions.

D. Contractor shall deliver to Owner, with copies to each additional insured identified in the Contract, certificates of insurance and endorsements establishing that Contractor has obtained and is maintaining the policies and coverages required by the Contract. Upon request by Owner or any other insured, Contractor shall also furnish other evidence of such required insurance, including but not limited to copies of policies, documentation of applicable self-insured retentions (if allowed) and deductibles, full disclosure of all relevant exclusions, and evidence of insurance required to be purchased and maintained by

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Subcontractors or Suppliers. In any documentation furnished under this provision, Contractor, Subcontractors, and Suppliers may block out (redact) (1) any confidential premium or pricing information and (2) any wording specific to a project or jurisdiction other than those applicable to this Contract.

E. Owner shall deliver to Contractor, with copies to each additional insured identified in the Contract, certificates of insurance and endorsements establishing that Owner has obtained and is maintaining the policies and coverages required of Owner by the Contract (if any). Upon request by Contractor or any other insured, Owner shall also provide other evidence of such required insurance (if any), including but not limited to copies of policies, documentation of applicable self-insured retentions (if allowed) and deductibles, and full disclosure of all relevant exclusions. In any documentation furnished under this provision, Owner may block out (redact) (1) any confidential premium or pricing information and (2) any wording specific to a project or jurisdiction other than those relevant to this Contract.

F. Failure of Owner or Contractor to demand such certificates or other evidence of the other party's full compliance with these insurance requirements, or failure of Owner or Contractor to identify a deficiency in compliance from the evidence provided, will not be construed as a waiver of the other party's obligation to obtain and maintain such insurance.

G. In addition to the liability insurance required to be provided by Contractor, the Owner, at Owner's option, may purchase and maintain Owner's own liability insurance. Owner's liability policies, if any, operate separately and independently from policies required to be provided by Contractor, and Contractor cannot rely upon Owner's liability policies for any of Contractor's obligations to the Owner, Engineer, or third parties.

H. Contractor shall require:

1. Subcontractors to purchase and maintain worker's compensation, commercial general liability, and other insurance that is appropriate for their participation in the Project, and to name as additional insureds Owner and Engineer (and any other individuals or entities identified in the Supplementary Conditions as additional insureds on Contractor's liability policies) on each Subcontractor's commercial general liability insurance policy; and

2. Suppliers to purchase and maintain insurance that is appropriate for their participation in the Project.

I. If either party does not purchase or maintain the insurance required of such party by the Contract, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage.

J. If Contractor has failed to obtain and maintain required insurance, Contractor's entitlement to enter or remain at the Site will end immediately, and Owner may impose an appropriate set-off against payment for any associated costs (including but not limited to the cost of purchasing necessary insurance coverage), and exercise Owner's termination rights under Article 16.

K. Without prejudice to any other right or remedy, if a party has failed to obtain required insurance, the other party may elect (but is in no way obligated) to obtain equivalent insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and the Contract Price will be adjusted accordingly.

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L. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor or Contractor's interests. Contractor is responsible for determining whether such coverage and limits are adequate to protect its interests, and for obtaining and maintaining any additional insurance that Contractor deems necessary.

M. The insurance and insurance limits required herein will not be deemed as a limitation on Contractor's liability, or that of its Subcontractors or Suppliers, under the indemnities granted to Owner and other individuals and entities in the Contract or otherwise.

N. All the policies of insurance required to be purchased and maintained under this Contract will contain a provision or endorsement that the coverage afforded will not be canceled, or renewal refused, until at least 10 days prior written notice has been given to the purchasing policyholder. Within three days of receipt of any such written notice, the purchasing policyholder shall provide a copy of the notice to each other insured and Engineer.

6.03 *Contractor's Insurance*

A. *Required Insurance*: Contractor shall purchase and maintain Worker's Compensation, Commercial General Liability, and other insurance pursuant to the specific requirements of the Supplementary Conditions.

B. *General Provisions*: The policies of insurance required by this Paragraph 6.03 as supplemented must:

1. include at least the specific coverages required;

2. be written for not less than the limits provided, or those required by Laws or Regulations, whichever is greater;

3. remain in effect at least until the Work is complete (as set forth in Paragraph 15.06.D), and longer if expressly required elsewhere in this Contract, and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work as a warranty or correction obligation, or otherwise, or returning to the Site to conduct other tasks arising from the Contract;

4. apply with respect to the performance of the Work, whether such performance is by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable; and

5. include all necessary endorsements to support the stated requirements.

C. *Additional Insureds*: The Contractor's commercial general liability, automobile liability, employer's liability, umbrella or excess, pollution liability, and unmanned aerial vehicle liability policies, if required by this Contract, must:

1. include and list as additional insureds Owner and Engineer, and any individuals or entities identified as additional insureds in the Supplementary Conditions;

2. include coverage for the respective officers, directors, members, partners, employees, and consultants of all such additional insureds;

3. afford primary coverage to these additional insureds for all claims covered thereby (including as applicable those arising from both ongoing and completed operations);

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4. not seek contribution from insurance maintained by the additional insured; and

5. as to commercial general liability insurance, apply to additional insureds with respect to liability caused in whole or in part by Contractor's acts or omissions, or the acts and omissions of those working on Contractor's behalf, in the performance of Contractor's operations.

6.04 *Builder's Risk and Other Property Insurance*

A. *Builder's Risk*: Unless otherwise provided in the Supplementary Conditions, Contractor shall purchase and maintain builder's risk insurance upon the Work on a completed value basis, in the amount of the Work's full insurable replacement cost (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). The specific requirements applicable to the builder's risk insurance are set forth in the Supplementary Conditions.

B. *Property Insurance for Facilities of Owner Where Work Will Occur*: Owner is responsible for obtaining and maintaining property insurance covering each existing structure, building, or facility in which any part of the Work will occur, or to which any part of the Work will attach or be adjoined. Such property insurance will be written on a special perils (all-risk) form, on a replacement cost basis, providing coverage consistent with that required for the builder's risk insurance, and will be maintained until the Work is complete, as set forth in Paragraph 15.06.D.

C. *Property Insurance for Substantially Complete Facilities*: Promptly after Substantial Completion, and before actual occupancy or use of the substantially completed Work, Owner will obtain property insurance for such substantially completed Work, and maintain such property insurance at least until the Work is complete, as set forth in Paragraph 15.06.D. Such property insurance will be written on a special perils (all-risk) form, on a replacement cost basis, and provide coverage consistent with that required for the builder's risk insurance. The builder's risk insurance may terminate upon written confirmation of Owner's procurement of such property insurance.

D. *Partial Occupancy or Use by Owner*: If Owner will occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work, as provided in Paragraph 15.04, then Owner (directly, if it is the purchaser of the builder's risk policy, or through Contractor) will provide advance notice of such occupancy or use to the builder's risk insurer, and obtain an endorsement consenting to the continuation of coverage prior to commencing such partial occupancy or use.

E. *Insurance of Other Property; Additional Insurance*: If the express insurance provisions of the Contract do not require or address the insurance of a property item or interest, then the entity or individual owning such property item will be responsible for insuring it. If Contractor elects to obtain other special insurance to be included in or supplement the builder's risk or property insurance policies provided under this Paragraph 6.04, it may do so at Contractor's expense.

6.05 *Property Losses; Subrogation*

A. The builder's risk insurance policy purchased and maintained in accordance with Paragraph 6.04 (or an installation floater policy if authorized by the Supplementary Conditions), will contain provisions to the effect that in the event of payment of any loss or damage the insurer will have no rights of recovery against any insureds thereunder, or against

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Engineer or its consultants, or their officers, directors, members, partners, employees, agents, consultants, or subcontractors.

1. Owner and Contractor waive all rights against each other and the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from any of the perils, risks, or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Engineer, its consultants, all individuals or entities identified in the Supplementary Conditions as builder's risk or installation floater insureds, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, under such policies for losses and damages so caused.
2. None of the above waivers extends to the rights that any party making such waiver may have to the proceeds of insurance held by Owner or Contractor as trustee or fiduciary, or otherwise payable under any policy so issued.

B. Any property insurance policy maintained by Owner covering any loss, damage, or consequential loss to Owner's existing structures, buildings, or facilities in which any part of the Work will occur, or to which any part of the Work will attach or adjoin; to adjacent structures, buildings, or facilities of Owner; or to part or all of the completed or substantially completed Work, during partial occupancy or use pursuant to Paragraph 15.04, after Substantial Completion pursuant to Paragraph 15.03, or after final payment pursuant to Paragraph 15.06, will contain provisions to the effect that in the event of payment of any loss or damage the insurer will have no rights of recovery against any insureds thereunder, or against Contractor, Subcontractors, or Engineer, or the officers, directors, members, partners, employees, agents, consultants, or subcontractors of each and any of them, and that the insured is allowed to waive the insurer's rights of subrogation in a written contract executed prior to the loss, damage, or consequential loss.

1. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from fire or any of the perils, risks, or causes of loss covered by such policies.

C. The waivers in this Paragraph 6.05 include the waiver of rights due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other insured peril, risk, or cause of loss.

D. Contractor shall be responsible for assuring that each Subcontract contains provisions whereby the Subcontractor waives all rights against Owner, Contractor, all individuals or entities identified in the Supplementary Conditions as insureds, the Engineer and its consultants, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, relating to, or resulting from fire or other peril, risk, or cause of loss covered by builder's risk insurance, installation floater, and any other property insurance applicable to the Work.

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6.06 *Receipt and Application of Property Insurance Proceeds*

A. Any insured loss under the builder's risk and other policies of property insurance required by Paragraph 6.04 will be adjusted and settled with the named insured that purchased the policy. Such named insured shall act as fiduciary for the other insureds, and give notice to such other insureds that adjustment and settlement of a claim is in progress. Any other insured may state its position regarding a claim for insured loss in writing within 15 days after notice of such claim.

B. Proceeds for such insured losses may be made payable by the insurer either jointly to multiple insureds, or to the named insured that purchased the policy in its own right and as fiduciary for other insureds, subject to the requirements of any applicable mortgage clause. A named insured receiving insurance proceeds under the builder's risk and other policies of insurance required by Paragraph 6.04 shall maintain such proceeds in a segregated account, and distribute such proceeds in accordance with such agreement as the parties in interest may reach, or as otherwise required under the dispute resolution provisions of this Contract or applicable Laws and Regulations.

C. If no other special agreement is reached, Contractor shall repair or replace the damaged Work, using allocated insurance proceeds.

ARTICLE 7—CONTRACTOR'S RESPONSIBILITIES

7.01 *Contractor's Means and Methods of Construction*

A. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.

B. If the Contract Documents note, or Contractor determines, that professional engineering or other design services are needed to carry out Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures, or for Site safety, then Contractor shall cause such services to be provided by a properly licensed design professional, at Contractor's expense. Such services are not Owner-delegated professional design services under this Contract, and neither Owner nor Engineer has any responsibility with respect to (1) Contractor's determination of the need for such services, (2) the qualifications or licensing of the design professionals retained or employed by Contractor, (3) the performance of such services, or (4) any errors, omissions, or defects in such services.

7.02 *Supervision and Superintendence*

A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents.

B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who will not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

7.03 *Labor; Working Hours*

A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall maintain good discipline and order at the Site.

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B. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of Contractor's employees; of Suppliers and Subcontractors, and their employees; and of any other individuals or entities performing or furnishing any of the Work, just as Contractor is responsible for Contractor's own acts and omissions.

C. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site will be performed during regular working hours, Monday through Friday. Contractor will not perform Work on a Saturday, Sunday, or any legal holiday. Contractor may perform Work outside regular working hours or on Saturdays, Sundays, or legal holidays only with Owner's written consent, which will not be unreasonably withheld.

7.04 *Services, Materials, and Equipment*

A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start up, and completion of the Work, whether or not such items are specifically called for in the Contract Documents.

B. All materials and equipment incorporated into the Work must be new and of good quality, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications will expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.

C. All materials and equipment must be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

7.05 *"Or Equals"*

A. *Contractor's Request; Governing Criteria*: Whenever an item of equipment or material is specified or described in the Contract Documents by using the names of one or more proprietary items or specific Suppliers, the Contract Price has been based upon Contractor furnishing such item as specified. The specification or description of such an item is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or equal" item is permitted, Contractor may request that Engineer authorize the use of other items of equipment or material, or items from other proposed Suppliers, under the circumstances described below.

1. If Engineer in its sole discretion determines that an item of equipment or material proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, Engineer will deem it an "or equal" item. For the purposes of this paragraph, a proposed item of equipment or material will be considered functionally equal to an item so named if:

a. in the exercise of reasonable judgment Engineer determines that the proposed item:

1) is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;

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2) will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole;

3) has a proven record of performance and availability of responsive service; and

4) is not objectionable to Owner.

b. Contractor certifies that, if the proposed item is approved and incorporated into the Work:

1) there will be no increase in cost to the Owner or increase in Contract Times; and

2) the item will conform substantially to the detailed requirements of the item named in the Contract Documents.

B. *Contractor's Expense*: Contractor shall provide all data in support of any proposed "or equal" item at Contractor's expense.

C. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each "or-equal" request. Engineer may require Contractor to furnish additional data about the proposed "or-equal" item. Engineer will be the sole judge of acceptability. No "or-equal" item will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an "or-equal," which will be evidenced by an approved Shop Drawing or other written communication. Engineer will advise Contractor in writing of any negative determination.

D. *Effect of Engineer's Determination*: Neither approval nor denial of an "or-equal" request will result in any change in Contract Price. The Engineer's denial of an "or-equal" request will be final and binding, and may not be reversed through an appeal under any provision of the Contract.

E. *Treatment as a Substitution Request*: If Engineer determines that an item of equipment or material proposed by Contractor does not qualify as an "or-equal" item, Contractor may request that Engineer consider the item a proposed substitute pursuant to Paragraph 7.06.

7.06 *Substitutes*

A. *Contractor's Request; Governing Criteria*: Unless the specification or description of an item of equipment or material required to be furnished under the Contract Documents contains or is followed by words reading that no substitution is permitted, Contractor may request that Engineer authorize the use of other items of equipment or material under the circumstances described below. To the extent possible such requests must be made before commencement of related construction at the Site.

1. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is functionally equivalent to that named and an acceptable substitute therefor. Engineer will not accept requests for review of proposed substitute items of equipment or material from anyone other than Contractor.

2. The requirements for review by Engineer will be as set forth in Paragraph 7.06.B, as supplemented by the Specifications, and as Engineer may decide is appropriate under the circumstances.

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3. Contractor shall make written application to Engineer for review of a proposed substitute item of equipment or material that Contractor seeks to furnish or use. The application:

    a. will certify that the proposed substitute item will:

        1) perform adequately the functions and achieve the results called for by the general design;

        2) be similar in substance to the item specified; and

        3) be suited to the same use as the item specified.

    b. will state:

        1) the extent, if any, to which the use of the proposed substitute item will necessitate a change in Contract Times;

        2) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item; and

        3) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty.

    c. will identify:

        1) all variations of the proposed substitute item from the item specified; and

        2) available engineering, sales, maintenance, repair, and replacement services.

    d. will contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including but not limited to changes in Contract Price, shared savings, costs of redesign, and claims of other contractors affected by any resulting change.

B. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each substitute request, and to obtain comments and direction from Owner. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No substitute will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an acceptable substitute. Engineer's determination will be evidenced by a Field Order or a proposed Change Order accounting for the substitution itself and all related impacts, including changes in Contract Price or Contract Times. Engineer will advise Contractor in writing of any negative determination.

C. *Special Guarantee*: Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.

D. *Reimbursement of Engineer's Cost*: Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

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E. *Contractor's Expense*: Contractor shall provide all data in support of any proposed substitute at Contractor's expense.

F. *Effect of Engineer's Determination*: If Engineer approves the substitution request, Contractor shall execute the proposed Change Order and proceed with the substitution. The Engineer's denial of a substitution request will be final and binding, and may not be reversed through an appeal under any provision of the Contract. Contractor may challenge the scope of reimbursement costs imposed under Paragraph 7.06.D, by timely submittal of a Change Proposal.

7.07 *Concerning Subcontractors and Suppliers*

A. Contractor may retain Subcontractors and Suppliers for the performance of parts of the Work. Such Subcontractors and Suppliers must be acceptable to Owner. The Contractor's retention of a Subcontractor or Supplier for the performance of parts of the Work will not relieve Contractor's obligation to Owner to perform and complete the Work in accordance with the Contract Documents.

B. Contractor shall retain specific Subcontractors and Suppliers for the performance of designated parts of the Work if required by the Contract to do so.

C. Subsequent to the submittal of Contractor's Bid or final negotiation of the terms of the Contract, Owner may not require Contractor to retain any Subcontractor or Supplier to furnish or perform any of the Work against which Contractor has reasonable objection.

D. Prior to entry into any binding subcontract or purchase order, Contractor shall submit to Owner the identity of the proposed Subcontractor or Supplier (unless Owner has already deemed such proposed Subcontractor or Supplier acceptable during the bidding process or otherwise). Such proposed Subcontractor or Supplier shall be deemed acceptable to Owner unless Owner raises a substantive, reasonable objection within 5 days.

E. Owner may require the replacement of any Subcontractor or Supplier. Owner also may require Contractor to retain specific replacements; provided, however, that Owner may not require a replacement to which Contractor has a reasonable objection. If Contractor has submitted the identity of certain Subcontractors or Suppliers for acceptance by Owner, and Owner has accepted it (either in writing or by failing to make written objection thereto), then Owner may subsequently revoke the acceptance of any such Subcontractor or Supplier so identified solely on the basis of substantive, reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor or Supplier.

F. If Owner requires the replacement of any Subcontractor or Supplier retained by Contractor to perform any part of the Work, then Contractor shall be entitled to an adjustment in Contract Price or Contract Times, with respect to the replacement; and Contractor shall initiate a Change Proposal for such adjustment within 30 days of Owner's requirement of replacement.

G. No acceptance by Owner of any such Subcontractor or Supplier, whether initially or as a replacement, will constitute a waiver of the right of Owner to the completion of the Work in accordance with the Contract Documents.

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H. On a monthly basis, Contractor shall submit to Engineer a complete list of all Subcontractors and Suppliers having a direct contract with Contractor, and of all other Subcontractors and Suppliers known to Contractor at the time of submittal.

I. Contractor shall be solely responsible for scheduling and coordinating the work of Subcontractors and Suppliers.

J. The divisions and sections of the Specifications and the identifications of any Drawings do not control Contractor in dividing the Work among Subcontractors or Suppliers, or in delineating the Work to be performed by any specific trade.

K. All Work performed for Contractor by a Subcontractor or Supplier must be pursuant to an appropriate contractual agreement that specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract for the benefit of Owner and Engineer.

L. Owner may furnish to any Subcontractor or Supplier, to the extent practicable, information about amounts paid to Contractor for Work performed for Contractor by the Subcontractor or Supplier.

M. Contractor shall restrict all Subcontractors and Suppliers from communicating with Engineer or Owner, except through Contractor or in case of an emergency, or as otherwise expressly allowed in this Contract.

7.08 *Patent Fees and Royalties*

A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If an invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights will be disclosed in the Contract Documents.

B. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, and its officers, directors, members, partners, employees, agents, consultants, and subcontractors, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device specified in the Contract Documents, but not identified as being subject to payment of any license fee or royalty to others required by patent rights or copyrights.

C. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

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7.09 *Permits*

A. Unless otherwise provided in the Contract Documents, Contractor shall obtain and pay for all construction permits, licenses, and certificates of occupancy. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of the submission of Contractor's Bid (or when Contractor became bound under a negotiated contract). Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

7.10 *Taxes*

A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

7.11 *Laws and Regulations*

A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.

B. If Contractor performs any Work or takes any other action knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all resulting costs and losses, and shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work or other action. It is not Contractor's responsibility to make certain that the Work described in the Contract Documents is in accordance with Laws and Regulations, but this does not relieve Contractor of its obligations under Paragraph 3.03.

C. Owner or Contractor may give written notice to the other party of any changes after the submission of Contractor's Bid (or after the date when Contractor became bound under a negotiated contract) in Laws or Regulations having an effect on the cost or time of performance of the Work, including but not limited to changes in Laws or Regulations having an effect on procuring permits and on sales, use, value-added, consumption, and other similar taxes. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times resulting from such changes, then within 30 days of such written notice Contractor may submit a Change Proposal, or Owner may initiate a Claim.

7.12 *Record Documents*

A. Contractor shall maintain in a safe place at the Site one printed record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, written interpretations and clarifications, and approved Shop Drawings. Contractor shall keep such record documents in good order and annotate them to show changes made during construction. These record documents, together with all approved Samples, will be available to Engineer for reference. Upon completion of the Work, Contractor shall deliver these record documents to Engineer.

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7.13 *Safety and Protection*

A. Contractor shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations.

B. Contractor shall designate a qualified and experienced safety representative whose duties and responsibilities are the prevention of Work-related accidents and the maintenance and supervision of safety precautions and programs.

C. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury, or loss to:

1. all persons on the Site or who may be affected by the Work;

2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and

3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, other work in progress, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

D. All damage, injury, or loss to any property referred to in Paragraph 7.13.C.2 or 7.13.C.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor at its expense (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).

E. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection.

F. Contractor shall notify Owner; the owners of adjacent property; the owners of Underground Facilities and other utilities (if the identity of such owners is known to Contractor); and other contractors and utility owners performing work at or adjacent to the Site, in writing, when Contractor knows that prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property or work in progress.

G. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. Any Owner's safety programs that are applicable to the Work are identified or included in the Supplementary Conditions or Specifications.

H. Contractor shall inform Owner and Engineer of the specific requirements of Contractor's safety program with which Owner's and Engineer's employees and representatives must comply while at the Site.

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I. Contractor's duties and responsibilities for safety and protection will continue until all the Work is completed, Engineer has issued a written notice to Owner and Contractor in accordance with Paragraph 15.06.C that the Work is acceptable, and Contractor has left the Site (except as otherwise expressly provided in connection with Substantial Completion).

J. Contractor's duties and responsibilities for safety and protection will resume whenever Contractor or any Subcontractor or Supplier returns to the Site to fulfill warranty or correction obligations, or to conduct other tasks arising from the Contract Documents.

7.14 *Hazard Communication Programs*

A. Contractor shall be responsible for coordinating any exchange of safety data sheets (formerly known as material safety data sheets) or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

7.15 *Emergencies*

A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused by an emergency, or are required as a result of Contractor's response to an emergency. If Engineer determines that a change in the Contract Documents is required because of an emergency or Contractor's response, a Work Change Directive or Change Order will be issued.

7.16 *Submittals*

A. *Shop Drawing and Sample Requirements*

1. Before submitting a Shop Drawing or Sample, Contractor shall:

a. review and coordinate the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;

b. determine and verify:

1) all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect to the Submittal;

2) the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and

3) all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto;

c. confirm that the Submittal is complete with respect to all related data included in the Submittal.

2. Each Shop Drawing or Sample must bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review of that Submittal, and that Contractor approves the Submittal.

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3. With each Shop Drawing or Sample, Contractor shall give Engineer specific written notice of any variations that the Submittal may have from the requirements of the Contract Documents. This notice must be set forth in a written communication separate from the Submittal; and, in addition, in the case of a Shop Drawing by a specific notation made on the Shop Drawing itself.

B. *Submittal Procedures for Shop Drawings and Samples*: Contractor shall label and submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals.

1. *Shop Drawings*

a. Contractor shall submit the number of copies required in the Specifications.

b. Data shown on the Shop Drawings must be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide, and to enable Engineer to review the information for the limited purposes required by Paragraph 7.16.C.

2. *Samples*

a. Contractor shall submit the number of Samples required in the Specifications.

b. Contractor shall clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the Submittal for the limited purposes required by Paragraph 7.16.C.

3. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.

C. *Engineer's Review of Shop Drawings and Samples*

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the accepted Schedule of Submittals. Engineer's review and approval will be only to determine if the items covered by the Submittals will, after installation or incorporation in the Work, comply with the requirements of the Contract Documents, and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.

2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction, or to safety precautions or programs incident thereto.

3. Engineer's review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

4. Engineer's review and approval of a Shop Drawing or Sample will not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 7.16.A.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer will

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document any such approved variation from the requirements of the Contract Documents in a Field Order or other appropriate Contract modification.

5. Engineer's review and approval of a Shop Drawing or Sample will not relieve Contractor from responsibility for complying with the requirements of Paragraphs 7.16.A and B.

6. Engineer's review and approval of a Shop Drawing or Sample, or of a variation from the requirements of the Contract Documents, will not, under any circumstances, change the Contract Times or Contract Price, unless such changes are included in a Change Order.

7. Neither Engineer's receipt, review, acceptance, or approval of a Shop Drawing or Sample will result in such item becoming a Contract Document.

8. Contractor shall perform the Work in compliance with the requirements and commitments set forth in approved Shop Drawings and Samples, subject to the provisions of Paragraph 7.16.C.4.

D. *Resubmittal Procedures for Shop Drawings and Samples*

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous Submittals.

2. Contractor shall furnish required Shop Drawing and Sample submittals with sufficient information and accuracy to obtain required approval of an item with no more than two resubmittals. Engineer will record Engineer's time for reviewing a third or subsequent resubmittal of a Shop Drawing or Sample, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due Contractor to secure reimbursement for such charges.

3. If Contractor requests a change of a previously approved Shop Drawing or Sample, Contractor shall be responsible for Engineer's charges to Owner for its review time, and Owner may impose a set-off against payments due Contractor to secure reimbursement for such charges, unless the need for such change is beyond the control of Contractor.

E. *Submittals Other than Shop Drawings, Samples, and Owner-Delegated Designs*

1. The following provisions apply to all Submittals other than Shop Drawings, Samples, and Owner-delegated designs:

   a. Contractor shall submit all such Submittals to the Engineer in accordance with the Schedule of Submittals and pursuant to the applicable terms of the Contract Documents.

   b. Engineer will provide timely review of all such Submittals in accordance with the Schedule of Submittals and return such Submittals with a notation of either Accepted or Not Accepted. Any such Submittal that is not returned within the time established in the Schedule of Submittals will be deemed accepted.

   c. Engineer's review will be only to determine if the Submittal is acceptable under the requirements of the Contract Documents as to general form and content of the Submittal.

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d. If any such Submittal is not accepted, Contractor shall confer with Engineer regarding the reason for the non-acceptance, and resubmit an acceptable document.

2. Procedures for the submittal and acceptance of the Progress Schedule, the Schedule of Submittals, and the Schedule of Values are set forth in Paragraphs 2.03. 2.04, and 2.05.

F. Owner-delegated Designs: Submittals pursuant to Owner-delegated designs are governed by the provisions of Paragraph 7.19.

7.17 *Contractor's General Warranty and Guarantee*

A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer is entitled to rely on Contractor's warranty and guarantee.

B. Owner's rights under this warranty and guarantee are in addition to, and are not limited by, Owner's rights under the correction period provisions of Paragraph 15.08. The time in which Owner may enforce its warranty and guarantee rights under this Paragraph 7.17 is limited only by applicable Laws and Regulations restricting actions to enforce such rights; provided, however, that after the end of the correction period under Paragraph 15.08:

1. Owner shall give Contractor written notice of any defective Work within 60 days of the discovery that such Work is defective; and

2. Such notice will be deemed the start of an event giving rise to a Claim under Paragraph 12.01.B, such that any related Claim must be brought within 30 days of the notice.

C. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, or improper modification, maintenance, or operation, by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or

2. normal wear and tear under normal usage.

D. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents is absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents, a release of Contractor's obligation to perform the Work in accordance with the Contract Documents, or a release of Owner's warranty and guarantee rights under this Paragraph 7.17:

1. Observations by Engineer;

2. Recommendation by Engineer or payment by Owner of any progress or final payment;

3. The issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;

4. Use or occupancy of the Work or any part thereof by Owner;

5. Any review and approval of a Shop Drawing or Sample submittal;

6. The issuance of a notice of acceptability by Engineer;

7. The end of the correction period established in Paragraph 15.08;

8. Any inspection, test, or approval by others; or

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9. Any correction of defective Work by Owner.

E. If the Contract requires the Contractor to accept the assignment of a contract entered into by Owner, then the specific warranties, guarantees, and correction obligations contained in the assigned contract will govern with respect to Contractor's performance obligations to Owner for the Work described in the assigned contract.

7.18 *Indemnification*

A. To the fullest extent permitted by Laws and Regulations, and in addition to any other obligations of Contractor under the Contract or otherwise, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from losses, damages, costs, and judgments (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising from third-party claims or actions relating to or resulting from the performance or furnishing of the Work, provided that any such claim, action, loss, cost, judgment or damage is attributable to bodily injury, sickness, disease, or death, or to damage to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom, but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable.

B. In any and all claims against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 7.18.A will not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

7.19 *Delegation of Professional Design Services*

A. Owner may require Contractor to provide professional design services for a portion of the Work by express delegation in the Contract Documents. Such delegation will specify the performance and design criteria that such services must satisfy, and the Submittals that Contractor must furnish to Engineer with respect to the Owner-delegated design.

B. Contractor shall cause such Owner-delegated professional design services to be provided pursuant to the professional standard of care by a properly licensed design professional, whose signature and seal must appear on all drawings, calculations, specifications, certifications, and Submittals prepared by such design professional. Such design professional must issue all certifications of design required by Laws and Regulations.

C. If a Shop Drawing or other Submittal related to the Owner-delegated design is prepared by Contractor, a Subcontractor, or others for submittal to Engineer, then such Shop Drawing or other Submittal must bear the written approval of Contractor's design professional when submitted by Contractor to Engineer.

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D. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, and approvals performed or provided by the design professionals retained or employed by Contractor under an Owner-delegated design, subject to the professional standard of care and the performance and design criteria stated in the Contract Documents.

E. Pursuant to this Paragraph 7.19, Engineer's review, approval, and other determinations regarding design drawings, calculations, specifications, certifications, and other Submittals furnished by Contractor pursuant to an Owner-delegated design will be only for the following limited purposes:

1. Checking for conformance with the requirements of this Paragraph 7.19;

2. Confirming that Contractor (through its design professionals) has used the performance and design criteria specified in the Contract Documents; and

3. Establishing that the design furnished by Contractor is consistent with the design concept expressed in the Contract Documents.

F. Contractor shall not be responsible for the adequacy of performance or design criteria specified by Owner or Engineer.

G. Contractor is not required to provide professional services in violation of applicable Laws and Regulations.

ARTICLE 8—OTHER WORK AT THE SITE

8.01 *Other Work*

A. In addition to and apart from the Work under the Contract Documents, the Owner may perform other work at or adjacent to the Site. Such other work may be performed by Owner's employees, or through contracts between the Owner and third parties. Owner may also arrange to have third-party utility owners perform work on their utilities and facilities at or adjacent to the Site.

B. If Owner performs other work at or adjacent to the Site with Owner's employees, or through contracts for such other work, then Owner shall give Contractor written notice thereof prior to starting any such other work. If Owner has advance information regarding the start of any third-party utility work that Owner has arranged to take place at or adjacent to the Site, Owner shall provide such information to Contractor.

C. Contractor shall afford proper and safe access to the Site to each contractor that performs such other work, each utility owner performing other work, and Owner, if Owner is performing other work with Owner's employees, and provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work.

D. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected.

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E. If the proper execution or results of any part of Contractor's Work depends upon work performed by others, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

F. The provisions of this article are not applicable to work that is performed by third-party utilities or other third-party entities without a contract with Owner, or that is performed without having been arranged by Owner. If such work occurs, then any related delay, disruption, or interference incurred by Contractor is governed by the provisions of Paragraph 4.05.C.3.

8.02 *Coordination*

A. If Owner intends to contract with others for the performance of other work at or adjacent to the Site, to perform other work at or adjacent to the Site with Owner's employees, or to arrange to have utility owners perform work at or adjacent to the Site, the following will be set forth in the Supplementary Conditions or provided to Contractor prior to the start of any such other work:

1. The identity of the individual or entity that will have authority and responsibility for coordination of the activities among the various contractors;

2. An itemization of the specific matters to be covered by such authority and responsibility; and

3. The extent of such authority and responsibilities.

B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

8.03 *Legal Relationships*

A. If, in the course of performing other work for Owner at or adjacent to the Site, the Owner's employees, any other contractor working for Owner, or any utility owner that Owner has arranged to perform work, causes damage to the Work or to the property of Contractor or its Subcontractors, or delays, disrupts, interferes with, or increases the scope or cost of the performance of the Work, through actions or inaction, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times. Contractor must submit any Change Proposal seeking an equitable adjustment in the Contract Price or the Contract Times under this paragraph within 30 days of the damaging, delaying, disrupting, or interfering event. The entitlement to, and extent of, any such equitable adjustment will take into account information (if any) regarding such other work that was provided to Contractor in the Contract Documents prior to the submittal of the Bid or the final negotiation of the terms of the Contract, and any remedies available to Contractor under Laws or Regulations concerning utility action or inaction. When applicable, any such equitable adjustment in Contract Price will be conditioned on Contractor assigning to Owner all Contractor's rights against such other contractor or utility owner with respect to the damage, delay, disruption, or interference that is the subject of the adjustment. Contractor's entitlement to an adjustment of the Contract Times or Contract Price is subject to the provisions of Paragraphs 4.05.D and 4.05.E.

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B. Contractor shall take reasonable and customary measures to avoid damaging, delaying, disrupting, or interfering with the work of Owner, any other contractor, or any utility owner performing other work at or adjacent to the Site.

1. If Contractor fails to take such measures and as a result damages, delays, disrupts, or interferes with the work of any such other contractor or utility owner, then Owner may impose a set-off against payments due Contractor, and assign to such other contractor or utility owner the Owner's contractual rights against Contractor with respect to the breach of the obligations set forth in this Paragraph 8.03.B.

2. When Owner is performing other work at or adjacent to the Site with Owner's employees, Contractor shall be liable to Owner for damage to such other work, and for the reasonable direct delay, disruption, and interference costs incurred by Owner as a result of Contractor's failure to take reasonable and customary measures with respect to Owner's other work. In response to such damage, delay, disruption, or interference, Owner may impose a set-off against payments due Contractor.

C. If Contractor damages, delays, disrupts, or interferes with the work of any other contractor, or any utility owner performing other work at or adjacent to the Site, through Contractor's failure to take reasonable and customary measures to avoid such impacts, or if any claim arising out of Contractor's actions, inactions, or negligence in performance of the Work at or adjacent to the Site is made by any such other contractor or utility owner against Contractor, Owner, or Engineer, then Contractor shall (1) promptly attempt to settle the claim as to all parties through negotiations with such other contractor or utility owner, or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law, and (2) indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against any such claims, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such damage, delay, disruption, or interference.

ARTICLE 9—OWNER'S RESPONSIBILITIES

9.01 *Communications to Contractor*

A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.

9.02 *Replacement of Engineer*

A. Owner may at its discretion appoint an engineer to replace Engineer, provided Contractor makes no reasonable objection to the replacement engineer. The replacement engineer's status under the Contract Documents will be that of the former Engineer.

9.03 *Furnish Data*

A. Owner shall promptly furnish the data required of Owner under the Contract Documents.

9.04 *Pay When Due*

A. Owner shall make payments to Contractor when they are due as provided in the Agreement.

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9.05 *Lands and Easements; Reports, Tests, and Drawings*

A. Owner's duties with respect to providing lands and easements are set forth in Paragraph 5.01.

B. Owner's duties with respect to providing engineering surveys to establish reference points are set forth in Paragraph 4.03.

C. Article 5 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of conditions at the Site, and drawings of physical conditions relating to existing surface or subsurface structures at the Site.

9.06 *Insurance*

A. Owner's responsibilities, if any, with respect to purchasing and maintaining liability and property insurance are set forth in Article 6.

9.07 *Change Orders*

A. Owner's responsibilities with respect to Change Orders are set forth in Article 11.

9.08 *Inspections, Tests, and Approvals*

A. Owner's responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 14.02.B.

9.09 *Limitations on Owner's Responsibilities*

A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

9.10 *Undisclosed Hazardous Environmental Condition*

A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 5.06.

9.11 *Evidence of Financial Arrangements*

A. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract (including obligations under proposed changes in the Work).

9.12 *Safety Programs*

A. While at the Site, Owner's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Owner has been informed.

B. Owner shall furnish copies of any applicable Owner safety programs to Contractor.

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ARTICLE 10—ENGINEER'S STATUS DURING CONSTRUCTION

10.01 *Owner's Representative*

A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract.

10.02 *Visits to Site*

A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe, as an experienced and qualified design professional, the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.

B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 10.07. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

10.03 *Resident Project Representative*

A. If Owner and Engineer have agreed that Engineer will furnish a Resident Project Representative to represent Engineer at the Site and assist Engineer in observing the progress and quality of the Work, then the authority and responsibilities of any such Resident Project Representative will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in the Supplementary Conditions and in Paragraph 10.07.

B. If Owner designates an individual or entity who is not Engineer's consultant, agent, or employee to represent Owner at the Site, then the responsibilities and authority of such individual or entity will be as provided in the Supplementary Conditions.

10.04 *Engineer's Authority*

A. Engineer has the authority to reject Work in accordance with Article 14.

B. Engineer's authority as to Submittals is set forth in Paragraph 7.16.

C. Engineer's authority as to design drawings, calculations, specifications, certifications and other Submittals from Contractor in response to Owner's delegation (if any) to Contractor of professional design services, is set forth in Paragraph 7.19.

D. Engineer's authority as to changes in the Work is set forth in Article 11.

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E. Engineer's authority as to Applications for Payment is set forth in Article 15.

10.05 *Determinations for Unit Price Work*

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor as set forth in Paragraph 13.03.

10.06 *Decisions on Requirements of Contract Documents and Acceptability of Work*

A. Engineer will render decisions regarding the requirements of the Contract Documents, and judge the acceptability of the Work, pursuant to the specific procedures set forth herein for initial interpretations, Change Proposals, and acceptance of the Work. In rendering such decisions and judgments, Engineer will not show partiality to Owner or Contractor, and will not be liable to Owner, Contractor, or others in connection with any proceedings, interpretations, decisions, or judgments conducted or rendered in good faith.

10.07 *Limitations on Engineer's Authority and Responsibilities*

A. Neither Engineer's authority or responsibility under this Article 10 or under any other provision of the Contract, nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer, will create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

D. Engineer's review of the final Application for Payment and accompanying documentation, and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Contractor under Paragraph 15.06.A, will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals, that the results certified indicate compliance with the Contract Documents.

E. The limitations upon authority and responsibility set forth in this Paragraph 10.07 also apply to the Resident Project Representative, if any.

10.08 *Compliance with Safety Program*

A. While at the Site, Engineer's employees and representatives will comply with the specific applicable requirements of Owner's and Contractor's safety programs of which Engineer has been informed.

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ARTICLE 11—CHANGES TO THE CONTRACT

11.01 *Amending and Supplementing the Contract*

A. The Contract may be amended or supplemented by a Change Order, a Work Change Directive, or a Field Order.

B. If an amendment or supplement to the Contract includes a change in the Contract Price or the Contract Times, such amendment or supplement must be set forth in a Change Order.

C. All changes to the Contract that involve (1) the performance or acceptability of the Work, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, must be supported by Engineer's recommendation. Owner and Contractor may amend other terms and conditions of the Contract without the recommendation of the Engineer.

11.02 *Change Orders*

A. Owner and Contractor shall execute appropriate Change Orders covering:

1. Changes in Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive;

2. Changes in Contract Price resulting from an Owner set-off, unless Contractor has duly contested such set-off;

3. Changes in the Work which are: (a) ordered by Owner pursuant to Paragraph 11.05, (b) required because of Owner's acceptance of defective Work under Paragraph 14.04 or Owner's correction of defective Work under Paragraph 14.07, or (c) agreed to by the parties, subject to the need for Engineer's recommendation if the change in the Work involves the design (as set forth in the Drawings, Specifications, or otherwise) or other engineering or technical matters; and

4. Changes that embody the substance of any final and binding results under: Paragraph 11.03.B, resolving the impact of a Work Change Directive; Paragraph 11.09, concerning Change Proposals; Article 12, Claims; Paragraph 13.02.D, final adjustments resulting from allowances; Paragraph 13.03.D, final adjustments relating to determination of quantities for Unit Price Work; and similar provisions.

B. If Owner or Contractor refuses to execute a Change Order that is required to be executed under the terms of Paragraph 11.02.A, it will be deemed to be of full force and effect, as if fully executed.

11.03 *Work Change Directives*

A. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the modification ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order, following negotiations by the parties as to the Work Change Directive's effect, if any, on the Contract Price and Contract Times; or, if negotiations are unsuccessful, by a determination under the terms of the Contract Documents governing adjustments, expressly including Paragraph 11.07 regarding change of Contract Price.

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B. If Owner has issued a Work Change Directive and:

1. Contractor believes that an adjustment in Contract Times or Contract Price is necessary, then Contractor shall submit any Change Proposal seeking such an adjustment no later than 30 days after the completion of the Work set out in the Work Change Directive.

2. Owner believes that an adjustment in Contract Times or Contract Price is necessary, then Owner shall submit any Claim seeking such an adjustment no later than 60 days after issuance of the Work Change Directive.

11.04 *Field Orders*

A. Engineer may authorize minor changes in the Work if the changes do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Such changes will be accomplished by a Field Order and will be binding on Owner and also on Contractor, which shall perform the Work involved promptly.

B. If Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, then before proceeding with the Work at issue, Contractor shall submit a Change Proposal as provided herein.

11.05 *Owner-Authorized Changes in the Work*

A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work. Changes involving the design (as set forth in the Drawings, Specifications, or otherwise) or other engineering or technical matters will be supported by Engineer's recommendation.

B. Such changes in the Work may be accomplished by a Change Order, if Owner and Contractor have agreed as to the effect, if any, of the changes on Contract Times or Contract Price; or by a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved; or, in the case of a deletion in the Work, promptly cease construction activities with respect to such deleted Work. Added or revised Work must be performed under the applicable conditions of the Contract Documents.

C. Nothing in this Paragraph 11.05 obligates Contractor to undertake work that Contractor reasonably concludes cannot be performed in a manner consistent with Contractor's safety obligations under the Contract Documents or Laws and Regulations.

11.06 *Unauthorized Changes in the Work*

A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents, as amended, modified, or supplemented, except in the case of an emergency as provided in Paragraph 7.15 or in the case of uncovering Work as provided in Paragraph 14.05.C.2.

11.07 *Change of Contract Price*

A. The Contract Price may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Price must comply with the provisions of Paragraph 11.09. Any Claim for an adjustment of Contract Price must comply with the provisions of Article 12.

B. An adjustment in the Contract Price will be determined as follows:

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1. Where the Work involved is covered by unit prices contained in the Contract Documents, then by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 13.03);

2. Where the Work involved is not covered by unit prices contained in the Contract Documents, then by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.07.C.2); or

3. Where the Work involved is not covered by unit prices contained in the Contract Documents and the parties do not reach mutual agreement to a lump sum, then on the basis of the Cost of the Work (determined as provided in Paragraph 13.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 11.07.C).

C. *Contractor's Fee*: When applicable, the Contractor's fee for overhead and profit will be determined as follows:

1. A mutually acceptable fixed fee; or

2. If a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:

a. For costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2, the Contractor's fee will be 15 percent;

b. For costs incurred under Paragraph 13.01.B.3, the Contractor's fee will be 5 percent;

c. Where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 11.07.C.2.a and 11.07.C.2.b is that the Contractor's fee will be based on: (1) a fee of 15 percent of the costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2 by the Subcontractor that actually performs the Work, at whatever tier, and (2) with respect to Contractor itself and to any Subcontractors of a tier higher than that of the Subcontractor that actually performs the Work, a fee of 5 percent of the amount (fee plus underlying costs incurred) attributable to the next lower tier Subcontractor; provided, however, that for any such subcontracted Work the maximum total fee to be paid by Owner will be no greater than 27 percent of the costs incurred by the Subcontractor that actually performs the Work;

d. No fee will be payable on the basis of costs itemized under Paragraphs 13.01.B.4, 13.01.B.5, and 13.01.C;

e. The amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in Cost of the Work will be the amount of the actual net decrease in Cost of the Work and a deduction of an additional amount equal to 5 percent of such actual net decrease in Cost of the Work; and

f. When both additions and credits are involved in any one change or Change Proposal, the adjustment in Contractor's fee will be computed by determining the sum of the costs in each of the cost categories in Paragraph 13.01.B (specifically, payroll costs, Paragraph 13.01.B.1; incorporated materials and equipment costs, Paragraph 13.01.B.2; Subcontract costs, Paragraph 13.01.B.3; special consultants costs, Paragraph 13.01.B.4; and other costs, Paragraph 13.01.B.5) and applying to each such cost category sum the appropriate fee from Paragraphs 11.07.C.2.a through 11.07.C.2.e, inclusive.

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11.08 *Change of Contract Times*

A. The Contract Times may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Times must comply with the provisions of Paragraph 11.09. Any Claim for an adjustment in the Contract Times must comply with the provisions of Article 12.

B. Delay, disruption, and interference in the Work, and any related changes in Contract Times, are addressed in and governed by Paragraph 4.05.

11.09 *Change Proposals*

A. *Purpose and Content*: Contractor shall submit a Change Proposal to Engineer to request an adjustment in the Contract Times or Contract Price; contest an initial decision by Engineer concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; challenge a set-off against payment due; or seek other relief under the Contract. The Change Proposal will specify any proposed change in Contract Times or Contract Price, or other proposed relief, and explain the reason for the proposed change, with citations to any governing or applicable provisions of the Contract Documents. Each Change Proposal will address only one issue, or a set of closely related issues.

B. *Change Proposal Procedures*

1. *Submittal*: Contractor shall submit each Change Proposal to Engineer within 30 days after the start of the event giving rise thereto, or after such initial decision.

2. *Supporting Data*: The Contractor shall submit supporting data, including the proposed change in Contract Price or Contract Time (if any), to the Engineer and Owner within 15 days after the submittal of the Change Proposal.

    a. Change Proposals based on or related to delay, interruption, or interference must comply with the provisions of Paragraphs 4.05.D and 4.05.E.

    b. Change proposals related to a change of Contract Price must include full and detailed accounts of materials incorporated into the Work and labor and equipment used for the subject Work.

    The supporting data must be accompanied by a written statement that the supporting data are accurate and complete, and that any requested time or price adjustment is the entire adjustment to which Contractor believes it is entitled as a result of said event.

3. *Engineer's Initial Review*: Engineer will advise Owner regarding the Change Proposal, and consider any comments or response from Owner regarding the Change Proposal. If in its discretion Engineer concludes that additional supporting data is needed before conducting a full review and making a decision regarding the Change Proposal, then Engineer may request that Contractor submit such additional supporting data by a date specified by Engineer, prior to Engineer beginning its full review of the Change Proposal.

4. *Engineer's Full Review and Action on the Change Proposal*: Upon receipt of Contractor's supporting data (including any additional data requested by Engineer), Engineer will conduct a full review of each Change Proposal and, within 30 days after such receipt of the Contractor's supporting data, either approve the Change Proposal in whole, deny it in whole, or approve it in part and deny it in part. Such actions must be in writing, with a copy provided to Owner and Contractor. If Engineer does not take action on the Change

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Proposal within 30 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of Engineer's inaction the Change Proposal is deemed denied, thereby commencing the time for appeal of the denial under Article 12.

5. *Binding Decision*: Engineer's decision is final and binding upon Owner and Contractor, unless Owner or Contractor appeals the decision by filing a Claim under Article 12.

C. *Resolution of Certain Change Proposals*: If the Change Proposal does not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters, then Engineer will notify the parties in writing that the Engineer is unable to resolve the Change Proposal. For purposes of further resolution of such a Change Proposal, such notice will be deemed a denial, and Contractor may choose to seek resolution under the terms of Article 12.

D. *Post-Completion*: Contractor shall not submit any Change Proposals after Engineer issues a written recommendation of final payment pursuant to Paragraph 15.06.B.

11.10 *Notification to Surety*

A. If the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times), the giving of any such notice will be Contractor's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

ARTICLE 12—CLAIMS

12.01 *Claims*

A. *Claims Process*: The following disputes between Owner and Contractor are subject to the Claims process set forth in this article:

1. Appeals by Owner or Contractor of Engineer's decisions regarding Change Proposals;

2. Owner demands for adjustments in the Contract Price or Contract Times, or other relief under the Contract Documents;

3. Disputes that Engineer has been unable to address because they do not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters; and

4. Subject to the waiver provisions of Paragraph 15.07, any dispute arising after Engineer has issued a written recommendation of final payment pursuant to Paragraph 15.06.B.

B. *Submittal of Claim*: The party submitting a Claim shall deliver it directly to the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto; in the case of appeals regarding Change Proposals within 30 days of the decision under appeal. The party submitting the Claim shall also furnish a copy to the Engineer, for its information only. The responsibility to substantiate a Claim rests with the party making the Claim. In the case of a Claim by Contractor seeking an increase in the Contract Times or Contract Price, Contractor shall certify that the Claim is made in good faith, that the supporting data are accurate and complete, and that to the best of Contractor's knowledge

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and belief the amount of time or money requested accurately reflects the full amount to which Contractor is entitled.

C. *Review and Resolution*: The party receiving a Claim shall review it thoroughly, giving full consideration to its merits. The two parties shall seek to resolve the Claim through the exchange of information and direct negotiations. The parties may extend the time for resolving the Claim by mutual agreement. All actions taken on a Claim will be stated in writing and submitted to the other party, with a copy to Engineer.

D. *Mediation*

1. At any time after initiation of a Claim, Owner and Contractor may mutually agree to mediation of the underlying dispute. The agreement to mediate will stay the Claim submittal and response process.

2. If Owner and Contractor agree to mediation, then after 60 days from such agreement, either Owner or Contractor may unilaterally terminate the mediation process, and the Claim submittal and decision process will resume as of the date of the termination. If the mediation proceeds but is unsuccessful in resolving the dispute, the Claim submittal and decision process will resume as of the date of the conclusion of the mediation, as determined by the mediator.

3. Owner and Contractor shall each pay one-half of the mediator's fees and costs.

E. *Partial Approval*: If the party receiving a Claim approves the Claim in part and denies it in part, such action will be final and binding unless within 30 days of such action the other party invokes the procedure set forth in Article 17 for final resolution of disputes.

F. *Denial of Claim*: If efforts to resolve a Claim are not successful, the party receiving the Claim may deny it by giving written notice of denial to the other party. If the receiving party does not take action on the Claim within 90 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of the inaction, the Claim is deemed denied, thereby commencing the time for appeal of the denial. A denial of the Claim will be final and binding unless within 30 days of the denial the other party invokes the procedure set forth in Article 17 for the final resolution of disputes.

G. *Final and Binding Results*: If the parties reach a mutual agreement regarding a Claim, whether through approval of the Claim, direct negotiations, mediation, or otherwise; or if a Claim is approved in part and denied in part, or denied in full, and such actions become final and binding; then the results of the agreement or action on the Claim will be incorporated in a Change Order or other written document to the extent they affect the Contract, including the Work, the Contract Times, or the Contract Price.

ARTICLE 13—COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

13.01 *Cost of the Work*

A. *Purposes for Determination of Cost of the Work*: The term Cost of the Work means the sum of all costs necessary for the proper performance of the Work at issue, as further defined below. The provisions of this Paragraph 13.01 are used for two distinct purposes:

1. To determine Cost of the Work when Cost of the Work is a component of the Contract Price, under cost-plus-fee, time-and-materials, or other cost-based terms; or

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2. When needed to determine the value of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price. When the value of any such adjustment is determined on the basis of Cost of the Work, Contractor is entitled only to those additional or incremental costs required because of the change in the Work or because of the event giving rise to the adjustment.

B. *Costs Included*: Except as otherwise may be agreed to in writing by Owner, costs included in the Cost of the Work will be in amounts no higher than those commonly incurred in the locality of the Project, will not include any of the costs itemized in Paragraph 13.01.C, and will include only the following items:

1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor in advance of the subject Work. Such employees include, without limitation, superintendents, foremen, safety managers, safety representatives, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work will be apportioned on the basis of their time spent on the Work. Payroll costs include, but are not limited to, salaries and wages plus the cost of fringe benefits, which include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, sick leave, and vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, will be included in the above to the extent authorized by Owner.

2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts will accrue to Owner. All trade discounts, rebates, and refunds and returns from sale of surplus materials and equipment will accrue to Owner, and Contractor shall make provisions so that they may be obtained.

3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, which will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee will be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 13.01.

4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed or retained for services specifically related to the Work.

5. Other costs consisting of the following:

a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.

b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, which are

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consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.

1) In establishing included costs for materials such as scaffolding, plating, or sheeting, consideration will be given to the actual or the estimated life of the material for use on other projects; or rental rates may be established on the basis of purchase or salvage value of such items, whichever is less. Contractor will not be eligible for compensation for such items in an amount that exceeds the purchase cost of such item.

c. *Construction Equipment Rental*

1) Rentals of all construction equipment and machinery, and the parts thereof, in accordance with rental agreements approved by Owner as to price (including any surcharge or special rates applicable to overtime use of the construction equipment or machinery), and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs will be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts must cease when the use thereof is no longer necessary for the Work.

2) Costs for equipment and machinery owned by Contractor or a Contractor-related entity will be paid at a rate shown for such equipment in the equipment rental rate book specified in the Supplementary Conditions. An hourly rate will be computed by dividing the monthly rates by 176. These computed rates will include all operating costs.

3) With respect to Work that is the result of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price ("changed Work"), included costs will be based on the time the equipment or machinery is in use on the changed Work and the costs of transportation, loading, unloading, assembly, dismantling, and removal when directly attributable to the changed Work. The cost of any such equipment or machinery, or parts thereof, must cease to accrue when the use thereof is no longer necessary for the changed Work.

d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.

e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.

f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of builder's risk or other property insurance established in accordance with Paragraph 6.04), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses will be included in the Cost of the Work for the purpose of determining Contractor's fee.

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g. The cost of utilities, fuel, and sanitary facilities at the Site.

h. Minor expenses such as communication service at the Site, express and courier services, and similar petty cash items in connection with the Work.

i. The costs of premiums for all bonds and insurance that Contractor is required by the Contract Documents to purchase and maintain.

C. *Costs Excluded*: The term Cost of the Work does not include any of the following items:

1. Payroll costs and other compensation of Contractor's officers, executives, principals, general managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 13.01.B.1 or specifically covered by Paragraph 13.01.B.4. The payroll costs and other compensation excluded here are to be considered administrative costs covered by the Contractor's fee.

2. The cost of purchasing, renting, or furnishing small tools and hand tools.

3. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.

4. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.

5. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.

6. Expenses incurred in preparing and advancing Claims.

7. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraph 13.01.B.

D. *Contractor's Fee*

1. When the Work as a whole is performed on the basis of cost-plus-a-fee, then:

a. Contractor's fee for the Work set forth in the Contract Documents as of the Effective Date of the Contract will be determined as set forth in the Agreement.

b. for any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price on the basis of Cost of the Work, Contractor's fee will be determined as follows:

1) When the fee for the Work as a whole is a percentage of the Cost of the Work, the fee will automatically adjust as the Cost of the Work changes.

2) When the fee for the Work as a whole is a fixed fee, the fee for any additions or deletions will be determined in accordance with Paragraph 11.07.C.2.

2. When the Work as a whole is performed on the basis of a stipulated sum, or any other basis other than cost-plus-a-fee, then Contractor's fee for any Work covered by a Change

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Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price on the basis of Cost of the Work will be determined in accordance with Paragraph 11.07.C.2.

E. *Documentation and Audit*: Whenever the Cost of the Work for any purpose is to be determined pursuant to this Article 13, Contractor and pertinent Subcontractors will establish and maintain records of the costs in accordance with generally accepted accounting practices. Subject to prior written notice, Owner will be afforded reasonable access, during normal business hours, to all Contractor's accounts, records, books, correspondence, instructions, drawings, receipts, vouchers, memoranda, and similar data relating to the Cost of the Work and Contractor's fee. Contractor shall preserve all such documents for a period of three years after the final payment by Owner. Pertinent Subcontractors will afford such access to Owner, and preserve such documents, to the same extent required of Contractor.

13.02 *Allowances*

A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.

B. *Cash Allowances*: Contractor agrees that:

1. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and

2. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment for any of the foregoing will be valid.

C. *Owner's Contingency Allowance*: Contractor agrees that an Owner's contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.

D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor for Work covered by allowances, and the Contract Price will be correspondingly adjusted.

13.03 *Unit Price Work*

A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.

B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Payments to Contractor for Unit Price Work will be based on actual quantities.

C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.

D. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision

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thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, and the final adjustment of Contract Price will be set forth in a Change Order, subject to the provisions of the following paragraph.

E. *Adjustments in Unit Price*

1. Contractor or Owner shall be entitled to an adjustment in the unit price with respect to an item of Unit Price Work if:

a. the quantity of the item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and

b. Contractor's unit costs to perform the item of Unit Price Work have changed materially and significantly as a result of the quantity change.

2. The adjustment in unit price will account for and be coordinated with any related changes in quantities of other items of Work, and in Contractor's costs to perform such other Work, such that the resulting overall change in Contract Price is equitable to Owner and Contractor.

3. Adjusted unit prices will apply to all units of that item.

ARTICLE 14—TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK

14.01 *Access to Work*

A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and authorities having jurisdiction have access to the Site and the Work at reasonable times for their observation, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's safety procedures and programs so that they may comply with such procedures and programs as applicable.

14.02 *Tests, Inspections, and Approvals*

A. Contractor shall give Engineer timely notice of readiness of the Work (or specific parts thereof) for all required inspections and tests, and shall cooperate with inspection and testing personnel to facilitate required inspections and tests.

B. Owner shall retain and pay for the services of an independent inspector, testing laboratory, or other qualified individual or entity to perform all inspections and tests expressly required by the Contract Documents to be furnished and paid for by Owner, except that costs incurred in connection with tests or inspections of covered Work will be governed by the provisions of Paragraph 14.05.

C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.

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D. Contractor shall be responsible for arranging, obtaining, and paying for all inspections and tests required:

1. by the Contract Documents, unless the Contract Documents expressly allocate responsibility for a specific inspection or test to Owner;

2. to attain Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work;

3. by manufacturers of equipment furnished under the Contract Documents;

4. for testing, adjusting, and balancing of mechanical, electrical, and other equipment to be incorporated into the Work; and

5. for acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work.

Such inspections and tests will be performed by independent inspectors, testing laboratories, or other qualified individuals or entities acceptable to Owner and Engineer.

E. If the Contract Documents require the Work (or part thereof) to be approved by Owner, Engineer, or another designated individual or entity, then Contractor shall assume full responsibility for arranging and obtaining such approvals.

F. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation. Such uncovering will be at Contractor's expense unless Contractor had given Engineer timely notice of Contractor's intention to cover the same and Engineer had not acted with reasonable promptness in response to such notice.

14.03 *Defective Work*

A. *Contractor's Obligation*: It is Contractor's obligation to assure that the Work is not defective.

B. *Engineer's Authority*: Engineer has the authority to determine whether Work is defective, and to reject defective Work.

C. *Notice of Defects*: Prompt written notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor.

D. *Correction, or Removal and Replacement*: Promptly after receipt of written notice of defective Work, Contractor shall correct all such defective Work, whether or not fabricated, installed, or completed, or, if Engineer has rejected the defective Work, remove it from the Project and replace it with Work that is not defective.

E. *Preservation of Warranties*: When correcting defective Work, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

F. *Costs and Damages*: In addition to its correction, removal, and replacement obligations with respect to defective Work, Contractor shall pay all claims, costs, losses, and damages arising out of or relating to defective Work, including but not limited to the cost of the inspection, testing, correction, removal, replacement, or reconstruction of such defective Work, fines levied against Owner by governmental authorities because the Work is defective, and the costs of repair or replacement of work of others resulting from defective Work. Prior to final payment, if Owner and Contractor are unable to agree as to the measure of such claims, costs,

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losses, and damages resulting from defective Work, then Owner may impose a reasonable set-off against payments due under Article 15.

14.04 *Acceptance of Defective Work*

A. If, instead of requiring correction or removal and replacement of defective Work, Owner prefers to accept it, Owner may do so (subject, if such acceptance occurs prior to final payment, to Engineer's confirmation that such acceptance is in general accord with the design intent and applicable engineering principles, and will not endanger public safety). Contractor shall pay all claims, costs, losses, and damages attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness), and for the diminished value of the Work to the extent not otherwise paid by Contractor. If any such acceptance occurs prior to final payment, the necessary revisions in the Contract Documents with respect to the Work will be incorporated in a Change Order. If the parties are unable to agree as to the decrease in the Contract Price, reflecting the diminished value of Work so accepted, then Owner may impose a reasonable set-off against payments due under Article 15. If the acceptance of defective Work occurs after final payment, Contractor shall pay an appropriate amount to Owner.

14.05 *Uncovering Work*

A. Engineer has the authority to require additional inspection or testing of the Work, whether or not the Work is fabricated, installed, or completed.

B. If any Work is covered contrary to the written request of Engineer, then Contractor shall, if requested by Engineer, uncover such Work for Engineer's observation, and then replace the covering, all at Contractor's expense.

C. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, then Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, and provide all necessary labor, material, and equipment.

1. If it is found that the uncovered Work is defective, Contractor shall be responsible for all claims, costs, losses, and damages arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and pending Contractor's full discharge of this responsibility the Owner shall be entitled to impose a reasonable set-off against payments due under Article 15.

2. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, then Contractor may submit a Change Proposal within 30 days of the determination that the Work is not defective.

14.06 *Owner May Stop the Work*

A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, then Owner may order Contractor to stop the Work,

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or any portion thereof, until the cause for such order has been eliminated; however, this right of Owner to stop the Work will not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

14.07 *Owner May Correct Defective Work*

A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work, or to remove and replace defective Work as required by Engineer, then Owner may, after 7 days' written notice to Contractor, correct or remedy any such deficiency.

B. In exercising the rights and remedies under this Paragraph 14.07, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this paragraph.

C. All claims, costs, losses, and damages incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 14.07 will be charged against Contractor as set-offs against payments due under Article 15. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.

D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 14.07.

ARTICLE 15—PAYMENTS TO CONTRACTOR; SET-OFFS; COMPLETION; CORRECTION PERIOD

15.01 *Progress Payments*

A. *Basis for Progress Payments*: The Schedule of Values established as provided in Article 2 will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments for Unit Price Work will be based on the number of units completed during the pay period, as determined under the provisions of Paragraph 13.03. Progress payments for cost-based Work will be based on Cost of the Work completed by Contractor during the pay period.

B. *Applications for Payments*

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents.

2. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment must also be accompanied by: (a) a bill of sale, invoice, copies of subcontract or purchase order payments, or other documentation

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establishing full payment by Contractor for the materials and equipment; (b) at Owner's request, documentation warranting that Owner has received the materials and equipment free and clear of all Liens; and (c) evidence that the materials and equipment are covered by appropriate property insurance, a warehouse bond, or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.

3. Beginning with the second Application for Payment, each Application must include an affidavit of Contractor stating that all previous progress payments received by Contractor have been applied to discharge Contractor's legitimate obligations associated with prior Applications for Payment.

4. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

C. *Review of Applications*

1. Engineer will, within 10 days after receipt of each Application for Payment, including each resubmittal, either indicate in writing a recommendation of payment and present the Application to Owner, or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.

2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations of the executed Work as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:

   a. the Work has progressed to the point indicated;

   b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for Unit Price Work under Paragraph 13.03, and any other qualifications stated in the recommendation); and

   c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.

3. By recommending any such payment Engineer will not thereby be deemed to have represented that:

   a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract; or

   b. there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.

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4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:

    a. to supervise, direct, or control the Work;

    b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto;

    c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work;

    d. to make any examination to ascertain how or for what purposes Contractor has used the money paid by Owner; or

    e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.

5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 15.01.C.2.

6. Engineer will recommend reductions in payment (set-offs) necessary in Engineer's opinion to protect Owner from loss because:

    a. the Work is defective, requiring correction or replacement;

    b. the Contract Price has been reduced by Change Orders;

    c. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;

    d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible; or

    e. Engineer has actual knowledge of the occurrence of any of the events that would constitute a default by Contractor and therefore justify termination for cause under the Contract Documents.

D. *Payment Becomes Due*

1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended (subject to any Owner set-offs) will become due, and when due will be paid by Owner to Contractor.

E. *Reductions in Payment by Owner*

1. In addition to any reductions in payment (set-offs) recommended by Engineer, Owner is entitled to impose a set-off against payment based on any of the following:

    a. Claims have been made against Owner based on Contractor's conduct in the performance or furnishing of the Work, or Owner has incurred costs, losses, or damages resulting from Contractor's conduct in the performance or furnishing of the Work, including but not limited to claims, costs, losses, or damages from workplace injuries, adjacent property damage, non-compliance with Laws and Regulations, and patent infringement;

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b. Contractor has failed to take reasonable and customary measures to avoid damage, delay, disruption, and interference with other work at or adjacent to the Site;

c. Contractor has failed to provide and maintain required bonds or insurance;

d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible;

e. Owner has incurred extra charges or engineering costs related to submittal reviews, evaluations of proposed substitutes, tests and inspections, or return visits to manufacturing or assembly facilities;

f. The Work is defective, requiring correction or replacement;

g. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;

h. The Contract Price has been reduced by Change Orders;

i. An event has occurred that would constitute a default by Contractor and therefore justify a termination for cause;

j. Liquidated or other damages have accrued as a result of Contractor's failure to achieve Milestones, Substantial Completion, or final completion of the Work;

k. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens; or

l. Other items entitle Owner to a set-off against the amount recommended.

2. If Owner imposes any set-off against payment, whether based on its own knowledge or on the written recommendations of Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and the specific amount of the reduction, and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, if Contractor remedies the reasons for such action. The reduction imposed will be binding on Contractor unless it duly submits a Change Proposal contesting the reduction.

3. Upon a subsequent determination that Owner's refusal of payment was not justified, the amount wrongfully withheld will be treated as an amount due as determined by Paragraph 15.01.D.1 and subject to interest as provided in the Agreement.

15.02 *Contractor's Warranty of Title*

A. Contractor warrants and guarantees that title to all Work, materials, and equipment furnished under the Contract will pass to Owner free and clear of (1) all Liens and other title defects, and (2) all patent, licensing, copyright, or royalty obligations, no later than 7 days after the time of payment by Owner.

15.03 *Substantial Completion*

A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete and request that Engineer issue a certificate of Substantial Completion. Contractor shall at the same time

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submit to Owner and Engineer an initial draft of punch list items to be completed or corrected before final payment.

B. Promptly after Contractor's notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.

C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a preliminary certificate of Substantial Completion which will fix the date of Substantial Completion. Engineer shall attach to the certificate a punch list of items to be completed or corrected before final payment. Owner shall have 7 days after receipt of the preliminary certificate during which to make written objection to Engineer as to any provisions of the certificate or attached punch list. If, after considering the objections to the provisions of the preliminary certificate, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the preliminary certificate to Owner, notify Contractor in writing that the Work is not substantially complete, stating the reasons therefor. If Owner does not object to the provisions of the certificate, or if despite consideration of Owner's objections Engineer concludes that the Work is substantially complete, then Engineer will, within said 14 days, execute and deliver to Owner and Contractor a final certificate of Substantial Completion (with a revised punch list of items to be completed or corrected) reflecting such changes from the preliminary certificate as Engineer believes justified after consideration of any objections from Owner.

D. At the time of receipt of the preliminary certificate of Substantial Completion, Owner and Contractor will confer regarding Owner's use or occupancy of the Work following Substantial Completion, review the builder's risk insurance policy with respect to the end of the builder's risk coverage, and confirm the transition to coverage of the Work under a permanent property insurance policy held by Owner. Unless Owner and Contractor agree otherwise in writing, Owner shall bear responsibility for security, operation, protection of the Work, property insurance, maintenance, heat, and utilities upon Owner's use or occupancy of the Work.

E. After Substantial Completion the Contractor shall promptly begin work on the punch list of items to be completed or corrected prior to final payment. In appropriate cases Contractor may submit monthly Applications for Payment for completed punch list items, following the progress payment procedures set forth above.

F. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the punch list.

15.04 *Partial Use or Occupancy*

A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without

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significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions:

1. At any time, Owner may request in writing that Contractor permit Owner to use or occupy any such part of the Work that Owner believes to be substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor, Owner, and Engineer will follow the procedures of Paragraph 15.03.A through 15.03.E for that part of the Work.

2. At any time, Contractor may notify Owner and Engineer in writing that Contractor considers any such part of the Work substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.

3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 15.03 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 6.04 regarding builder's risk or other property insurance.

15.05 *Final Inspection*

A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work, or agreed portion thereof, is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

15.06 *Final Payment*

A. *Application for Payment*

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of inspection, annotated record documents (as provided in Paragraph 7.12), and other documents, Contractor may make application for final payment.

2. The final Application for Payment must be accompanied (except as previously delivered) by:

   a. all documentation called for in the Contract Documents;

   b. consent of the surety, if any, to final payment;

   c. satisfactory evidence that all title issues have been resolved such that title to all Work, materials, and equipment has passed to Owner free and clear of any Liens or other title defects, or will so pass upon final payment.

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d. a list of all duly pending Change Proposals and Claims; and

e. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of the Work, and of Liens filed in connection with the Work.

3. In lieu of the releases or waivers of Liens specified in Paragraph 15.06.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (a) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (b) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien, or Owner at its option may issue joint checks payable to Contractor and specified Subcontractors and Suppliers.

B. *Engineer's Review of Final Application and Recommendation of Payment*: If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract have been fulfilled, Engineer will, within 10 days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of final payment and present the final Application for Payment to Owner for payment. Such recommendation will account for any set-offs against payment that are necessary in Engineer's opinion to protect Owner from loss for the reasons stated above with respect to progress payments. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

C. *Notice of Acceptability*: In support of its recommendation of payment of the final Application for Payment, Engineer will also give written notice to Owner and Contractor that the Work is acceptable, subject to stated limitations in the notice and to the provisions of Paragraph 15.07.

D. *Completion of Work*: The Work is complete (subject to surviving obligations) when it is ready for final payment as established by the Engineer's written recommendation of final payment and issuance of notice of the acceptability of the Work.

E. *Final Payment Becomes Due*: Upon receipt from Engineer of the final Application for Payment and accompanying documentation, Owner shall set off against the amount recommended by Engineer for final payment any further sum to which Owner is entitled, including but not limited to set-offs for liquidated damages and set-offs allowed under the provisions of this Contract with respect to progress payments. Owner shall pay the resulting balance due to Contractor within 30 days of Owner's receipt of the final Application for Payment from Engineer.

15.07 *Waiver of Claims*

A. By making final payment, Owner waives its claim or right to liquidated damages or other damages for late completion by Contractor, except as set forth in an outstanding Claim,

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appeal under the provisions of Article 17, set-off, or express reservation of rights by Owner. Owner reserves all other claims or rights after final payment.

B. The acceptance of final payment by Contractor will constitute a waiver by Contractor of all claims and rights against Owner other than those pending matters that have been duly submitted as a Claim, or appealed under the provisions of Article 17.

15.08 *Correction Period*

A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the Supplementary Conditions or the terms of any applicable special guarantee required by the Contract Documents), Owner gives Contractor written notice that any Work has been found to be defective, or that Contractor's repair of any damages to the Site or adjacent areas has been found to be defective, then after receipt of such notice of defect Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:

1. correct the defective repairs to the Site or such adjacent areas;
2. correct such defective Work;
3. remove the defective Work from the Project and replace it with Work that is not defective, if the defective Work has been rejected by Owner, and
4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others, or to other land or areas resulting from the corrective measures.

B. Owner shall give any such notice of defect within 60 days of the discovery that such Work or repairs is defective. If such notice is given within such 60 days but after the end of the correction period, the notice will be deemed a notice of defective Work under Paragraph 7.17.B.

C. If, after receipt of a notice of defect within 60 days and within the correction period, Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. Contractor shall pay all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others). Contractor's failure to pay such costs, losses, and damages within 10 days of invoice from Owner will be deemed the start of an event giving rise to a Claim under Paragraph 12.01.B, such that any related Claim must be brought within 30 days of the failure to pay.

D. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.

E. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this paragraph, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

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F. Contractor's obligations under this paragraph are in addition to all other obligations and warranties. The provisions of this paragraph are not to be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.

ARTICLE 16—SUSPENSION OF WORK AND TERMINATION

16.01 *Owner May Suspend Work*

A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by written notice to Contractor and Engineer. Such notice will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be entitled to an adjustment in the Contract Price or an extension of the Contract Times directly attributable to any such suspension. Any Change Proposal seeking such adjustments must be submitted no later than 30 days after the date fixed for resumption of Work.

16.02 *Owner May Terminate for Cause*

A. The occurrence of any one or more of the following events will constitute a default by Contractor and justify termination for cause:

1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment, or failure to adhere to the Progress Schedule);

2. Failure of Contractor to perform or otherwise to comply with a material term of the Contract Documents;

3. Contractor's disregard of Laws or Regulations of any public body having jurisdiction; or

4. Contractor's repeated disregard of the authority of Owner or Engineer.

B. If one or more of the events identified in Paragraph 16.02.A occurs, then after giving Contractor (and any surety) 10 days' written notice that Owner is considering a declaration that Contractor is in default and termination of the Contract, Owner may proceed to:

1. declare Contractor to be in default, and give Contractor (and any surety) written notice that the Contract is terminated; and

2. enforce the rights available to Owner under any applicable performance bond.

C. Subject to the terms and operation of any applicable performance bond, if Owner has terminated the Contract for cause, Owner may exclude Contractor from the Site, take possession of the Work, incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere, and complete the Work as Owner may deem expedient.

D. Owner may not proceed with termination of the Contract under Paragraph 16.02.B if Contractor within 7 days of receipt of notice of intent to terminate begins to correct its failure to perform and proceeds diligently to cure such failure.

E. If Owner proceeds as provided in Paragraph 16.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds the cost to complete the Work, including all related claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects,

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attorneys, and other professionals) sustained by Owner, such excess will be paid to Contractor. If the cost to complete the Work including such related claims, costs, losses, and damages exceeds such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this paragraph, Owner shall not be required to obtain the lowest price for the Work performed.

F. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue, or any rights or remedies of Owner against Contractor or any surety under any payment bond or performance bond. Any retention or payment of money due Contractor by Owner will not release Contractor from liability.

G. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 6.01.A, the provisions of that bond will govern over any inconsistent provisions of Paragraphs 16.02.B and 16.02.D.

16.03 *Owner May Terminate for Convenience*

A. Upon 7 days' written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):

1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;

2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses; and

3. other reasonable expenses directly attributable to termination, including costs incurred to prepare a termination for convenience cost proposal.

B. Contractor shall not be paid for any loss of anticipated profits or revenue, post-termination overhead costs, or other economic loss arising out of or resulting from such termination.

16.04 *Contractor May Stop Work or Terminate*

A. If, through no act or fault of Contractor, (1) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (2) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (3) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon 7 days' written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the contract and recover from Owner payment on the same terms as provided in Paragraph 16.03.

B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, 7 days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The

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provisions of this paragraph are not intended to preclude Contractor from submitting a Change Proposal for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this paragraph.

ARTICLE 17—FINAL RESOLUTION OF DISPUTES

17.01 *Methods and Procedures*

A. *Disputes Subject to Final Resolution*: The following disputed matters are subject to final resolution under the provisions of this article:

1. A timely appeal of an approval in part and denial in part of a Claim, or of a denial in full, pursuant to Article 12; and

2. Disputes between Owner and Contractor concerning the Work, or obligations under the Contract Documents, that arise after final payment has been made.

B. *Final Resolution of Disputes*: For any dispute subject to resolution under this article, Owner or Contractor may:

1. elect in writing to invoke the dispute resolution process provided for in the Supplementary Conditions;

2. agree with the other party to submit the dispute to another dispute resolution process; or

3. if no dispute resolution process is provided for in the Supplementary Conditions or mutually agreed to, give written notice to the other party of the intent to submit the dispute to a court of competent jurisdiction.

ARTICLE 18—MISCELLANEOUS

18.01 *Giving Notice*

A. Whenever any provision of the Contract requires the giving of written notice to Owner, Engineer, or Contractor, it will be deemed to have been validly given only if delivered:

1. in person, by a commercial courier service or otherwise, to the recipient's place of business;

2. by registered or certified mail, postage prepaid, to the recipient's place of business; or

3. by e-mail to the recipient, with the words "Formal Notice" or similar in the e-mail's subject line.

18.02 *Computation of Times*

A. When any period of time is referred to in the Contract by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

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18.03 *Cumulative Remedies*

A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract. The provisions of this paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

18.04 *Limitation of Damages*

A. With respect to any and all Change Proposals, Claims, disputes subject to final resolution, and other matters at issue, neither Owner nor Engineer, nor any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, shall be liable to Contractor for any claims, costs, losses, or damages sustained by Contractor on or in connection with any other project or anticipated project.

18.05 *No Waiver*

A. A party's non-enforcement of any provision will not constitute a waiver of that provision, nor will it affect the enforceability of that provision or of the remainder of this Contract.

18.06 *Survival of Obligations*

A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract, as well as all continuing obligations indicated in the Contract, will survive final payment, completion, and acceptance of the Work or termination of the Contract or of the services of Contractor.

18.07 *Controlling Law*

A. This Contract is to be governed by the law of the state in which the Project is located.

18.08 *Assignment of Contract*

A. Unless expressly agreed to elsewhere in the Contract, no assignment by a party to this Contract of any rights under or interests in the Contract will be binding on the other party without the written consent of the party sought to be bound; and, specifically but without limitation, money that may become due and money that is due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract.

18.09 *Successors and Assigns*

A. Owner and Contractor each binds itself, its successors, assigns, and legal representatives to the other party hereto, its successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

18.10 *Headings*

A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

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SECTION 00 80 00
SUPPLEMENTARY CONDITIONS

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract (No. EJCDC C-700, 2013 Edition) and other provisions of the Contract Documents as indicated below. All provisions which are not so amended or supplemented remain in full force and effect.

ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

The terms used in these supplementary conditions which are defined in the standard general conditions of the construction contract (EJCDC C-700, 2013 edition) have the meanings assigned to them in the general conditions.

ARTICLE 2 – PRELIMINARY MATTERS

SC-2.01 Delete Paragraphs 2.01 B. and C. in their entirety and insert the following in their place:

B. Evidence of Contractor's Insurance: When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner copies of the policies of insurance (including all endorsements, and identification of applicable self-insured retentions and deductibles) required to be provided by Contractor in Article 6. Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

C. Evidence of Owner's Insurance: After receipt from Contractor of the executed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor copies of the policies of insurance to be provided by Owner under Article 6 (if any). Owner may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

SC-2.02.A. Amend the first sentence of Paragraph 2.02.A. to read as follows:

Owner shall furnish to Contractor up to 5 copies of the Contract Documents which may include bound reduced drawings. Additional quantities of the Contract Documents will be furnished at reproduction cost.

ARTICLE 3 – DOCUMENTS INTENT, REQUIREMENTS, REUSE

Add the following new paragraph immediately after paragraph 3.03.B:

C. In the event of an inconsistency between provisions in any of the contract documents, the order of precedence shall be established by the most stringent of the criteria and conditions.

ARTICLE 4 – COMMENCEMENT AND PROGRESS OF THE WORK

SC-4.01.A Delete paragraph 4.01.A of the General Conditions and insert the following in its place:

A. The Contract Times will commence to run on the day indicated in the Notice to Proceed. Any Work undertaken by CONTRACTOR prior to the date indicated in the Notice to Proceed will be entirely at his own risk

ARTICLE 5 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

SC-5.03 Add the following new paragraphs immediately after Paragraph 5.03.B:

C. The following report of explorations and tests of subsurface conditions at or adjacent to the Site are known to Owner:

1. Report dated July 11, 2022, prepared by AGEC, Sandy, Utah, entitled: “Geotechnical Investigation Proposed Pump Station approximately 700 West South of Pony Express Parkway, Saratoga Springs, Utah (Job No. 1220067). The Technical Data contained in such report upon whose accuracy Contractor may rely are those indicated in the definition of Technical Data in the General Conditions.

SC 5.06 Delete Paragraphs 5.06.A and 5.06.B in their entirety and insert the following:

A. No reports or drawings related to Hazardous Environmental Conditions at the Site are known to Owner.

B. Not Used.

ARTICLE 6 – BONDS AND INSURANCE

SC 6.03 Add the following new paragraph immediately after Paragraph 6.03.J:

K. Contractor shall provide the following minimum insurance coverage with insurers admitted in the State of Utah with a Bests' rating of no less than A-, IX, and in the limits as listed in this document, unless approved by the Director of Risk Management and written for not less than the following, or greater if required by law and all such insurance to be primary to any insurance maintained by Owner, shall name Owner as additional insured with waiver of subrogation:

1. WORKERS' COMPENSATION and EMPLOYERS LIABILITY: Workers' compensation statutory limits, as required by the Workers Compensation Act of the State of Utah, and Employers Liability limits set at a minimum of $300,000 for each accident, disease, and employee. No officer or owner of any business or organization subject to the Workers’ Compensation Act of the State of Utah may be excluded from this requirement.

2. AUTOMOBILE LIABILITY: $1,000,000 combined single limit “per accident” for bodily injury and property damage. "Any Auto" coverage is required.

3. GENERAL LIABILITY: $1,000,000 combined single limit per occurrence, personal injury and property damage. 2,000,000 aggregate. Broad Form Commercial General Liability is required (ISO 1993 or better). Completed Operations insurance must be kept in effect for 2 years after completion of work.

4. The Contractor shall not commence Work under this Agreement until all of the insurance required herein shall have been obtained by the Contractor. The Contractor shall furnish to the Owner Certificates of Insurance verifying that such insurance has been obtained. Such certificates will provide that Owner will receive at least thirty (30) days prior written notice of any material change in, cancellation of, or non-renewal of such insurance.

5. If applicable, professional liability (errors & omissions) Insurance coverage for a limit of $2,000,000. Insurance shall be carried for two years after the work has been completed.

6. EMPLOYMENT PRACTICES LIABILITY: $1,000,000 per occurrence, $1,000,000 aggregate. Required for employers subject to the provisions of Title VII of the Civil Rights Act and the Utah Antidiscrimination Act.
7. If Contractor uses any subcontractors, Contractor will provide for subcontractors or require the same insurance provisions for its subcontractors.
8. The Contractor shall warranty all work for one year according to the provisions included within Article 15.08 of the General Conditions.
9. Any deductibles or self-insured retention exceeding 5% of the limit of the policy must be declared to and approved by the City. At the option of the City, the insurer may be required to either: reduce or eliminate such deductibles or self-insured retention with respect to the City, its officers, officials, and employees; or the contracting party may be required to procure a bond guaranteeing payment of losses and related investigations, claim distributions, and defense expenses.
10. The contracting party shall disclose to the City all incidents or occurrences of accident, injury, and property damage within 24 hours of occurrence.
11. The policies are to contain, or to be endorsed to contain, the following provisions:
    a. General Liability and Automobile Liability Coverages
        i. The City and its officers, officials, employees, and volunteers are to be covered as an additional insured with respect to liability arising out of activities performed by or on behalf of the contracting party; products and completed or ongoing operations of the contracting party; premises owned, leased, hired, or borrowed by the contracting party. The coverage shall contain no limitations on the scope of protection afforded to the City and its officers, officials, employees, or volunteers.
        ii. The contracting party's insurance coverage shall be a primary insurance. Any insurance or self-insurance maintained by the City, its officers, officials, employees, or volunteers shall be in excess of the contracting party's insurance and shall not reduce the contracting party’s obligations in this policy.
        iii. Any failure to comply with any reporting provision of the any policy shall not affect coverage provided to the City and its officers, officials, employees, or volunteers.
        iv. The contracting party's insurance shall apply separately to each insured against whom a claim is made or suit is brought, except with respect to the limits of the insurer's liability.
        v. All property damage liability insurance must include coverage for damages to premises rented. This provision may not be excluded by endorsement or omission from the commercial general liability coverage.
    b. Workers' Compensation and General Liability Coverage
        i. The insurer shall agree to waive all rights of subrogation against the City and its officers, officials, employees, and volunteers for losses arising from work performed by the contracting party for the City, and for any loss falling under general liability insurance coverage.

c. All Coverage

i. Each insurance policy required by this clause shall be endorsed to state that coverage shall not be suspended, voided, canceled by either party, reduced in coverage or in limits except after thirty (30) days' prior written notice by certified mail, return receipt requested, has been given to the City.

d. Waivers of Insurance

i. A waiver of automobile insurance may be granted by the City if the party seeking a waiver certifies to the City that it does not intend to use an automobile or any other motorized vehicle in the course of its business or within the City limits.

ii. A waiver of workers' compensation insurance may be granted by the City if the party seeking a waiver certifies to the City that it is a sole proprietor or is an organization with no employees. All such waivers are conditioned on compliance with the requirements to obtain a workers' compensation waiver found in the Workers' Compensation Act.

iii. Builder's Risk.

e. Special Coverages

i. The City may require special coverages in addition to the coverages listed in this policy for certain types of contractors, providers of certain services, or the issuance of certain permits. The limits for special coverages shall be determined through consideration of the hazardousness of the work or project, the proximity of the project to the public, and the duration of the work or project. Special coverage(s), if required, may not be excluded from the insured party's policy by endorsement. Special coverages which the City may require include:

a. Abuse and molestation coverage;

b. Advertising injury coverage;

c. Aircraft liability coverage;

d. Asbestos abatement liability coverage;

e. Boiler and machinery liability coverage;

f. Builder's risk coverage;

g. Course of construction coverage;

h. Environmental coverage;

i. Excess liability coverage;

j. Explosion, collapse, underground (XCU) coverage;

k. Garagekeeper's coverage;

l. Liquor liability coverage;

m. Medical malpractice coverage;

n. On-hook liability coverage;

o. Pollution liability coverage;

p. Railroad protective liability coverage;

q. Watercraft liability coverage

f. Claims-made Policies

i. With the exception of policies for professional liability, including errors and omissions, environmental liability, and employment liability, claims-made policies will not be accepted by the City as adequate insurance coverage.

g. Evaluation of Loss History

i. The City reserves the right to adjust all liability limits based on a pre-contract evaluation of a party's loss history. The City shall give fair notice of any adjustment of liability limits. In order to properly and fairly evaluate the risk of loss, the City shall require that all contract and permit applicants submit detailed plans for the contract or permit applied for, as well as a loss history conducted by a credible third party.

h. Care, Custody, or Control Exclusions

i. If a contracting party's business requires the exercise of care, custody, or control over City property or public property within the limits of the City, and the party's general liability coverage includes a care, custody, or control exclusion, that party must also possess supplementary insurance which covers the City or public property within the insured party's care, custody, or control.

i. Other Laws

i. All contracting parties shall obey all federal, state, county, and municipal laws, ordinances, regulations, and rules applicable to their operations and required insurance. Failure to do so shall result in the contracting party holding the City harmless from any liability arising out of or in connection with said violations. This shall include any attorney's fees and costs incurred by the City in connection with a violation of any federal, state, county, or municipal law, ordinance, or regulation by a contracting party.

SC-6.05. Add the following to the list of requirements in Paragraph 6.05.A, as a numbered item:

13. Include by express endorsement coverage of damage to Contractor's equipment.

ARTICLE 7 – CONTRACTOR'S RESPONSIBILITIES

SC-7.02.B. Amend the first and second sentences of Paragraph 7.02.B to state "…all Work at the Site shall be performed during regular working hours, Monday through Friday. Contractor shall not perform Work on a Saturday, Sunday, or any legal holiday without written authorization from the Owner."

SC-7.02.C. Add the following new paragraph immediately after Paragraph 7.02.B:

Contractor shall be responsible for the cost of any overtime pay or other expense incurred by the Owner for Engineer's services (including those of the Resident

Project Representative, if any), Owner's representative, and construction observation services, occasioned by the performance of Work on Saturday, Sunday, any legal holiday, or as overtime on any regular work day. If Contractor is responsible but does not pay, or if the parties are unable to agree as to the amount owed, then Owner may impose a reasonable set-off against payments due under Article 15.

SC-7.02.C. Add the following new subparagraph immediately after Paragraph 7.02.C:

1. For purposes of administering the foregoing requirement, additional overtime costs are defined as any hours over 8 hours on any regular work day and any hours worked on Saturday, Sunday, and any legal holiday.

SC-7.12.H. Add a new paragraph immediately after paragraph 7.12 G. of the General Conditions which is to read as follows:

H. Protection of Person and Property: CONTRACTOR is solely responsible for safety measures in connection with the Project. CONTRACTOR shall take appropriate measures to prevent damage, injury or loss to: (1) all persons on the site or who may be affected by the Project; (2) all labor, materials and equipment to be incorporated into the Project; (3) other property at the site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities and underground facilities. CONTRACTOR shall comply with all applicable laws and regulations relating to the safety and protection of persons or property. CONTRACTOR shall erect and maintain all necessary safeguards for such safety and protection. If CONTRACTOR must enter a confined space, it shall have all personnel and monitoring equipment on site to necessary to comply with all OSHA and Owner's safety guidelines. A Confined Space Entry Permit shall be properly completed before entering a confined space. CONTRACTOR shall be responsible to erect and maintain all necessary traffic barricades and to provide all necessary traffic control. CONTRACTOR shall notify owners of adjacent property, including Blue Stakes notification to underground utility owners and shall cooperate with them in the protection, removal, relocation or replacement of their property. Any damage, injury or loss to any property caused, directly or indirectly, in whole or in part, by CONTRACTOR, any subcontractor, supplier, individual or entity performing the Project, shall be remedied by CONTRACTOR.

SC-7.18.D. Add a new paragraph immediately after paragraph 7.18 C. of the General Conditions which is to read as follows:

D. To the fullest extent permitted by law, CONTRACTOR agrees to indemnify and hold harmless Owner from and against all claims, costs, losses and damages, including attorney fees, arising out of the performance of this Agreement, provided that any such claim, cost, loss, or damage: (1) is attributable to bodily injury, sickness, disease , death, injury to tangible property, loss of use of property, including interruption of business; and (2) is caused in whole or in part by any negligent act or omission of CONTRACTOR, any subcontractor or supplier for whom CONTRACTOR is responsible, regardless of whether caused in part by any negligent act or omission of Owner.

ARTICLE 8 – OTHER WORK AT THE SITE

Add a new paragraph immediately after paragraph 7.02 of the General Conditions which is to read as follows:

C. Should CONTRACTOR cause damage to the work or property of any separate contractor at the site, or should any claim arising out of CONTRACTOR's performance of the Work at the site be made by any separate contractor against CONTRACTOR, OWNER, ENGINEER, ENGINEER's Consultants, the Construction Coordinator or any other person, CONTRACTOR shall promptly attempt to settle with such other contractor by agreement, or otherwise resolve the dispute by arbitration or at law. CONTRACTOR shall, to the fullest extent permitted by Laws and Regulations, indemnify and hold OWNER, ENGINEER, ENGINEER's Consultants and the Construction Coordinator harmless from and against all claims, damages, losses and expenses (including, but not limited to, fees of engineers, architects, attorneys and other professionals and court and arbitration costs) arising directly, indirectly or consequentially out of any action, legal or equitable, brought by any separate contractor against OWNER, ENGINEER, ENGINEER's Consultants or the Construction Coordinator to the extent based on a claim arising out of CONTRACTOR's performance of the Work. Should a separate contractor cause damage to the Work or property of CONTRACTOR or should the performance of Work by any separate contractor at the site give rise to any other claim, CONTRACTOR shall not institute any action, legal or equitable, against OWNER, ENGINEER, ENGINEER's Consultants or the Construction Coordinator or permit any action against any of them to be maintained and continued in its name or for its benefit in any court or before any arbiter which seeks to impose liability on or to recover damages from OWNER, ENGINEER, ENGINEER's Consultants or the Construction Coordinator on account of any such damage or claim. If CONTRACTOR is delayed at any time in performing or furnishing Work by any act or neglect of a separate contractor and OWNER and CONTRACTOR are unable to agree as to the extent of any adjustment in Contract Times attributable thereto, CONTRACTOR may make a claim for an extension of times in accordance with Article 11. An extension of the Contract Times shall be CONTRACTOR's exclusive remedy with respect to OWNER, ENGINEER, ENGINEER's Consultants and Construction Coordinator for any delay, disruption, interference or hinderance caused by any separate contractor. This paragraph does not prevent recovery from OWNER, ENGINEER, ENGINEER's Consultant or Construction Coordinator for activities that are their respective responsibilities.

ARTICLE 10 – ENGINEER'S STATUS DURING CONSTRUCTION

SC-10.03 Project Representative

Add the following new paragraphs immediately after Paragraph 10.03.A:

B. The Resident Project Representative (RPR) will be Engineer's representative at the Site, will act as directed by and under the supervision of Engineer, and will confer with Engineer regarding RPR's actions.

1. General: RPR's dealings in matters pertaining to the Work in general shall be with Engineer and Contractor. RPR's dealings with Subcontractors shall only be through or with the full knowledge and approval of Contractor. RPR shall generally communicate with Owner only with the knowledge of and under the direction of Engineer.

2. Schedules: Review the progress schedule, schedule of Shop Drawing and Sample submittals, and Schedule of Values prepared by Contractor and consult with Engineer concerning acceptability.

3. Conferences and Meetings: Attend meetings with Contractor, such as preconstruction conferences, progress meetings, job conferences, and other Project-related meetings, and prepare and circulate copies of minutes thereof.

4. Liaison:

    a. Serve as Engineer's liaison with Contractor. Working principally through Contractor's authorized representative or designee, assist in providing information regarding the provisions and intent of the Contract Documents.

    b. Assist Engineer in serving as Owner's liaison with Contractor when Contractor's operations affect Owner's on-Site operations.

    c. Assist in obtaining from Owner additional details or information, when required for proper execution of the Work.

5. Interpretation of Contract Documents: Report to Engineer when clarifications and interpretations of the Contract Documents are needed and transmit to Contractor clarifications and interpretations as issued by Engineer.

6. Shop Drawings and Samples:

    a. Record date of receipt of Samples and Contractor-approved Shop Drawings.

    b. Receive Samples which are furnished at the Site by Contractor, and notify Engineer of availability of Samples for examination.

    c. Advise Engineer and Contractor of the commencement of any portion of the Work requiring a Shop Drawing or Sample submittal for which RPR believes that the submittal has not been approved by Engineer.

7. Modifications: Consider and evaluate Contractor's suggestions for modifications in Drawings or Specifications and report such suggestions, together with RPR's recommendations, if any, to Engineer. Transmit to Contractor in writing decisions as issued by Engineer.

8. Review of Work and Rejection of Defective Work:

    a. Conduct on-Site observations of Contractor's work in progress to assist Engineer in determining if the Work is in general proceeding in accordance with the Contract Documents.

    b. Report to Engineer whenever RPR believes that any part of Contractor's work in progress is defective, will not produce a completed Project that conforms generally to the Contract Documents, or will imperil the integrity of the design concept of the completed Project as a functioning whole as indicated in the Contract Documents, or has been damaged, or does not meet the requirements of any inspection, test or approval required to be made; and advise Engineer of that part of work in progress that RPR believes should be corrected or rejected or should be uncovered for observation, or requires special testing, inspection or approval.

9. Inspections, Tests, and System Start-ups:

    a. Verify that tests, equipment, and systems start-ups and operating and maintenance training are conducted in the presence of appropriate

Owner's personnel, and that Contractor maintains adequate records thereof.

b. Observe, record, and report to Engineer appropriate details relative to the test procedures and systems start-ups.

10. Records:

a. Prepare a daily report or keep a diary or log book, recording Contractor's hours on the Site, Subcontractors present at the Site, weather conditions, data relative to questions of Change Orders, Field Orders, Work Change Directives, or changed conditions, Site visitors, deliveries of equipment or materials, daily activities, decisions, observations in general, and specific observations in more detail as in the case of observing test procedures; and send copies to Engineer.

b. Record names, addresses, fax numbers, e-mail addresses, web site locations, and telephone numbers of all Contractors, Subcontractors, and major Suppliers of materials and equipment.

c. Maintain records for use in preparing Project documentation.

11. Reports:

a. Furnish to Engineer periodic reports as required of progress of the Work and of Contractor's compliance with the Progress Schedule and schedule of Shop Drawing and Sample submittals.

b. Draft and recommend to Engineer proposed Change Orders, Work Change Directives, and Field Orders. Obtain backup material from Contractor.

c. Immediately notify Engineer of the occurrence of any Site accidents, emergencies, acts of God endangering the Work, force majeure or delay events, damage to property by fire or other causes, or the discovery of any Constituent of Concern or Hazardous Environmental Condition.

12. Payment Requests: Review applications for payment with Contractor for compliance with the established procedure for their submission and forward with recommendations to Engineer, noting particularly the relationship of the payment requested to the Schedule of Values, Work completed, and materials and equipment delivered at the Site but not incorporated in the Work.

13. Certificates, Operation and Maintenance Manuals: During the course of the Work, verify that materials and equipment certificates, operation and maintenance manuals and other data required by the Contract Documents to be assembled and furnished by Contractor are applicable to the items actually installed and in accordance with the Contract Documents, and have these documents delivered to Engineer for review and forwarding to Owner prior to payment for that part of the Work.

14. Completion:

a. Participate in Engineer's visits to the Site to determine Substantial Completion, assist in the determination of Substantial Completion and the preparation of a punch list of items to be completed or corrected.

b. Participate in Engineer's final visit to the Site to determine completion of the Work, in the company of Owner and Contractor, and prepare a final punch list of items to be completed and deficiencies to be remedied.

c. Observe whether all items on the final list have been completed or corrected and make recommendations to Engineer concerning acceptance and issuance of the notice of acceptability of the work.

C. The RPR shall not:

1. Authorize any deviation from the Contract Documents or substitution of materials or equipment (including “or-equal” items).

2. Exceed limitations of Engineer’s authority as set forth in the Contract Documents.

3. Undertake any of the responsibilities of Contractor, Subcontractors, or Suppliers.

4. Advise on, issue directions relative to, or assume control over any aspect of the means, methods, techniques, sequences or procedures of Contractor’s work.

5. Advise on, issue directions regarding, or assume control over security or safety practices, precautions, and programs in connection with the activities or operations of Owner or Contractor.

6. Participate in specialized field or laboratory tests or inspections conducted off-site by others except as specifically authorized by Engineer.

7. Accept Shop Drawing or Sample submittals from anyone other than Contractor.

8. Authorize Owner to occupy the Project in whole or in part.

ARTICLE 13 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

SC 13.01.B.5.c Delete Paragraph 13.01.B.5.c in its entirety and insert the following in its place:

c. Construction Equipment and Machinery:

1) Rentals of all construction equipment and machinery, and the parts thereof, in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.

2) Costs for equipment and machinery owned by Contractor will be paid at a rate shown for such equipment in the Rental Rate Blue Book. An hourly rate will be computed by dividing the monthly rates by 176. These computed rates will include all operating costs. Costs will include the time the equipment or machinery is in use on the changed Work and the costs of transportation, loading, unloading, assembly, dismantling, and removal when directly attributable to the changed Work. The cost of any such equipment or machinery, or parts thereof, shall cease to accrue when the use thereof is no longer necessary for the changed Work. Equipment or machinery with a value of less than $1,000 will be considered small tools.

SC 13.03.E Delete Paragraph 13.03.E in its entirety and insert the following in its place:

E. The unit price of an item of Unit Price Work shall be subject to reevaluation and adjustment under the following conditions:

1. if the extended price of a particular item of Unit Price Work amounts to 25 percent or more of the Contract Price (based on estimated quantities at the time

of Contract formation) and the variation in the quantity of that particular item of Unit Price Work actually furnished or performed by Contractor differs by more than 25 percent from the estimated quantity of such item indicated in the Agreement; and

2. if there is no corresponding adjustment with respect to any other item of Work; and

3. if Contractor believes that Contractor has incurred additional expense as a result thereof, Contractor may submit a Change Proposal, or if Owner believes that the quantity variation entitles Owner to an adjustment in the unit price, Owner may make a Claim, seeking an adjustment in the Contract Price.

ARTICLE 15 – PAYMENTS TO CONTRACTOR; SET-OFFS; COMPLETION; CORRECTION PERIOD

SC 15.01.B.1 The first sentence of paragraph 15.01.B.1 of the general conditions is hereby deleted in its entirety and the following is substituted in lieu thereof:

1. At least thirty (30) days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents.SC 15.01.D.1 The first sentence of paragraph 15.01.D.1 of the general conditions is hereby deleted in its entirety and the following is substituted in lieu thereof:

SC 15.03.B Add the following new subparagraph to Paragraph 15.03.B:

1. If some or all of the Work has been determined not to be at a point of Substantial Completion and will require re-inspection or re-testing by Engineer, the cost of such re-inspection or re-testing, including the cost of time, travel and living expenses, shall be paid by Contractor to Owner. If Contractor does not pay, or the parties are unable to agree as to the amount owed, then Owner may impose a reasonable set-off against payments due under Article 15.

SC15.01.D.1. The first sentence of paragraph 15.01.D.1 of the general conditions is hereby deleted in its entirety and the following is substituted in lieu thereof:

1. Twenty days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended (sub ject to any Owner set-offs) will become due, and when due will be paid by Owner to Contractor.

SC 15.03.B Add the following new subparagraph to Paragraph 15.03.B:

1. If some or all of the Work has been determined not to be at a point of Substantial Completion and will require re-inspection or re-testing by Engineer, the cost of such re-inspection or re-testing, including the cost of time, travel and living expenses, shall be paid by Contractor to Owner. If Contractor does not pay, or the parties are unable to agree as to the amount owed, then Owner may impose a reasonable set-off against payments due under Article 15.

ARTICLE 17 – FINAL RESOLUTION OF DISPUTES

SC-17.02 Add the following new paragraph immediately after Paragraph 17.01.

SC-17.02 Arbitration

A. All matters subject to final resolution under this Article will be decided by arbitration in accordance with the rules of the State of Utah, subject to the conditions and limitations of this paragraph. This agreement to arbitrate and any other agreement or consent to arbitrate entered into will be specifically enforceable under the prevailing law of any court having jurisdiction.

B. The demand for arbitration will be filed in writing with the other party to the Contract and with the selected arbitrator or arbitration provider, and a copy will be sent to Engineer for information. The demand for arbitration will be made within the specific time required in this Article, or if no specified time is applicable within a reasonable time after the matter in question has arisen, and in no event shall any such demand be made after the date when institution of legal or equitable proceedings based on such matter in question would be barred by the applicable statute of limitations. The demand for arbitration should include specific reference to Paragraph SC-17.02.D below.

C. No arbitration arising out of or relating to the Contract shall include by consolidation, joinder, or in any other manner any other individual or entity (including Engineer, and Engineer's consultants and the officers, directors, partners, agents, employees or consultants of any of them) who is not a party to this Contract unless:

   1. the inclusion of such other individual or entity is necessary if complete relief is to be afforded among those who are already parties to the arbitration; and

   2. such other individual or entity is substantially involved in a question of law or fact which is common to those who are already parties to the arbitration and which will arise in such proceedings.

D. The award rendered by the arbitrator(s) shall be consistent with the agreement of the parties, in writing, and include a concise breakdown of the award, and a written explanation of the award specifically citing the Contract provisions deemed applicable and relied on in making the award.

E. The award will be final. Judgment may be entered upon it in any court having jurisdiction thereof, and it will not be subject to modification or appeal, subject to provisions of the Laws and Regulations relating to vacating or modifying an arbitral award.

F. The fees and expenses of the arbitrators and any arbitration service shall be shared equally by Owner and Contractor.

SC-17.03 Attorneys' Fees: For any matter subject to final resolution under this Article, the prevailing party shall be entitled to an award of its attorneys' fees incurred in the final resolution proceedings, in an equitable amount to be determined in the discretion of the court, arbitrator, arbitration panel, or other arbiter of the matter subject to final resolution, taking into account the parties' initial demand or defense positions in comparison with the final result.

- END OF DOCUMENT -

PART 4
TECHNICAL SPECIFICATIONS

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SECTION 01 11 00
SUMMARY OF WORK

PART 1 GENERAL

1.1 GENERAL

A. The Work to be performed under this Project shall consist of furnishing all labor, materials, and equipment necessary or required to complete the work in all respects as shown on the Contract Drawings and as herein specified. All work, materials, and services not expressly shown or called for in the Contract Documents which may be necessary to complete the construction of the work in good faith shall be performed, furnished, and installed by CONTRACTOR as though originally so specified or shown, at no increase in cost to OWNER.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

Construct and functionally commission all parts of a 600 gpm drinking water wellhouse system including two buildings (wellhouse and fluoride) of masonry block with pitched roofs; 150 HP vertical turbine pump, motor, piping, valves, onsite hypochlorite generation system, fluoridation system, filtration system with automated backwash system, vault and monitoring, landscaping and irrigation system, HVAC, electrical, controls, paving, C&G, sidewalks, driveways, chain link fence and gates, drainage and water pipelines, and other work.

A. The work is located on the property that is north east of the intersection of Highway 89 and Green Road in Fruit Heights, Utah.

1.3 CONTRACT METHOD

A. The Work hereunder will be constructed under a single unit price contract.

1.4 CONTRACTOR USE OF PROJECT SITE

A. CONTRACTOR's use of the Project Site shall be limited to its construction operations, including on-site storage of materials, on-site fabrication facilities.

1.5 PROJECT SECURITY

A. CONTRACTOR shall make all necessary provisions to protect the Project and CONTRACTOR's facilities from fire, theft, and vandalism, and the public from unnecessary exposure to injury.

1.6 CHANGES IN THE WORK

A. It is mutually understood that it is inherent in the nature of public works construction that some changes in the plans and specifications may be necessary during the course of construction to adjust them to unforeseen field conditions, and that it is of the essence of the Contract to recognize a normal and expected margin of change. ENGINEER shall have the right to make such changes, from time to time, in the plans, in the character if the Work, and in the scope of the Project as may be necessary or desirable to ensure the completion of the Work in the most satisfactory manner without invalidating the Contract.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

SECTION 01 14 00
WORK RESTRICTIONS

PART 1 GENERAL

A. OWNER and/or utility owners may be working within the Project area while this contract is in progress. If so, CONTRACTOR shall schedule Work in conjunction with these other entities to minimize mutual interference.

B. All compaction and other testing requirements specified shall be provided and paid for by CONTRACTOR.

C. CONTRACTOR shall notify ENGINEER of the schedule for materials testing as required in Section 01400 – Quality Requirements and Section 01400M – Quality Requirements (Modified) a minimum of 24 hours in advance in order to provide ENGINEER time to be present during desired testing. CONTRACTOR shall be responsible for obtaining copies of testing reports or data and ensuring that the work is in full compliance with the Contract Documents.

D. CONTRACTOR shall notify owners of Private rights-of-way 72 hours prior to work being performed across owner's right-of-way.

E. If required to work in City Streets or Utah Department of Transportation (UDOT) right-of-way, CONTRACTOR shall notify right-of-way owner 72 hours prior to work being performed therein. Work within the City Streets or UDOT right-of-way shall be in accordance with required permits and any license agreement with OWNER. CONTRACTOR shall obtain and comply with all required permits.

F. CONTRACTOR must work with all adjacent property owners to ensure no harm or damage is caused to homes or property during construction of the project.

1.2 MEASUREMENT AND PAYMENT

A. Work Restrictions shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

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SECTION 01 22 00
MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.1 REQUIREMENTS

A. All work completed under this contract shall be in accordance with the Contract Drawings and Specifications and will be measured by ENGINEER/OWNER. The quantities appearing on the Bid Schedule are approximate only, and are prepared for the comparison of bids. Payment to CONTRACTOR on bid items with unit prices other than "Lump Sum" will be made for actual quantities of work performed and accepted, or material furnished in accordance with the Contract. The scheduled quantities of work to be done and materials to be furnished may be increased or decreased in accordance with the General Conditions.

B. The term "Lump Sum" when used as an item of payment will mean complete payment for the work described in the contract. When a complete structure, portion of work, or unit is specified "Lump Sum" as the unit of measurement, the unit will include fittings, accessories, and all work necessary to complete the work as shown on the Drawings and as specified.

C. Unit Price Payment" Includes: Full compensation for required labor, products, tools, equipment, plant and facilities, transportation, services and incidentals; erection, application or installation of an item of the Work; and overhead and profit.

D. When the accepted quantities of work vary from the quantities in the Bid Schedule, CONTRACTOR shall accept as payment in full, so far as contract items are concerned, payment at the original contract unit prices for the work done. OWNER reserves the right to add to or delete from quantities listed in the bid schedule in order to match the total bid with the budgeted money available.

1.2 BASE BID SCHEDULE

A. Payments will be as described below, less retainage amounts described in the General Conditions. Retainage amounts will be released as described in the General Conditions.

B. Bid Item 1 – Mobilization / Demobilization

1. Mobilization includes general and miscellaneous responsibilities and operations not normally attributed to any other single bid item. It includes, but is not limited to, work described in Section 01 71 13 – Mobilization.
2. It will be measured based on percent of total work in Bid Schedule completed.
3. Payment of lump sum bid amount in Bid Schedule will be as follows:
   a. When 10% of contract amount is earned, 25% of this item will be paid.
   b. When 25% of contract amount is earned, 25% more of this item will be paid.
   c. When 50% of contract amount is earned, 25% more of this item will be paid.
   d. When 100% of contract amount is earned (Startup Testing and Demobilization), the last 25% of this item will be paid.

C. Bid Item 2 – Construction Surveying

1. Contractor work to provide all Construction Surveying per Section 01 30 00 Administrative Requirements, performed by a registered professional land surveyor.
2. Measured based on percent of work complete.
3. Payment of lump sum bid amount in Bid Schedule will be as follows:
   a. When 10% of total contract amount is earned, 75% of this item will be paid.
   b. When 75% of total contract amount is earned, the rest of this item will be paid.

D. Bid Item 3 – QC and Testing Agency Services

1. This item is for Contractor's QC Work and Testing Agency Services, including, but not limited to, all work in Sections 01 45 23 and 01 45 00.
2. It will be measured based on percent of successful QC testing work complete which is based on the percent of total Contract work complete (tested and accepted).
3. Payment of lump sum bid amount in Bid Schedule will be as follows:
   a. When 10% of contract amount is earned, 25% of this item will be paid.
   b. When 25% of contract amount is earned, 25% more of this item will be paid.
   c. When 50% of contract amount is earned, 25% more of this item will be paid.
   d. When 75% of contract amount is earned, the last 25% of this item will be paid

E. Bid Item 4 – SWPPP and Implementation

1. Pay and perform all work for SWPPP and Implementation. Submit SWPPP.
2. Measurement is based on percent of be paid for each permit and percent of SWPPP implementation which is complete
3. SWPPP payment will be as follows:
   a. When 100% of SWPPP implementation facilities are installed, 75% of SWPPP permit Work will be paid.
   b. The last 25%, which is for SWPPP maintenance, will be paid at Substantial Completion.

F. Bid Item 5 – Owner to Pay RMP to Provide Power to Site (excludes Contractor-installed RMP conduits)

1. Owner shall pay RMP directly to provide power to site so this bid item is zero. RMP will provide overhead pole, power cable (through a Contractor-installed conduit), meter, transformer, testing and startup.
2. However, Contractor is responsible to make all arrangements for, and do all coordination for, and construct conduit for, RMP to provide power supply including, but not limited to:
   a. furnish and install RMP conduit (comply with on-line RMP standards) from a pole (to be installed by RMP). As shown on plans, Contractor shall horizontally directionally drill conduit under 40- ft wide asphalt road and install RMP conduit across project site to the new electric meter and transformer shown on Sheet C-2**. Contractor costs to provide arrangements for, coordination for, and RMP conduit for, RMP to supply electric power supply to site shall be put in bid item 24.**

G. Bid Item 6 – All Earthwork, Haul off Excess, Finished Grading

1. Perform all earthwork including removing soils down to elevation 4599.50 under both buildings and replacing it with the required backfill; hauling off and disposing of

excess earth from: under buildings, trenches, MHs, vault; under AC paving and walks, and earth pile (volume approximately 2000 cubic yards) on north property line (see Sheet C-2); and doing all finished grading except landscaping.

2. Measurement and Payment will be based on the following:
   a. 25% will be paid when the excess from the vault, MH and north property line earth pile are hauled of.
   b. Another 25% will be paid when both building foundations are placed and backfilled with imported earth.
   c. Another 25% will be paid when the subgrade for AC paving and sidewalk are prepared and their excess hauled off.
   d. The last 25% will be paid when finished grading and topsoils are done.

H. Bid Item 7 – 12-inch Storm Drain

1. This will be measured based on the horizontal linear feet of 12-inch storm drain (pipe shall be either RCP or ADS HP Storm) is acceptably installed and backfilled.
2. Measurement and payment of unit cost bid amount in Bid Schedule will be for each linear foot of pipe completed and accepted. No payment will be made until 12-inch pipe connections are made to existing storm drain box, so drains can function.

I. Bid Item 8 – Curb Inlet (APWA Plan 315.1)

1. This will be measured and paid based on the number of cube inlet boxes based correctly located, installed, backfilled and functional (to drain).

J. Bid Item 9 – 8” DIP Water Pipeline and Fluoride Injection MH

1. 75 percent of the pipeline will be paid when the pipeline and Fluoride Injection MH is correctly installed backfilled, tested, disinfected, and accepted. The last 25 percent will be paid when the final connection to the existing 8-inch pipeline is complete and accepted.

K. Bid Item 10 – Misc Drains Outside Buildings (2- to 8-inch Dia)

1. These will be measured and paid on a lump sum basis when drains are properly installed, backfilled and accepted. This includes the 2- to 8-inch drains tied to backwash vault, the 4-inch drains not under the wellhouse nor under the Fluoride Building.

L. Bid Item 11 – Drain MH’s: 48”, 60”, 72” and 4” Gate Valve

1. This will be measured and paid based on the percent of total work complete, tested water tight, and accepted. 50% will be paid for the 72” MH and valve, the other 50% for the other two MH’s. Work includes flap valves but not automation.

M. Bid Item 12 – Precast Concrete Vault (8’ x 16’ x 9;’ high) inside dimensions

1. This will be measured and paid (a single payment) when the vault is installed, backfilled, tested water tight, and approved. The Work includes design and submitting HS20 rated vault design with two access MHs, a ladder, a weir, Sch 80 PVC connections (water tight cast with vault), installation and backfill, and leak test.

N. Bid Item 13 – Appurtenances for MHs and Vault: Level Monitors, Vaults, Automation.

1. This will be measured and paid when the system is fully function including both level monitors (for 72" MH and for vault) are functionally tied to RTU to automatically operate backwash system based on water level in vault, and to signal to WBWCD SCADA system an alarm if water depth in 72" MH exceeds 6-inches.

O. Bid Item 14 – Type E Curb and Gutter

1. This will be measured and paid for based on the number of linear feet of Type E Curb and Gutter installed and accepted on accepted compacted subgrade. Before payment, drainage test curb and gutter in presence of Engineer to verify there are not puddles.

P. Bid Item 15 – 4 Foot Wide Concrete Waterway

1. This will be measured and paid for based on the number of linear feet of 4-foot wide concreted waterway installed and accepted on accepted compacted subgrade. Before payment, drainage test waterway in presence of Engineer to verify there are not puddles.

Q. Bid Item 16 – APWA Plan 222 (Sim) Conc Driveway

1. This will be measured and paid for per each driveway (6" THK, 42' wide sawcut at TBC, 30' wide at 9' north of TBC), properly installed, sawcut curb w/ sloped edges at 12:1 (Plan 221 sim), compacted subgrade, placed concrete, finished and cured, complete.

R. Bid Item 17 – 6-ft wide Conc Sidewalk (Match Exst C&G Elev - outside W & S fences)

1. This will be measured and paid per each linear foot of 6-foot wide concrete side walk installed per specs and per Fruit Heights Standard Detail CS-03. Work required: 95% compacted subgrade; FG sidewalk to slope at 2% (from fence) to existing TBC; finish and cure complete.

S. Bid Item 18 – Black PVC Coated Chain Link Fence and Gates

1. This will be measured and paid for per each linear foot of fence and gate per plans and specifications. Fence the perimeter of the wellhouse property per Sheet C-1. Provide a 32-ft roller gate and a 32-foot wide, 2-panel gate, pad-lockable swing gate with drop rod drilled into conc at each driveway.

T. Bid Item 19 – AC Paving: 4" AC over 12" UTBC

1. This will be measured and paid for per each square foot of AC paving (4-inch min thick asphalt concrete over 12-inch min thick untreated based course 95% compacted over 95% compacted subgrade. AC pave all areas in Note 4, Sheet C-2, including areas in the public street south of the existing C&G. Slope AC paving fished surfaces per Sheet C-2 so there are not puddles. Before payment, Engineer to witness AC paving flooding to verify there are not puddles.

U. Bid Item 20 – Wellhouse Building Piping System

1. Wellhouse Building Piping Systems shall be measured and paid for on percent of the lump sum amount for all wellhouse building piping complete, tested and accepted. Work includes all piping, materials (DIP, WSP, PVC, HDPE, copper, SS, etc) types (pressure, drains, water, etc), components (valves, meters, gages, couplings, fittings, insulting flanges, diffusers, adapters, ties to other systems) of all piping within and below wellhouse, complete, tested, functional, and accepted.

V. Bid Item 21 – Wellhouse Structure

1. Wellhouse Structure shall be measured and paid for on percent of the lump sum amount for materials and installation complete of all well house structure work per plans and specifications, including but not limited to footings, foundations, masonry walls, concrete floor, perimeter sidewalks, housekeeping pads, pump base, doors, windows, trusses, roofing system, cupolas for roof access for pumps and equipment, skylights, insulation, interior finishes, painting, and all other work.

W. Bid Item 22 – Fluoridation Building Structure

1. Fluoridation Building Structure shall be measured and paid for on percent of the lump sum amount for materials and installation complete of all Fluoridation Building Structure work per plans and specifications, including but not limited to footings, foundations, masonry walls, concrete floor, perimeter sidewalks, housekeeping pads, doors, windows, trusses, roofing system, insulation, interior finishes, painting, and all other work.

X. Bid Items 23 – Deep Well Pump & Motor

1. This will be measured and paid for as a single lump sum item based on percentage of work complete, tested, and accepted in accordance with plans and specifications.

Y. Bid Item 24 – Electrical and I&C Systems (on- and off- site and in 2 buildings) Complete (except items 5, 13, 23, 25, 26, 27, 28, 29)

1. Electrical and I&C (Instrumentation and Controls) Systems Compete shall be measured and paid for based on percentage of work complete, tested and accepted in accordance with plans and specifications; including furnishing and installing all electrical, instrumentation, and controls equipment, VFD, etc, and **coordinating all work, debugging, startup and operationally testing all work for the project.** Work includes: variable frequency drive, panelboards, transformers, lighting, service outlets, pressure switches, pressure transducers, intrusion switches, flood switches, buried conduits, functional SCADA and Ethernet terminations and connections to control panels and to WBWCD existing systems, electrical service connection, connecting up pump motor, grounding (lightning protection system), connections to HVAC, access card readers on doors, network door controllers, CCTV security cameras, and all other items as shown on the Contract Drawings required for a complete and operable electrical system.

Z. Bid Item 25 – Main Control Panel and Programming

1. Main Control Panel and Programming for all facilities on project site shall be measured and paid for as a single payment when wellhouse and all systems are

complete, tested, functionally operable, and accepted by Engineer and Owner. **Contractor shall contract for this work to either SKM or M8 Automation:** to provide complete control panel with PLC, HMI and programming. Contractor to coordinate who terminates instrumentation and who installs it on the wall. Work includes all labor, materials, and equipment to furnish, install, program, test, debug the control panel / RTU for all system operations including pumping systems, controls, filtration system, backwash system, chlorination system, fluoridation system, all instrumentation, cabinet, supports, components, electrician support during loop checks, and all other related items internal to control panel per plans and specifications not paid elsewhere. Site installation of the control panel, wiring and conductors is under bid item 24.

AA. Bid Item 26 – HVAC System Complete

1. HVAC System Compete shall be measured and paid for based on percentage of work complete, tested and accepted in accordance with plans and specifications, including but not limited to all materials, wire, ductwork, insulation, equipment, electric unit heaters, ductwork, exhaust fans, supports, thermostats, air handling units, balancing, startup, debugging, operationally testing, acceptable and complete HVAC systems for both buildings.

BB. Bid Item 27 – Chlorination Generation System Complete

1. Chlorination Generation System Complete shall be measured and paid for based on percentage of work complete, tested and accepted in accordance with plans and specifications including, but not limited to, all labor, materials, and equipment for furnishing, installing, and testing the chlorine chlorination system, chlorine generator, brine tank, chlorine solution tank; exhaust fan; dust bag housing, water softeners, water filters; piping and tubing, valves, supports; two metering pumps; FRP table; all equipment in schedule on Sheet C--8; all work in Section 46 32 13; wiring, connections, testing, until functionally operating properly and efficiently, and all other related work.

CC. Bid Item 28 – Fluoridation System Complete

1. Fluoridation System Complete shall be measured and paid for based on percentage of work complete, tested and accepted in accordance with plans and specifications including, but not limited to, all labor, materials, and equipment for furnishing, installing, and testing the fluoridation system, bulk and day tank; exhaust fan; transfer pump, dosing pump, solution pump; piping and tubing, valves, supports; emergency eyewash and shower system, compressor and pneumatic system, all equipment in schedules and tables on Sheets C-10 and C-12; all work in Section 46 31 12; wiring, connections, testing, debugging, until functionally operating properly and efficiently, and all other related work.

DD. Bid Item 29 – Iron and Manganese Filtration System Complete

1. Iron and Manganese Filtration System Complete *(Materials)* shall be measured and paid for based on percentage of work complete, tested and accepted in accordance with plans and specifications including, but not limited to, all labor, materials, and equipment for furnishing the fully automated well water filtration system, filters,

controls, instrumentation, power, piping and tubing, valves, supports; backwash system that backwashes in response to both pressure and backwash tank water level, all equipment and work shown in plans and in Section 46 34 00 and its appendix pages; wiring, connections, and all other related work. *Put all costs for system installation, including testing and debugging until functionally operating properly and efficiently in bid item 20 - Wellhouse Building Piping System.*

EE. Bid Item 30 – Landscaping

1. Landscaping shall be measured and paid for based on percentage of work complete, tested and accepted in accordance with plans and specifications including, but not limited to, all labor, materials, and equipment for furnishing, installing all landscaping, protecting existing trees, upland grass seed mix, concrete mow strips, weeding, bark mulch, multiple types of rock surfacing, boulders, and all other work, as shown in the plans and detailed in specifications.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

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SECTION 01 30 00
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.1 COORDINATION AND PROJECT CONDITIONS

A. Coordinate scheduling, Submittals, and Work of various sections of Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements.

B. Coordinate completion and clean-up of Work of separate sections in preparation for Substantial Completion.

C. After OWNER occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of OWNER's activities.

D. OWNER, UDOT, land owners, and/or utility owners may be working within the project area while this contract is in progress. If so, CONTRACTOR shall schedule his work in conjunction with these other organizations to minimize mutual interference.

E. All existing City waterlines and service connections shall remain active during construction except during connections to new water mains are required. All connections to the existing waterlines, except those being hot-tapped, shall only be done upon successful completion of mainline installation and testing.

F. Water service to this area can be interrupted to that CONTRACTOR shall connect up new 24- and 16-inch pipelines. Included in Construction Schedule forecasted connection dates for these water lines. Schedule with City final connection dates and times. A copy of CONTRACTOR'S notification letter shall be reviewed and approved by OWNER prior to distribution.

G. If required to work in Foothill Blvd, or any other City Street or Utah Department of Transportation (UDOT) right-of-way, CONTRACTOR shall notify UDOT 72 hours prior to work being performed therein. Work within the City Streets or UDOT right-of-way shall be in accordance with their required permit and their license agreement with OWNER. CONTRACTOR shall obtain and comply with all required permits.

H. Coordination with Adjacent Property Owner

1. Once each week, CONTRACTOR shall hand deliver or mail a written **"Construction Status Update Notice"** to all residents, businesses, schools and property owners adjacent to and affected by the Work. Notice shall be on CONTRACTOR's company letterhead paper and be secured to doorknob should occupants not be home. Obtain ENGINEER's review of notice prior to distribution. As a minimum the notice shall contain the following:

    a. name and phone number of CONTRACTOR's representative for the project
    b. work anticipated for the next 7 days including work locations and work by subcontractors and utility companies
    c. rough estimate of construction schedule through end of project

d. anticipated driveway approach closures
e. anticipated water, sewer or power outages
f. anticipated vehicular traffic impacts, rerouting or lane closures
g. anticipated pedestrian impacts and sidewalk closures
h. changes to public transportation bus routes
i. any other construction or work items which will impact or restrict the normal use of streets and amenities

2. Failure to comply with this contract provision is considered grounds for project suspension per Article 16.01 of the General Conditions (EJCDC 00 70 00).

1.2 FIELD ENGINEERING

A. ENGINEER shall provide the following construction staking at no cost to CONTRACTOR.

1. Benchmark network throughout the construction zone
2. Pipeline alignment stakes at approximately 100-foot intervals and all bends and designated changes in grade.
3. Stake locations for air valve vaults, air vents and other fittings

B. Construction staking and surveying shall be performed by a registered Land Surveyor in the State of Utah.

C. CONTRACTOR shall provide all other survey construction staking as necessary to complete the required work according to the contract documents.

D. ENGINEER shall not be responsible for stakes, etc. removed through negligence of CONTRACTOR and in that event shall be compensated by CONTRACTOR for re-staking efforts.

E. Locate and protect survey control and reference points. Promptly notify ENGINEER of discrepancies discovered.

F. Control datum for survey is that shown on Contract Drawings.

G. Protect survey control points prior to starting site work; preserve permanent reference points during construction.

H. Promptly report to ENGINEER loss or destruction of reference point or relocation required because of changes in grades or other reasons.

I. Coordinate with all property owners to determine the location of existing sewer and water service laterals.

J. All service laterals shall be verified and indicated on the Record Drawings supplied by CONTRACTOR to ENGINEER.

1.3 PRECONSTRUCTION MEETING

A. Prior to the commencement of work at the site, a preconstruction conference will be held at a mutually agreed time and place which shall be attended by CONTRACTOR's

Project Manager, its superintendent, and its subcontractors as appropriate. Other attendees will be:

1. ENGINEER and the Resident Project Representative (RPR)
2. Representatives of OWNER
3. Governmental representatives as appropriate
4. Others as requested by CONTRACTOR, OWNER, or ENGINEER.

B. Unless previously submitted to ENGINEER, CONTRACTOR shall bring to the conference one copy of each of the following:

1. Progress schedule
2. Procurement schedule of major equipment and materials and items requiring long lead time
3. Shop Drawings/Sample/Substitute or "Or Equal" submittal schedule.

C. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The agenda may include the following:

1. CONTRACTOR's tentative schedules
2. Transmittal, review, and distribution of CONTRACTOR's submittals
3. Processing applications for payment
4. Maintaining record documents
5. Critical work sequencing
6. Field decisions and Change Orders
7. Use of project site, office and storage areas, security, housekeeping, and OWNER's needs
8. Major equipment deliveries and priorities
9. CONTRACTOR's assignments for safety and first aid

D. ENGINEER will preside at the preconstruction conference and will arrange for keeping the minutes and distributing the minutes to all persons in attendance.

E. CONTRACTOR should plan on the conference taking no less than 6 hours.

1.4 PROGRESS MEETINGS

A. CONTRACTOR shall schedule and hold regular on-site progress meetings at least weekly and at other times as required by ENGINEER or as required by progress of the work. CONTRACTOR, ENGINEER, and all subcontractors active on the site shall be represented at each meeting. CONTRACTOR may at its discretion request attendance by representatives of its suppliers, manufacturers', and other subcontractors.

B. ENGINEER shall preside at the meetings and provide for keeping and distribution of the minutes. The purpose of the meetings will be to review the progress of the work, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop.

C. At each construction progress meeting a progress report shall be presented by CONTRACTOR containing an updated Progress Schedule. Where the delayed completion date of a project phase is noted, CONTRACTOR shall describe the

anticipated delays or problems and outline the action plan being taken to resolve the issues.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION –

SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall prepare a schedule of the WORK in accordance with the Contract Documents that will allow ENGINEER and/or OWNER to determine if the WORK can be substantially complete within the Contract Time.

B. CONTRACTOR shall develop the project construction schedule using a computer software program using the Critical Path Method (CPM) for scheduling. The program shall be **Primavera Project Planner (P6),** or approved equal.

1.2 RELATED WORK

A. Related work in other sections includes but is not limited to:

1. 01 30 00 Administrative Requirements
2. 01 33 00 Submittal Procedures

1.3 DEFINITIONS

A. **Activity.** A discrete, identifiable task or event that takes time, uses resources, has a definable start and stop date, furthers the work's progress, and can be used to plan, schedule, and monitor a project.

B. **Activity ID.** A unique, alphanumeric, identification code assigned to an activity.

C. **Bar Chart.** Also called a Gantt chart, a graphic representation of a schedule without relationships. A timescale appears along the horizontal axis.

D. **Completion Date, Contract.** The original date specified in the contract for completion of the project or a revised date resulting from authorized time extensions. The contract may also specify completion dates for interim milestones, phases, or other portions of the project.

E. **Completion Date, Scheduled.** The completion date projected or forecasted by the schedule. The schedule may also project or forecast interim completion dates for milestones, phases, or other portions of the project.

F. **Constraints.** A restriction imposed on the start or finish dates of an activity that modifies or overrides the activity's logic relationships.

G. **Critical Path**. The **Longest Path.**

H. **Data Date.** The first day in the Initial or Baseline Schedule and the first day for performance of the work remaining in the Monthly Schedule Update. (May also be defined as the date from which a schedule is calculated.)

I. **Float, Total.** The amount of time an activity can be delayed and not delay the project completion date.

J. Holidays. Holidays observed are:

1. 1st day in January (New Year's Day)
2. 3rd Monday in January (Martin Luther King, Jr. Day)
3. 3rd Monday in February (Presidents' Day)
4. Last Monday in May (Memorial Day)
5. 4th day in July (Independence Day)
6. 24th day in July (Pioneer Day)
7. 1st Monday in September (Labor Day)
8. 11th day in November (Veterans Day)
9. 4th Thursday in November (Thanksgiving Day)
10. 25th day in December (Christmas Day)
11. For holidays that fall on a Saturday, both the Saturday and the preceding Friday are considered to be holidays. For holidays that fall on a Sunday, both the Sunday and the following Monday are considered to be holidays.

K. **Longest Path.** The sequence of activities that establishes the scheduled completion date.

L. **Open End.** The condition that exists when an activity has either no predecessor or no successor, or when an activity's only predecessor relationship is a finish-to-finish relationship or only successor relationship is a start-to-start relationship.

1.4 ADMINISTRATIVE REQUIREMENTS

A. General Requirements - Plan and schedule the project and report progress to the owner. Provide a schedule using the critical path method (CPM). The owner's acceptance of any schedule, whether initial, baseline, or update, does not modify the contract or constitute endorsement or validation by OWNER of the contractor's logic, activity durations, or assumptions in creating the schedule. By accepting the schedule, OWNER does not guaranty that the project can be performed or completed as scheduled. If CONTRACTOR or OWNER discovers errors after the schedule has been accepted, correct the error in the next schedule submission.

B. Title Block: Show on each page the following items:

1. Project Title, Contract Number, and CONTRACTOR's name
2. Date of Submittal, revision number, page number, and Project status cutoff date
3. Approval signatures for each subcontractor
4. Legend of Symbols, codes, and abbreviations
5. Network nomenclature, e.g., "Detailed" or "Summary" or "Building Area" identification

C. Required Schedules

1. **Initial Schedule -** OWNER will use the initial schedule to monitor progress until the baseline schedule is accepted. Prepare and submit a schedule for the first 60 calendar days of work plus a summary bar chart schedule for the balance of the project. Activity durations on the summary chart may exceed 15 working days.

    a. At least 10 calendar days before the preconstruction meeting, submit the initial schedule to the owner. Ensure that the schedule shows milestone and

completion dates no later than the specified contract milestone and completion dates.

b. OWNER will review the initial schedule at the preconstruction meeting. At this meeting, be prepared to generally discuss the proposed schedule for the entire project, not just the 60-day period covered by the initial schedule. If deviations to the staging, phasing, or sequencing required by the contract documents are proposed, be prepared to discuss these deviations.

c. Within 5 calendar days of the preconstruction meeting, OWNER will respond by accepting the initial schedule, rejecting the schedule and identifying the reason for rejection, or by asking for more information. Address the reasons for rejection or provide the information requested and resubmit the revised initial schedule no more than 5 calendar days after OWNER's response. OWNER may withhold progress payments until CONTRACTOR submits the initial schedule.

2. **Baseline Schedule -** No more than 30 calendar days after approval of the initial schedule, prepare and submit a baseline schedule to OWNER for review. Within 10 calendar days of receipt of the baseline schedule, OWNER will respond by accepting the baseline schedule, rejecting the schedule and identifying the reason for rejection, or by asking for more information. Address the reasons for rejection or provide the information requested and resubmit the revised baseline schedule no more than 10 calendar days after OWNER's response. OWNER may withhold progress payments until the contractor submits and OWNER accepts the baseline schedule.

3. **Monthly Schedule Update** - Prepare and submit a monthly schedule update to OWNER that depicts the status of the project as of the end of the month. The update will reflect a new data date, work performed up to, but not including, the new data date, and the plan for completing the project. Submit the schedule update by the first Monday of the following month. OWNER may withhold progress payments until the contractor submits and the owner accepts the schedule update.

4. **Final Schedule** - Within 30 calendar days of final acceptance of the project, submit a final schedule with actual start and finish dates for each activity. Include with the submission a certification signed by the principal of the firm stating:

   a. “To the best of my knowledge, the enclosed final schedule reflects the actual start and finish dates of the activities contained herein.”

1.5 SCHEDULE REQUIREMENTS

A. Provide a schedule that meets the following requirements:

1. Calculate the schedule using the Retained Logic scheduling option unless written authorization is obtained from OWNER to use the Progress Override scheduling option.
2. Do not use the following types of logic relationships:
   a. Negative lags
   b. Lags in excess of 10 workdays
   c. Start-to-Finish relationships
   d. Open Ends (Only the first activity will have no predecessor and only the last activity will have no successor)

e. Constraints (CONTRACTOR may use a limited number of constraints only with OWNER's written authorization)
f. Manually modified dates (CONTRACTOR may manually modify dates only with OWNER's written authorization)
g. Obtain OWNER's authorization prior to using lags with finish-to-start relationships

3. Includes the following work activities, as applicable:
   a. Work to be performed by CONTRACTOR, subcontractors, and suppliers.
   b. Work to be performed by OWNER, other contractors, and third parties such as government agencies and authorities, permitting authorities, or other entities required for completion of the project.
   c. The project start date, scheduled completion date, and other contractually mandated milestones, start or finish dates for phases, or site access or availability dates.
   d. Submittal, review, and approval activities when applicable, including time periods for OWNER's approval as specified in the contract documents.
   e. Fabrication, delivery, installation, testing, and similar activities for materials, plants, and equipment
   f. Sampling and testing periods
   g. Settlement and surcharge periods
   h. Cure periods
   i. Utility notification and relocation
   j. Installation, erection and removal, and similar activities related to temporary systems or structures such as temporary electrical systems or shoring.
   k. Punch list, substantial completion, final cleanup, and similar activities.
   l. Required acceptance testing, inspections, or similar activities.
   m. Duration for receipt of permits or acquisition of rights-of-way.
4. Define the following attributes for each activity in the schedule:
   a. A unique alphanumeric Activity ID.
   b. A unique descriptive name, using such attributes as work type and location to distinguish activities.
   c. A duration stated in workdays of no more than 15 workdays, unless a longer duration is requested by CONTRACTOR and approved by OWNER.

1.6 SCHEDULE SUBMISSION REQUIREMENTS

A. For each schedule submission, submit the following items:

1. A Transmittal Letter
2. A narrative report
3. A Primavera Version 6.0 compatible electronic file of the schedule on a CD, DVD, or thumb-drive
4. The critical path in bar chart format (Longest Path sort)
5. Work paths with total float values within 20 workdays of the critical path's total float value in bar chart format. For example, if the critical path has a total float value of zero, then show all of the work paths with total float values of 20 or less.
6. An activity network diagram plotted in color, on E-size paper, with each sheet of the plot including a title, match data for diagram correlation, a page number, and a legend. The activity network diagram should only be submitted with schedules with revised relationships or activity durations.
7. A Predecessor/Successor report with the following items for each activity:
   a. Activity ID and description

b. Original duration
c. Remaining duration
d. Calendar ID
e. Predecessors and Successors
f. Early state date
g. Early finish date
h. Late start date
i. Late finish date
j. Total float
k. Relationship type
l. Lags
m. Constraints

B. Narrative Reports for the Initial and Baseline Schedule – For each submission of the initial and baseline schedule provide a narrative report that includes the following information:

1. Explanation of the overall plan to complete the project, including where the work will begin and the how the work and crews will flow through the project.
2. Use and application of the workdays per week, number of shifts per day, number of hours per shift, holidays observed, and how the schedule accommodates adverse weather days for each month or activity.
3. If the project is a multi-year project, then identify the work to be completed in each construction season
4. A statement explaining why the schedule completion date is forecast to occur before or after the contract completion date
5. An explanation stating why any of the contract milestone dates are forecast to occur late
6. A description of problems or issues anticipated.
7. A description of anticipated delays, including:
   a. Identification of the delayed activity by activity ID and description
   b. Type of delay
   c. Cause of the delay
   d. Effect of the delay on other activities, milestones, and completion dates
   e. Identification of the actions needed to avoid or mitigate the delay
8. A description of the critical path
9. A description of work paths with total float values within 20 workdays of the critical path's total float value. For example, if the critical path has a total float value of zero, then describe all of the work paths with total float values of 20 or less.
10. A statement identifying constraints and an explanation of the reason for and purpose of each constraint
11. A statement describing the status of required permits
12. The statement describing the reason for the use of each lag

C. Narrative Reports for the Monthly Schedule Update and Revised Schedule – For each submission of the monthly schedule update and revised schedule provide a narrative report that includes the following information:

1. A description of the status of the scheduled completion date (and any contract milestone date(s)) since the last schedule submitted

2. A statement explaining why the scheduled completion date is forecast to occur before or after the contract completion date. An explanation stating why any of the contract milestone dates are forecasted to occur late
3. A description of the work performed since the last schedule update.
4. A description of unusual labor, shift, equipment, or material conditions or restrictions encountered or anticipated.
5. A description of the problems encountered or anticipated since the last schedule submission.
6. A statement that identifies and describes any current and anticipated delays. A discussion of delays in the narrative report does not constitute notice and does not replace the need for CONTRACTOR to provide notice as required by the contract. Include the following:
    a. Identification of the delayed activity by activity ID and description
    b. Type of delay
    c. Cause of the delay
    d. Effect of the delay on other activities, milestones, and completion dates
    e. Identification of the actions needed to avoid or mitigate the delay.
7. A description of the critical path
8. A description of changes in the critical path and schedule completion date (for the project or its milestones) from the last schedule submission
9. Descriptions of the status of work paths that have total float values within 20 workdays of the critical path identified in the previous schedule submission.
10. Descriptions of work paths with total float values within 20 workdays of the critical path's total float value. For example, if the critical path has a total float value of negative 25, then show all of the near critical paths with total float values of negative 5 or less.
11. A statement or Claim Digger report that identifies the changes made between the previous schedule submission and the current proposed schedule, including, but not limited to:
    a. Data date
    b. Completion date
    c. Activity code assignments
    d. Scheduling options
    e. Activity descriptions
    f. Added activities
    g. Deleted activities
    h. Added activity relationships
    i. Deleted activity relationships
    j. Activity original durations
    k. Activity remaining durations
    l. Activity actual start and finishes
    m. Percent complete
    n. Constraints
    o. Activity resources
    p. Activity costs
    q. Activity coding
12. A statement providing status of pending items, including, but not limited to:
    a. Permits
    b. Change orders
    c. Time extension requests

d. Noncompliance or similar notices indicating deficiencies in CONTRACTOR's performance

1.7 FLOAT TIME

A. Neither OWNER nor CONTRACTOR owns the float time. The Project owns the float time. Liability for the delay to the project complete date rests with the party causing the delay.

1.8 CHANGE ORDERS

A. Upon approval of a Change Order or upon receipt by CONTRACTOR of authorization to proceed with additional work, the change shall be reflected in the next Monthly Schedule update. Contractor shall utilize a sub-network in the schedule depicting the changed work and its effect on other activities. This sub-network shall be tied to the main network with appropriate logic so that a true analysis of the critical path can be made. In order to receive an extension in Contract Times and change in price for time extension, CONTRACTOR must submit the sub-network analysis.

1.9 INCLEMENT WEATHER PROVISIONS

A. CONTRACTOR's schedule shall include at least the number of days of delay due to unusually severe weather as required by the Supplementary General Conditions.

1.10 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for construction progress scheduling. Full compensation for construction progress scheduling shall be considered as included in the contract unit or lump sum bid prices for the various items of the contract to which it relates.

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

1.1 SUBMITTAL PROCEDURES

A. Wherever Submittals are required by the Contract Documents, transmit 5 copies of each Submittal to ENGINEER with a Submittal transmittal form which is acceptable to ENGINEER.

B. Sequentially number transmittal forms. Mark revised Submittals with original number and sequential alphabetic suffix, i.e., Submittal 1, Submittal 1.A, etc.

C. Identify Project, Contractor, subcontractor and/or supplier; pertinent drawing and detail number, and Specification section number, appropriate to Submittal.

D. CONTRACTOR shall review Submittals prior to submission to ENGINEER. Apply Contractor's stamp, signed and dated, certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with requirements of the Work and Contract Documents. Identify any deviations from the Contract Documents on the Submittal transmittal form.

E. Schedule Submittals to expedite Project, and deliver to ENGINEER at their business address. Coordinate submission of related items.

F. Submittals shall be submitted sufficiently in advance to allow ENGINEER not less than ten regular working days for examining the drawings. These drawings shall be accurate, distinct, and complete and shall contain all required information, including satisfactory identification of items and unit assemblies in relation to the contract drawings and/or specifications.

G. Identify variations from Contract Documents and product or system limitations which may adversely affect successful performance of completed Work.

H. If a Submittal is returned to CONTRACTOR marked “APPROVED”, or similar notification, formal revision and resubmission will not be required.

I. If a Submittal is returned marked “APPROVED – MAKE CORRECTIONS NOTED”, or similar notification, CONTRACTOR shall make the corrections on the Submittal, however, formal revision and resubmission will not be required.

J. Resubmittals

1. If a Submittal is returned marked “AMEND AND RESUBMIT”, or similar notification, CONTRACTOR shall revise the Submittal and resubmit the required number of copies.
2. Identify changes made since the previous submission.

K. Rejected Submittals

1. If a Submittal is returned marked “REJECTED – RESUBMIT”, or similar notification, it shall mean either that the proposed material or product does not satisfy the

specification, the Submittal is so incomplete that is cannot be reviewed, or is a substitution request not submitted in accordance with Section 01 60 00 – Product Requirements.

2. CONTRACTOR shall prepare a new Submittal or submit a substitution request according to Section 01 60 00 – Product Requirements and shall submit the required number of copies.

L. Distribute copies of reviewed Submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.

M. Submittals not requested will not be recognized or processed.

N. Unless noted otherwise, corrections indicated on Submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as changes to the contract requirements.

O. Fabrication or purchase of an item may only commence after ENGINEER has reviewed the pertinent Submittals and returned copies to CONTRACTOR marked either “APPROVED” or “APPROVED – MAKE CORRECTIONS NOTED”.

P. ENGINEER's review of CONTRACTOR Submittals shall not relieve CONTRACTOR of the entire responsibility for the corrections of details and dimensions. CONTRACTOR shall assume all responsibility and risk for any misfits due to any errors in CONTRACTOR Submittals. CONTRACTOR shall be responsible for dimensions and quantities, coordinating with all trades, the design of adequate connections and details, and satisfactory and safe performance of the work.

1.2 CONSTRUCTION PROGRESS SCHEDULES

A. Submit initial schedules within 15 days after date of Owner-Contractor Agreement. After review comments on the initial schedule are received from ENGINEER and OWNER, CONTRACTOR shall resubmit required revised data within ten days.

B. Submit revised Progress Schedules with each Application for Payment.

C. Distribute copies of reviewed schedules to Project site file, subcontractors, suppliers, and other concerned parties. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.

D. Submit computer generated horizontal bar chart with separate line for each major portion of Work or operation, identifying first work day of each week.

E. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate early and late start, early and late finish, float dates, and duration.

F. Indicate estimated percentage of completion for each item of Work at each submission.

G. Submit separate schedule of submittal dates for shop drawings, product data, and samples.

1.3 PRODUCT DATA

A. Product Data: Submit to ENGINEER for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

B. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

C. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents described in Section 01 78 50 - Project Closeout.

1.4 SHOP DRAWINGS

A. Shop Drawings: Submit to ENGINEER for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

B. Fabrication of an item may be commenced only after ENGINEER has reviewed the pertinent submittals and returned copies to CONTRACTOR marked either "APPROVED", or "APPROVED - MAKE CORRECTIONS NOTED". Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as the basis of claims for extra work.

C. When required by individual specification sections, provide shop drawings signed and sealed by professional engineer responsible for designing components shown on shop drawings.

1. Include signed and sealed calculations to support design.
2. Submit drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.
3. Make revisions and provide additional information when required by authorities having jurisdiction.

D. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents described in Section 01 78 50 - Project Closeout.

1.5 SAMPLES

A. Whenever indicated in the Specifications or requested by ENGINEER, CONTRACTOR shall submit at least 1 sample of each item or material to ENGINEER for acceptance at no additional cost to OWNER.

B. Samples, as required herein, shall be submitted for acceptance prior to ordering such material for delivery to the jobsite, and shall be submitted in an orderly sequence so that dependent materials or equipment can be assembled and reviewed without causing delay in the Work.

C. Unless otherwise specified, all colors and textures of specified items will be selected by ENGINEER from the manufacturer's standard colors and standard materials, products, or equipment lines.

1.6 CERTIFICATES

A. When specified in individual Specification sections, submit certification by manufacturer, installation/application subcontractor, or CONTRACTOR to ENGINEER, in quantities specified for Product Data.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or Product, but must be acceptable to ENGINEER.

1.7 MANUFACTURER'S INSTRUCTIONS

A. When specified in individual Specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to ENGINEER for delivery to Owner in quantities specified for Product Data.

B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.8 MANUFACTURER'S FIELD REPORTS

A. When required in individual sections, have Manufacturer or Supplier provide qualified representative to observe field conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance of equipment as applicable and to make written report of observations and recommendations to ENGINEER.

1.9 OPERATIONS AND MAINTENANCE MANUAL SUBMITTAL

A. CONTRACTOR shall furnish to ENGINEER five (5) identical sets of Operations and Maintenance Manuals. Each set shall consist of one or more volumes, each of which shall be bound in a standard size, 3-ring, loose-leaf, vinyl, hard-cover binder suitable for bookshelf storage. Binder ring size shall not exceed 2.5 inches. A Table of Contents shall be provided which indicates all equipment and suppliers in the Operations and Maintenance Manuals.

B. CONTRACTOR shall also furnish ENGINEER one copy of the Operations and Maintenance Manuals in PDF electronic format.

C. CONTRACTOR shall include in the Operations and Maintenance manuals full details for care and maintenance for all visible surfaces as well as the following for each item of mechanical, electrical, and instrumentation equipment (except for equipment furnished by the Owner):

1. Complete operating instructions, including location of controls, special tools or other equipment required, related instrumentation, and other equipment needed for operation.

2. Preventative maintenance procedures and schedules
3. A description of proper maintenance activities
4. Complete parts lists, by generic title, identification number, and catalog number, complete with exploded views of each assembly.
5. Disassembly and reassembly instruction
6. Name and location of nearest supplier and spare parts warehouse
7. Name and location of manufacturer
8. Recommended troubleshooting and start-up procedures
9. Prints of the record drawings, including diagrams and schematics, as required under the electrical and instrumentation portions of these specifications.

D. All Operations and Maintenance manuals shall be submitted in final form to ENGINEER not later than the 75 percent of construction completion date. All discrepancies found by ENGINEER in the Operations and Maintenance manuals shall be corrected by CONTRACTOR prior to final acceptance of the project.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION –

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SECTION 01 41 00
PERMITS

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section is to furnish the known list of required permits, and several of the requirements of these permits, for the Work under the Contract Documents. CONTRACTOR should note that the list is not necessarily complete and that additional permit requirements may exist or arise.

1.2 GENERAL

A. During the Bid period, CONTRACTOR shall review all permits and the requirements of all permits and shall comply with said requirements wherever said permit compliance work has not been performed by OWNER or others, or has not been agreed to be performed in the Contract documents.

B. During the bid period, permits and the conditions of permits will be available for review at the office of OWNER.

C. CONTRACTOR shall obtain all permits required for the execution of the Work that have not been obtained by OWNER, as indicated in this Section. Submit copies of all CONTRACTOR obtained permits to the Owner/Engineer and keep a copy of each onsite. Comply with the conditions of all Owner and Contractor obtained permits.

D. Include in the Bid the cost of obtaining all necessary permits, including application fees and other costs, and the costs of complying with the conditions of all permits, including the conditions of permits obtained by OWNER which have not already been done by OWNER. Any permit fees listed in this Section are estimates and for Contractor's information only. CONTRACTOR shall verify and pay all actual fees.

E. Completeness of the list of Contractor obtained permits is not guaranteed. The absence of information does not relieve CONTRACTOR of responsibility for determining and verifying the extent of permits required, of obtaining such permits, and complying with the conditions of each permit. Some permit applications, and conditions have been obtained during design and are provided in this Section for Contractor convenience. OWNER does not guarantee the accuracy of the permit applications, requirements, and/or fees.

1.3 SUMMARY OF PERMITS OBTAINED BY OWNER

A. The following permits or licenses have been, or shall be, obtained by OWNER for this Project. Copies of the permits and their requirements are available at Owner's offices. No additional compensation or Contract Extensions shall be granted to Contractor because of delays by Owner to obtain any permit unless CONTRACTOR is unable to proceed and complete the Work because of such delays as demonstrated by CONTRACTOR's approved Project schedule.

1. Plan Approval from the Utah Division of Drinking Water.

1.4 SUMMARY OF PERMITS TO BE OBTAINED BY CONTRACTOR

A. The following permits shall be obtained and paid for by Contractor.

1. Fruit Heights City.
   a. $60 Excavation Permit
   b. $65 Plan Review Fee
   c. $700 Building Permit.
   d. Construction Water Supply Permit: As needed to secure a treated water supply at the Contractor's trailer OR staging area.
2. Utah Division of Water Quality: Construction Activity Stormwater Permit.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

- END OF SECTION -

SECTION 01 42 13
ABBREVIATIONS

PART 1 GENERAL

1.1 DESCRIPTION

A. Wherever in these Specifications references are made to the standards, specifications, or other published data of the various national, regional, or local organizations, such organizations may be referred to by their acronym or abbreviation only. As a guide to the user of these Specifications, the following acronyms or abbreviations which may appear in these Specifications shall have the meanings indicated herein.

B. See Drawings Sheet G-3 for other Abbreviations.

C. Abbreviations and acronyms not included in below list are per ASME Y 1.1.

1.2 ABBREVIATIONS AND ACRONYMS

AASHTO	American Association of the State Highway and Transportation Officials
ABMA	American Bearing Manufacturers Association (formerly AFBMA)
ACI	American Concrete Institute
AGA	American Gas Association
AGC	American General Contractors
AI	The Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American Nation Standards Institute, Inc.
APA	American Plywood Association
API	American Petroleum Institute
APWA	American Public Works Association
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASOC	American Society of Quality Control
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
AWPB	American Wood Preservers Bureau
BBC	Basic Building Code, Building Officials and Code Administrators International
CGA	Compressed Gas Association
CLFMI	Chain Link Fence Manufacturer's Institute
CMA	Concrete Masonry Association
CRSI	Concrete Reinforcing Steel Institute
CWI	Certified Welding Inspector
DIP	Ductile Iron Pipe
DIPRA	Ductile Iron Pipe Research Association
DWQ	Department of Water Quality

DWR	Drinking Water Regulations
ECTC	Erosion Control Technology Council
EIA	Electronic Industries Association
EPA	Environmental Protection Agency
ETC	Electrical Test Laboratories
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FM	Factory Mutual System
HI	Hydraulic Institute
IBC	International Building Code
ICBO	International Conference of Building Officials
ICC	International Code Council
ICC-ES	International Code Council Evaluation Service
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IFC	International Fire Code
IMC	International Mechanical Code
IPC	International Plumbing Code
ISA	Instrument Society of America
ISO	International Organization of Standardization
ITE	Institute of Traffic Engineers
LPI	Lightning Protection Institute
MBMA	Metal Building Manufacturer's Association
MSS	Manufacturers Standardization Society
NAAMM	National Association of Architectural Metal Manufacturers
NACE	National Association of Corrosion Engineers
NBS	National Bureau of Standards
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
NISO	National Information Standards Organization
NSF	NSF International (formerly National Sanitation Foundation)
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PVC	Polyvinyl Chloride Pipe
RJ	Restrained Joint Piping
RMA	Rubber Manufacturers Association
RWMA	Resistance Welder Manufacturer's Association
SAE	Society of Automotive Engineers
SSPC	Society for Protective Coating (formerly Steel Structure Painting Council)
SSPWC	Standard Specification for Public Works Construction
TB	Thrust Block
TPI	Truss Plate Institute
UDOT	Utah Department of Transportation
UBC	Uniform Building Code
UL	Underwriters Laboratories, Inc.
UNO	Unless Noted Otherwise
WCRSI	Western Concrete Reinforcing Steel Institute
WI	Woodwork Institute

WRI	Wire Reinforcements Institute, Inc.
WSP	Welded Steel Pipe
WWPA	Western Wood Products Association

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION –

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SECTION 01 42 19
REFERENCE STANDARDS

PART 1 GENERAL

1.1 QUALITY ASSURANCE

A. TITLES OF SECTIONS AND PARAGRAPHS. Captions accompanying Specifications sections and paragraphs are for convenience of reference only, and do not form a part of the Specification.

B. APPLICABLE PUBLICATIONS. Whenever in these Specifications references are made to published specifications, codes, standards, or other requirements, it shall be understood that wherever no date is specified, only the latest specifications, standards or requirements of the respective issuing agencies which have been published as of the date that the work is advertised for bids, shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth herein or shown on the drawings shall be waived because of any provision of, or omission from, said standards or requirements.

C. SPECIALISTS, ASSIGNMENTS. In certain instances, specifications test requires (or implies) that specific work is to be assigned to specialists or expert entities, who must be engaged for the performance of that work. Such assignments shall be recognized as special requirements and shall not be interpreted so as to conflict with the enforcement of building codes and similar regulations governing the work; also, they are not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of work is recognized as "expert" for the indicated construction processes or operations. Nevertheless, the final responsibility for fulfillment of the entire set of contract requirements remains with CONTRACTOR.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of the Specifications, all Work specified herein shall conform to or exceed the requirements of all applicable codes and the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of these Specifications nor the applicable codes.

B. Reference herein to "Building Code" or “Uniform Building Code” shall mean the International Building Code of the International Code Council. The latest edition of the code as approved and used by the local agency as of the date of award, as adopted by the agency having jurisdiction, shall apply to the Work herein, including all addenda, modifications, amendments, or other lawful changes thereto.

C. In case of conflict between codes, reference standards, drawings and the other Contract Document, the most stringent requirements shall govern. All conflicts shall be brought to the attention of ENGINEER for clarification and directions prior to ordering or providing any materials or labor. CONTRACTOR shall bid the most stringent requirements.

D. APPLICABLE STANDARD SPECIFICATIONS. CONTRACTOR shall construct the Work specified herein in accordance with the requirements of the Contract Documents

and the referenced portions of those referenced codes, standards, and Specifications listed herein; except, that wherever references to "Standard Specifications" are made, the provisions therein for measurement and payment shall not apply.

E. References in the Contract Documents to "Standard Specifications" shall mean the Contract Documents including all current supplements, addenda, and revisions thereof.

F. References herein to "OSHA Regulations for Construction" shall mean Title 29, Part 1926, Construction Safety and Health Regulations, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

G. References herein to "OSHA Standards" shall mean Title 29, Part 1910, Occupational Safety and Health Standards, Code of Federal Regulations (OSHA), including changes and amendments thereto.

H. UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY. Wells, tanks, pumping stations and culinary water pipelines shall conform to the requirements of Utah Administrative Code Rule R 309. Water and sewer pipeline installation shall conform to the requirements of Utah Administrative Code Rule R 317-3-2.9 “Protection of Water Supplies” for horizontal and vertical separation.

I. UTAH DEPARTMENT OF TRANSPORTATION (UDOT) REQUIREMENTS. CONTRACTOR's work on UDOT property or right-of-way shall conform to UDOT’s latest edition of Standard Specifications For Road and Bridge Construction.

J. U.S. ARMY CORPS OF ENGINEERS (COE) REQUIREMENTS. CONTRACTOR's work shall conform to COE Specifications in accordance with Section 404 of the Clean Water Act for excavation in wetlands.

K. Reference herein to APWA shall mean the latest edition of the “Manual of Standard Specifications” and “Manual of Standard Plans” as prepared by the American Public Works Association and the Associated General Contractors of America.

L. All provisions of the Manual of Standard Specifications, Latest Edition and Manual of Standard Plans, Latest Edition both published by the Utah Chapter of the American Public Works Association are hereby made a part of the Contract Documents by reference. The publications may be purchased separately from the Utah Technology Transfer Center, Utah State University, 4111 Old Main Hill, Logan, UT 84322-4111. Any conflicts, between the technical specifications, drawings, and other provisions or documents contained in the Contract Form or Contract Documents versus provisions contained in the Manual of Standard Specifications, Latest Edition and Manual of Standard Plans, Latest Edition published by the Utah Chapter of the American Public Works Association, shall be resolved in favor of the technical specifications, drawing, and provisions contained in the Contract form or Contract Documents.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

SECTION 01 45 00
QUALITY CONTROL AND MATERIALS TESTING

PART 1 GENERAL

1.1 SUMMARY

A. This Section outlines responsibilities for controlling quality of materials, products and workmanship.

1.2 MATERIALS

A. All materials incorporated in the project shall be new and shall fully comply with the Specifications. Unless otherwise clearly provided in the Specifications, all workmanship, equipment, materials, and articles incorporated in the Work covered by the Contract are to be of the best available grade of their respective kinds. Whenever, in the specifications, any material, article, device, product, fixture, form, type of construction, or process indicated or specified by patent or proprietary name, by name of manufacturer, or by catalog number, such specifications shall be deemed to be used for the purpose of establishing a standard of quality and facilitating the description of the material or process desired and shall be deemed to be followed by the words "or approved equal" and CONTRACTOR may in such case, upon receiving ENGINEER's approval, purchase and use any item, type, or process which shall be substantially equal in every respect to that indicated or specified.

B. Materials and equipment may be used in the Work based upon receipt of a Supplier's certificate of compliance. Certificate must be in possession of CONTRACTOR and reviewed by ENGINEER prior to use.

C. Quality Assurance Testing by OWNER and/or ENGINEER shall not relieve CONTRACTOR of responsibility to furnish materials and work in full compliance with Contract Documents.

1.3 MANUFACTURER'S INSTRUCTIONS

A. Should instructions conflict with Contract Documents, request clarification before proceeding.

B. When required in individual sections, submit manufacturer's instructions in the quantity required for product data, delivery, handling, storage, assembly, installation, start-up, adjusting, balancing, and finishing, as appropriate.

1.4 WORKMANSHIP

A. Maintain performance control and supervision over Subcontractors, Suppliers, manufacturers, products, services, workmanship, and site conditions, to produce work in accordance with Contract Documents.

B. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.

C. Provide suitable qualified personnel to produce specified quality.

D. Ensure finishes match approved samples.

1.5 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. When manufacturers' tolerances conflict with Contract Documents, request clarification from ENGINEER before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.6 TESTING AND INSPECTION SERVICES

A. Testing agency and testing for quality control and material testing shall be furnished by CONTRACTOR as part of the project. Results of testing shall be reported to CONTRACTOR and ENGINEER on site. Reports of the testing shall be transmitted directly to ENGINEER.

B. Materials to be supplied under this contract will be tested and/or inspected either at their place of origin or at the site of the work by the testing agency. CONTRACTOR shall give ENGINEER written notification well in advance of actual readiness of materials to be tested and/or inspected at point of origin so ENGINEER may witness testing by the testing agency. Satisfactory tests and inspections at the point of origin shall not be construed as a final acceptance of the material nor shall it preclude retesting or reinspection at the site of the work.

C. CONTRACTOR shall furnish such samples of materials as are requested by the ENGINEER, without charge. No material shall be used until reports from the testing agency have been reviewed and accepted by ENGINEER. See Section 01 33 00 - Submittal Procedures.

1.7 UNSATISFACTORY CONDITIONS

A. Examine areas and conditions under which materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to installer.

1.8 AUTHORITY AND DUTIES OF PROJECT REPRESENTATIVE

A. Refer to Section 00 73 00 "Supplementary Conditions" sub-section SC 10.03 "Resident Project Representative".

1.9 QUALITY CONTROL TESTING

A. ENGINEER’s failure to detect any defective Work or materials does not prevent later rejection when such defect is discovered nor does it obligate ENGINEER for acceptance.

B. CONTRACTOR shall provide 24-hours minimum notice to ENGINEER for all testing required by these specifications so ENGINEER may coordinate or be present during testing.

1.10 TESTING ACCEPTANCE AND FREQUENCY

A. Minimum Quality Control Testing Frequency: As defined in Table 01 45 00-1, CONTRACTOR shall be responsible to ensure that all testing is performed at the frequencies shown. CONTRACTOR shall uncover any work at no cost to OWNER to allow the testing agency to perform required testing at the frequency shown.

B. Acceptance of Defective Work: As defined in Article 14.04 of the General Conditions.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.

B. Verify existing substrate is capable of structural support or attachment of new Work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Verify utility services are available, of correct characteristics, and in correct locations.

3.2 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

TABLE 01 45 00-1: QUALITY CONTROL TESTING FREQUENCY

SYSTEM or MATERIAL	TESTS	MINIMUM REQUIRED FREQUENCY
SUBGRADE AND BACKFILL MATERIALS		
Section 31 23 15 Excavation and Backfill for Buried Pipelines	Field Density	1 test per 200 linear feet per 1.5 feet of backfill thickness placed.
	Laboratory	1 test for each material type which includes proctor, classification, and gradation.
Section 31 23 23 Excavation and Backfill for Structures	Field Density	1 test per 2000 square feet per 1.5 feet of backfill thickness placed within 20 feet of pump station building. At least one test per 1.5 feet of backfill thickness under pump station.
	Laboratory	1 test for each material type which includes proctor, classification, and gradation.
Section 32 11 23 Road Base - Untreated Base Course	Field Density	Base course subgrade: 1 test per 2,000 square feet of area. Base course: 1 test per 2,000 square feet of area.
	Laboratory	Base course: 1 test for each material type which includes proctor, classification, and gradation.
ASPHALT		
Section 32 12 16 Hot-Mix Asphalt Concrete Paving	Mix Design	Marshall Test Method: 1 test initially per each type of material and each change in target, and for each day of production thereafter. Specific Gravity: 1 per each Marshall Test Extraction: 1 test per each Marshall Test
	Field Density	Bituminous surfaces: 1 test per 2,000 square feet placed or part thereof.
	Asphalt Thickness and Core Density	Bituminous surfaces: 1 test sample every 300 linear feet of completed roadway.
PORTLAND CEMENT CONCRETE		
Section 3 30 00 Cast-in-Place Concrete	Slump	1 test every day of placement (if less than 100 cubic yards in a day), 1 test for every 100 cubic yards, or 1 test for each 3,000 square feet of surface area for slabs and more frequently if batching appears inconsistent.
	Entrained air	1 test with slump test.
	Ambient and concrete temperatures	1 test with slump test.
	Water cement ratio.	to be verified and provided with batch tickets.

SYSTEM or MATERIAL	TESTS	MINIMUM REQUIRED FREQUENCY
	Compressive strength	1 set of 5 cylinders. 1 test every day of placement (if less than 100 cubic yards in a day), 1 test for every 100 cubic yards, or 1 test for each 3,000 square feet of surface area for slabs, and more frequently if batching appears inconsistent.

NOTES:

1 Additional tests shall be conducted when variations occur due to the contractor's operations, weather conditions, site conditions, etc.
2 Classification, moisture content, Atterberg limits and specific gravity tests shall be conducted for each compaction test if applicable.
3 Tests can substitute for same tests required under "Aggregates" (from bins or source), although gradations will be required when blending aggregates.
4 Aggregate moisture tests are to be conducted in conjunction with concrete strength tests for water/cement calculations.

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SECTION 01 45 23

TESTING AGENCY SERVICES

PART 1 GENERAL

1.1 SUMMARY

A. CONTRACTOR shall be responsible for providing Construction Quality Control Testing of all soils, concrete, etc. as required by the various sections of these Specifications. This section includes the following:

1. Use of independent testing agency
2. Control testing report submittal requirements
3. Responsibilities of testing agency

1.2 RELATED WORK

A. Related work specified in other sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 01 22 00 Measurement and Payment

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publication is referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM D 3740 Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
2. ASTM D 4561 Standard Practice for Quality Control Systems for Organizations Producing and Applying Bituminous Paving Materials
3. ASTM E 329 Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

1.4 DEFINITIONS

A. Independent Testing Agency: A testing agency NOT owned by CONTRACTOR, and an agency that does not have any preferential affiliation or association with CONTRACTOR, or any of CONTRACTOR's Subcontractors and Suppliers other than entering into a contract with CONTRACTOR to perform the duties defined in these Specifications.

B. Professional Engineer: An engineer who complies with Utah licensing law and is acceptable to the authority having jurisdiction.

1.5 QUALITY ASSURANCE

A. CONTRACTOR shall employ and pay for services of an independent testing agency which complies with ASTM D 3740, ASTM D 4561, and ASTM E 329 to test materials for contract compliance.

1.6 CONTRACTOR SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures

B. If CONTRACTOR is employing and paying for an independent testing agency, prior to start of Work, submit testing agency's name, address, telephone number and the following:

1. Concrete Technician: Approved by ENGINEER or ACI certified.
2. Person charged with engineering managerial responsibility
3. Professional engineer on staff to review services
4. Level of certification of technicians

1.7 TESTING AGENCY SUBMITTALS

A. Field Test Report: Submit report no later than the end of the current day.

B. Laboratory Test Report: Submit original report within 48 hours after test results are determined.

C. Final Summary Report: Submit prior to final payment

D. On all reports include:

1. Project title, number and date of the report
2. Date, time and location of test
3. Name and address of material Supplier
4. Identification of product being tested and type of test performed
5. Identify whether test is initial test or retest
6. Results of testing and interpretation of results
7. Name of technician who performed the testing

1.8 RESPONSIBILITIES OF TESTING AGENCY

A. Calibrate testing equipment at least annually with devices with an accuracy traceable to either National Bureau of Standards or acceptable values of natural physical constraints.

B. Provide sufficient personnel at site and cooperate with CONTRACTOR, ENGINEER and OWNER's Representative in performance of testing service.

C. Secure samples using procedures specified in the applicable testing code.

D. Perform testing of products in accordance with applicable sections of the Contract Documents.

E. Immediately report any compliance or noncompliance of materials and mixes to CONTRACTOR, ENGINEER, and OWNER's Representative.

F. When an out-of-tolerance condition exists, perform additional inspections and testing until the specified tolerance is attained, and identify retesting on test reports.

1.9 LIMITS ON TESTING AGENCY AUTHORITY

A. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.

B. Agency may not suspend Work.

C. Agency has no authority to accept Work for OWNER.

1.10 MEASUREMENT AND PAYMENT

A. Testing agency services shall be measured or paid as provided in Section 01 22 00-Measurement and Payment.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

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SECTION 01 50 00
TEMPORARY CONSTRUCTION UTILITIES AND ENVIRONMENTAL CONTROLS

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers temporary utilities, including electricity, lighting, telephone service, water, and sanitary facilities; temporary controls, including barriers, protection of work, and water control; and construction facilities, including parking, progress cleaning, and temporary buildings.

1.2 TEMPORARY UTILITIES

A. Temporary Electricity: CONTRACTOR shall provide, maintain, and pay for all power required by CONTRACTOR, including electrical service to CONTRACTORS field office.

B. Temporary Lighting: CONTRACTOR shall provide all temporary lighting required for execution of his work and for employee and public safety. As a minimum, lighting levels during working hours shall meet the requirements of OSHA Subsection 1926.56 illumination.

C. Temporary Heating and Cooling

1. Provide heating and cooling devices as needed to maintain specified conditions for construction operations.

D. Temporary Ventilation

1. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

E. Telephone Service: CONTRACTOR shall provide, maintain and pay for telephone service to the field office at time of project mobilization.

F. Temporary Water Service

1. CONTRACTOR shall provide for all his workers on the project, adequate and reasonably convenient uncontaminated drinking water supply. All facilities shall comply with the regulations of the local and State Departments of Health.
2. CONTRACTOR shall be responsible to arrange for water, both potable and non-potable water.
3. When water is taken from a city water system or any other potable water supply source for construction purposes, suitable precautions shall be taken to prevent cross connections and contamination of water supply.

G. Temporary Sanitary Facilities: CONTRACTOR shall provide and maintain sanitary facilities for his employees and his subcontractors' employees that will comply with the regulations of the local and State Departments of Health.

1.3 TEMPORARY CONTROLS

A. Barriers: Provide barriers as necessary to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

B. Project Security

1. CONTRACTOR shall make all necessary provisions to protect the project and CONTRACTOR's facilities from fire, theft, and vandalism, and the public from unnecessary exposure to injury.
2. Entry Control:
   a. Restrict entrance of persons and vehicles into Project site.
   b. Allow entrance only to authorized persons.

C. Dust Control: Execute Work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into the atmosphere. Give all unpaved streets, roads, detours, or haul roads used in the construction area an approved dust-preventive treatment or periodically water to prevent dust. Applicable environmental regulations for dust prevention shall be strictly enforced.

D. Pest Control: Provide methods, means, and facilities to prevent rodents, pests and insects from damaging the Work.

E. Pollution Control: Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations. All chemicals used during construction or furnished for project operation whether defoliant, soil sterilant, herbicide, pesticide, disinfectant, polymer, reactant or of other classification, shall show approval of the U.S. Department of Agriculture. Use of all such chemicals and disposal of residues shall be in strict accordance with the printed instruction of the manufacturer.

F. Protection of Work: CONTRACTOR shall protect installed work and provide special protection where specified in individual specifications sections. CONTRACTOR shall provide temporary and removable protection for installed products, and shall control activity in immediate work area to minimize damage.

G. Open Burning: No open burning of waste materials will be allowed.

H. Explosives and Blasting: The use of explosives on the work will not be permitted.

I. Noise Abatement: In inhabited areas, particularly residential, operations shall be performed in a manner to minimize unnecessary noise generation.

J. STORM AND GROUND WATER

1. CONTRACTOR shall provide and maintain at all times during construction, ample means and devices with which to promptly remove and properly dispose of all water entering the excavation or other parts of the work, whether the water be from surface or underground water sources.

2. In excavation, fill, and grading operations, care shall be taken to disturb the pre-existing drainage pattern as little as possible. Particular care shall be taken not to direct drainage water into private property or into streets or drainage ways inadequate for the increased flow.
3. CONTRACTOR shall maintain effective means to minimize the quantity of sediments leaving the work area either by storm water or CONTRACTOR's own dewatering operations. CONTRACTOR shall be responsible for obtaining required permits and complying with all City, State, and Federal storm water management regulations and requirements, including preparing and implementing a Storm Water Pollution Prevention Plan (SWPPP) for Construction Activities. If required, CONTRACTOR shall submit a copy of the Notice of Intent and the SWPPP to the OWNER for review and approval.

1.4 CONSTRUCTION FACILITIES

A. VEHICULAR ACCESS

1. Construct temporary access roads from public thoroughfares to serve construction area, of width and load bearing capacity to accommodate unimpeded traffic for construction purposes.
2. Extend and relocate vehicular access as Work progress requires, provide detours as necessary for unimpeded traffic flow.
3. Location of temporary access roads and detours shall be approved by ENGINEER.
4. Provide unimpeded access for emergency vehicles.
5. Provide and maintain access to fire hydrants and control valves free of obstructions.
6. Provide means of removing mud from vehicle wheels before entering streets.
7. When possible, use existing on-site roads for construction traffic.

B. Parking: CONTRACTOR shall provide temporary parking areas to accommodate use of construction personnel. Parking shall be located in an area approved by ENGINEER.

C. Progress Cleaning

1. CONTRACTOR shall maintain areas free of waste materials, debris, and rubbish. Maintain the site in a clean and orderly condition. Upon completion of work, repair all damage caused by equipment and leave the project site free of rubbish or excess materials of any kind.
2. Thoroughly clean all spilled dirt, gravel, or other foreign materials caused by the construction operations from all streets and roads at the conclusion of each day's operation.
3. It shall be the responsibility of CONTRACTOR to promptly clean up and remove any oil and/or fuel spills caused by CONTRACTOR or his Sub-contractors during the course of the project. Contaminated soil shall be properly disposed of by CONTRACTOR in accordance with all applicable laws. CONTRACTOR shall be responsible for any damages to OWNER resulting from CONTRACTOR's negligence in promptly cleaning up said spills.

1.5 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Prior to Final Application for Payment, CONTRACTOR shall remove temporary above grade or buried utilities, equipment, facilities, and materials; clean and repair damage

caused by installation or use of temporary work; and restore existing facilities used during construction to original condition.

1.6 CULTURAL RESOURCES

A. CONTRACTOR's attention is directed to the National Historic Preservation Act of 1966 (16 U.S.C. 470) and 36 CFR 800 which provides for the preservation of potential historical architectural, archeological, or cultural resources (hereinafter called "cultural resources").

B. CONTRACTOR shall conform to the applicable requirements of the National Historic Preservation Act of 1966 as it relates to the preservation of cultural resources.

C. If a suspected or unsuspected historical, archaeological, or paleontological item, feature, or site or other cultural resource is encountered during subsurface excavations at the site of construction, the following procedures shall be instituted:

1. Construction operations shall be immediately stopped in the vicinity of the discovery and ENGINEER and OWNER shall be notified of the nature and exact location of the finding. CONTRACTOR shall not damage the discovered objects and shall provide written confirmation of the discovery to ENGINEER within two (2) calendar days.
2. OWNER and ENGINEER will then immediately notify the State Historical Preservation Office (SHPO) and the Utah Geological Survey (UGS).
3. SHPO and UGS will investigate the finding and determine if the resource requires protection and the disposition of the said resource.

D. If SHPO and UGS determine that the potential find is a bona fide cultural resource, CONTRACTOR shall suspend work at the location of the find under the provisions for changes contained in Articles 11, 12, and 13 of the General Conditions, Section 00 70 00 – General Conditions.

PART 2 PRODUCTS

2.1 TEMPORARY EROSION CONTROL MATERIALS

A. EROSION CONTROL BLANKETS

1. Erosion control blankets shall meet the requirements of the Erosion Control Technology Council (ECTC) and the FHWA Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, FP-03 Section 713.17 as a Type 3.B Extended Term Double Net Erosion Control Blanket. The erosion control blanket shall be fabricated from UV-stabilized polypropylene and a straw/coconut blend. The blanket shall be **Model SC150 by Tensar North American Green, Excel CS-3 by Western Excelsior**, or approved equal. The functional longevity shall be 24 months minimum.

B. SILT FENCE

1. Use woven fabric meeting the following properties.

Table 1 - Silt Fence Geotextile			
Property	**ASTM**	**MARV's**	
		Standard	**High Performance**
Grab Tensile Strength, lbs.	D 4632	90[(a)]	120[(a)]
Grab Elongation, %	D 4632	< 40	< 40
Flux, gal/min/ft^2	D 4491	15	90
Apparent Opening Size, (AOS-US sieve)	D 4751	> 20	> 30
Ultraviolet Degradation, %	D 4355	70	90
NOTES (a) Percent of tensile strength retained determined after weathering per ASTM D 4355 for 500-hours			

2. High performance fence to have tape yarns in one principle direction only.
3. Add stabilizers or inhibitors to make the filaments resistant to sunlight or heat deterioration.
4. Finish edges to prevent outer yarn from pulling away from the fabric.
5. Sheets of fabric may be sewn or bonded together. Provide minimum width recommended by manufacturer.
6. No deviation from any requirement in Table 2 due to the presence of seams.
7. Manufactured with pockets for posts, hems with cord, or with posts pre-attached using staples or button head nails.

C. POSTS

1. Minimum length: 4-feet.
2. Steel: Round, U shaped, T shaped, or C shaped with a minimum weight of 1.3-pounds per foot, and have projections for fastening wire.
3. Wood as follows:
   a. Soft wood posts at least 3-inches in diameter, or nominal 2 x 4-inches and straight to provide a fence without noticeable misalignment.
   b. Hard wood post providing a minimum cross-sectional area of 2.25 square-inches.
4. Fasteners for Wooden Posts:
   a. Wire staples No. 17 gage minimum with a crown at least 3/4-inches wide and legs at least 1/2-inch long.
   b. Nails 14 gage minimum, 1-inch long with 3/4-inch button.

PART 3 EXECUTION

3.1 SILT FENCE

A. Beginning work means acceptance of existing conditions.

B. Maintain the silt fence until revegetation is complete (defined as when cover reaches a density of at least 70% of pre-disturbance levels.

C. Clear area of any debris and obstructions that may damage geotextile.

D. Place post in all low points.

E. Install posts a maximum of 8-feet apart with at least 18-inches in the ground. If not possible to achieve depth, secure posts to prevent overturning.

F. Attach filter fabric by wire, cord, pockets, staples, nails, or other effective means.

1. When using a wire support fence, provide at least 6 horizontal wires with a minimum of 12 gage wire. Space vertical wires 6-inches maximum. Secure geotextile to the up slope side of the post. Extend wire into the trench a minimum of 2-inches and extend a maximum or 36-inches above the ground surface.

G. Install fabric so 6 to 8-inches of fabric remain at the bottom to be buried. Splice together only at support posts with at least a minimum overlap of 18-inches. Extend buried portion 6-inches deep and the rest upstream of the fabric fence.

H. Sediment Removal: Remove sediment before deposit reaches 1/2 of the height of the silt fence or raise the height of silt fence. After removal of sediment, dress landscape.

I. Schedule of Locations: Typical locations include the toe of fill slopes, the downhill side of fill slopes, the downhill side of large cut areas, and at natural drainage areas. Limit geotextile materials to handle an area equivalent to 1,000 square feet per 10-feet of fence. Use caution should site slope be steeper than 1:1 (horizontal:vertical), and water flow rates exceed 1 cubic foot per second per 10-feet of fence face.

- END OF SECTION –

SECTION 01 50 30
PROTECTION OF EXISTING FACILITIES

PART 1 GENERAL

1.1 DESCRIPTION

A. Any existing facilities, disturbed which are located in or adjacent to the line of work such as curbs, gutters, drive approaches, sidewalks, driveways, fences, underground pipes, conduits, or utilities, shall be cleaned up and restored in kind by CONTRACTOR and in accordance with the Specifications contained herein governing the various types of services involved.

B. CONTRACTOR shall not perform work that would affect any oil, gas, sewer, or water pipeline; any telephone, fiber optic, television cable, or electric transmission line; any fence; or any structure, until authorization has been obtained from owner of the improvement. Provide owner of the improvement due notice of the beginning of the work, and remove, shore, support, or otherwise protect such improvement or replace the same.

1.2 RELATED WORK

A. Related work specified in other sections includes, but is not limited to:

Section 01 78 50 Project Closeout

1.3 RESTORATION OF FENCES

A. Where it is necessary to remove any fence to facilitate CONTRACTOR's operation, CONTRACTOR shall obtain prior agreement with owner of the fence for removal of the fence and shall be responsible for any damage due to negligence of CONTRACTOR. As soon as practical, the fence shall be restored substantially to the same or improved condition as it was prior to the commencement of the work. Where livestock is present CONTRACTOR shall provide temporary fencing to keep livestock away from the construction area.

1.4 UNDERGROUND SERVICE ALERT

A. Prior to any excavation in the vicinity of any existing underground facilities, including all water, sewer, storm drain, gas, petroleum products, or other pipelines; all buried electric power, communications, or television cables; all traffic signal and street lighting facilities; and all roadway and state highway rights-of-way, CONTRACTOR shall notify the regional notification center (Blue Stakes of Utah) at 1-800-662-4111 or 811 or submit an on-line request at www.bluestakes.org at least 2 days, but no more than 7 days, prior to such excavation.

1.5 INTERFERING STRUCTURES AND UTILITIES

A. CONTRACTOR shall exercise all possible caution to prevent damage to existing structures and utilities, whether above ground or underground. Prior to submittal of Shop Drawings, and prior to commencing any excavations for new pipelines or structures, conduct investigations, including exploratory excavations and borings, to

determine the location and type of underground utilities and services connections that could result in damage to such utilities. It shall be the responsibility of CONTRACTOR to locate and expose all existing underground and overhead structures and utilities in such a manner as to prevent damage to same. CONTRACTOR shall notify all utility offices concerned at least 48 hours in advance of construction operations in which a utility agency's facilities may be involved. This shall include, but not be limited to, irrigation water, culinary water, telephone, television cables, fiber optic communication, gas, and electric. CONTRACTOR shall be responsible for any and all changes to, reconnections to public utility facilities encountered or interrupted during prosecution of the work, and all costs relating hereto shall be at CONTRACTOR's expense. CONTRACTOR shall contract with and pay Public Utility Agencies for work required in connection with all utility interferences and handle all necessary notifications, scheduling, coordination, and details. The cost of public utility interferences shall be included in CONTRACTOR's lump sum or unit price bid covering the major contract facility to which interference or changes are attributable.

B. All exploratory excavations shall be performed as soon as practicable after Notice to Proceed and, in any event, a sufficient time in advance of the construction to avoid possible delays to CONTRACTOR's progress. Prepare a report identifying each utility by its size, elevation, station and material of construction. Immediately notify ENGINEER and the utility in writing as to any utility discovered in a different position than as marked in the field or shown on the Drawings, or any utility which is not marked in the field or not shown on the Drawings.

C. The number of exploratory excavations required shall be that number which is sufficient to determine the alignment and grade of the utility. Conform to local agency requirements for backfill and pavement repair subsequent to performing exploratory excavations.

D. Any damages to private property, either inside or outside the limits of the easements provided by OWNER, shall be the responsibility of CONTRACTOR. Any roads, structures, or utilities damaged by the work shall be repaired or replaced in a condition equal to or better than the condition prior to the damage. Such repair or replacement shall be accomplished at CONTRACTOR's expense without additional compensation from OWNER.

E. CONTRACTOR shall remove and replace small miscellaneous structures such as fences and culverts which are damaged by the construction activity at his own expense without additional compensation from OWNER. CONTRACTOR shall replace these structures in a condition as good as or better than their original condition.

F. At points where CONTRACTOR's operations are adjacent to or across properties of railway, telegraph, telephone, irrigation canal, power, gas, water, or adjacent to other property (damage to which might result in considerable expense, loss, and inconvenience), no work shall be started until all arrangements necessary for the protection thereof have been made.

G. The locations of the major existing culinary water lines, gas pipes, underground electric, cable television, and telephone lines that are shown on the plans were taken from city maps, and maps supplied by the utility owner. No excavations were made to verify the locations shown for underground utilities, unless specifically stated on the Drawings. It should be expected that some location discrepancies will occur. Neither OWNER nor its

officers or agents shall be responsible for damages to CONTRACTOR as a result of the locations of the utilities being other than those shown on the plans or for the existence of utilities not shown on the plans.

H. CONTRACTOR shall be solely and directly responsible to owners and operators of such properties for any damage, injury, expense, loss or inconvenience, delay, suits, actions, or claims of any character brought because of an injury or damage which may result from the carrying out of the work to be done under the contract.

I. All utilities including all water, sewer, storm drain, gas, petroleum products, or other pipelines; all buried electric power, communications, or television cables; all traffic signal and street lighting facilities encountered along the line of the work shall remain continuously in service during all operations under the Contract, unless other arrangements satisfactory to ENGINEER are made with owner of said utility.

J. In the event of interruption to either domestic or irrigation water, or to other utility services as a result of accidental breakage, or as a result of being exposed or unsupported, CONTRACTOR shall promptly notify the proper authority. CONTRACTOR shall cooperate with the authority in restoration of service as soon as possible, and shall not allow interruption of any water or utility service outside working hours unless prior approval is received.

K. In case it shall be necessary to move the property of any public utility or franchise holder, such utility company or franchise holder will, upon request of CONTRACTOR, be notified by OWNER to move such property within a specified reasonable time. When utility lines that are to be moved are encountered within the area of operations, CONTRACTOR shall notify ENGINEER a sufficient time in advance for the necessary measures to be taken to prevent interruption of service.

L. Where the proper completion of the WORK requires the temporary or permanent removal and/or relocation of an existing Utility or other improvement which is indicated, CONTRACTOR shall remove and, without unnecessary delay, temporarily replace or relocate such Utility or improvement in a manner satisfactory to ENGINEER and OWNER of the facility. In all cases of such temporary removal or relocation, restoration to the former location shall be accomplished by CONTRACTOR in a manner that will restore or replace the Utility or improvement as nearly as possible to its former locations and to as good or better condition than found prior to removal.

1.6 RIGHTS-OF-WAY

A. CONTRACTOR shall be required to confine construction operations within the dedicated rights-of-way for public thorough fares, or within areas for which construction easements have been obtained, unless they have made special arrangements with the affected property owners in advance. CONTRACTOR shall be required to protect stored materials, cultivated trees and crops, and other items adjacent to the proposed construction site.

B. CONTRACTOR shall submit for approval by ENGINEER the type and size of equipment used, and the methods for work performed on the rights-of-way across private properties, to avoid or minimize injury to trees, shrubs, gardens, lawns, fences, driveways, retaining walls, or other improvements within the rights-of-way.

C. The construction easement widths and access to private properties are as shown on the Drawings and as described in the easement documents; however CONTRACTOR is to minimize impacts to surface improvements within the right-of-way. CONTRACTOR shall obtain a signed release from the property owner, approving restoration of work in the construction easements across or bordering private properties. See Project Closeout Section 01 78 50, 1.4.D.

D. Property owners affected by the construction shall be notified by CONTRACTOR at least 48 hours in advance of the time the construction begins. During all construction operations, CONTRACTOR shall construct and maintain such facilities as may be required to provide access by all property owners to their property. No person shall be cut off from access to his property for a period exceeding 8 hours unless CONTRACTOR has made special arrangements with the affected persons. CONTRACTOR shall, daily or more frequently if necessary, grade all disturbed areas to be smooth for motor vehicle traffic.

1.7 PROTECTION OF SURVEY, STREET OR ROADWAY MARKERS

A. CONTRACTOR shall not destroy, remove, or otherwise disturb any existing survey markers or other existing street or roadway markers without proper authorization. No pavement breaking or excavation shall be started until all survey or other permanent marker points that will be disturbed by the construction operations have been properly referenced. Survey markers or points disturbed by CONTRACTOR shall be accurately restored after street or roadway resurfacing has been completed.

1.8 TREES OR SHRUBS WITHIN PROJECT LIMITS

A. Except where trees or shrubs are indicated to be removed, CONTRACTOR shall exercise all necessary precautions so as not to damage or destroy any trees or shrubs, including those lying within street rights-of-way and project limits, and shall not trim or remove any trees unless such trees have been approved for trimming or removal by the jurisdictional agency or OWNER. Existing trees and shrubs which are damaged during construction shall be trimmed or replaced by CONTRACTOR or a certified tree company under permit from the jurisdictional agency and/or OWNER. Tree trimming and replacement shall be accomplished in accordance with the following paragraphs.

1. Symmetry of the tree shall be preserved; no stubs or splits or torn branches left; clean cuts shall be made close to the trunk or large branch. Spikes shall not be used for climbing live trees. Cuts over 1-1/2 inches in diameter shall be coated with a tree paint product that is waterproof, adhesive, and elastic, and free from kerosenes, coal tar, creosote, or other material injurious to the life of the tree.
2. CONTRACTOR shall immediately notify the jurisdictional agency and/or OWNER if any tree or shrub is damaged by CONTRACTOR's operations. If, in the opinion of said agency or OWNER, the damage is such that replacement is necessary, CONTRACTOR shall replace the tree or shrub at its own expense. The tree or shrub shall be of a like size and variety as the one damaged, or, if of a smaller size, CONTRACTOR shall pay to OWNER of said tree a compensatory payment acceptable to the tree or shrub owner, subject to the approval of the jurisdictional agency or OWNER. The size of the tree or shrub shall be not less than 1-inch diameter nor less than 6 feet in height.

1.9 RESTORATION OF PAVEMENT

A. Pavement work shall meet the specifications for installation as noted in APWA Section 33 12 16.

B. All paved areas damaged during construction shall be replaced with similar materials of equal thickness to match the existing adjacent undisturbed areas, except where specific resurfacing requirements have been called for in the Contract or in the requirements of the agency issuing the permit. The pavement restoration requirement to match existing sections shall apply to all components of existing sections, including sub-base, base, and pavement. Pavements which are subject to partial removal shall be neatly sawcut in straight lines.

C. Wherever required by the local agency having jurisdiction, CONTRACTOR shall place temporary surfacing promptly after backfilling and shall maintain such surfacing for the period of time fixed by said authorities before proceeding with the final restoration of improvements.

1.10 CONCRETE WORK

A. Concrete work shall meet the specifications for installation as noted in APWA Section 32 16 13 Driveway, Sidewalk, Curb and Gutter.

B. All flat work in streets tying into existing flatwork shall be doweled into the existing concrete. Dowels to be spaced at 12" O.C. and be No. 5 rebar x 14" for slabs up to 8 inches in thickness and No. 8 rebar x 18" for slabs over 8 inches.

1.11 LAWNS

A. Lawns that are damaged or destroyed during performance of the work shall be repaired or replaced with turf sod according to APWA Section 32 92 00 - Turf and Grass.

1.12 FENCES

A. Fences that are damaged or destroyed during performance of the work shall be repaired or replaced back to the original condition or better to the satisfaction of the land owner and OWNER.

1.13 LANDSCAPING

A. All landscaping on private property that is damaged or destroyed during performance of the work shall be repaired or replaced back to the original condition or better to the satisfaction of the land owner and OWNER.

1.14 OTHER SURFACE IMPROVEMENTS

A. All other surface improvements not explicitly mentioned herein that are damaged or destroyed during performance of the work shall be repaired or replaced back to original condition or better.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION –

SECTION 01 55 26
TRAFFIC CONTROL

PART 1 GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall comply with all rules and regulations of the City, County, and State authorities regarding the closing of public streets or highways. If conditions justify, ENGINEER may authorize CONTRACTOR to conduct his work in specific areas and to specific tasks to avoid sporadic and unorganized work efforts.

B. All work performed on or within the right-of-way of state roads shall have traffic control devices in place before work begins that meet the requirements of Utah Department of Transportation's "Specifications for Excavation on State Highways".

C. No road shall be closed by CONTRACTOR to the public except by express permission of ENGINEER and after obtaining the required permits. Where it is necessary to close a county or city road to thru traffic, the road shall be closed to thru traffic only - not local traffic. The road shall be closed for one block only, not over 700 feet. The road shall be barricaded at each point of public access with barricades meeting the Utah Department of Transportation's specifications.

D. Traffic must be kept open on those roads and streets where no detour is possible. CONTRACTOR shall, at all times, conduct his work so as to insure the least possible obstruction to traffic and normal commercial pursuits. All obstructions within traveled roadways shall be protected by approved signs, barricades, and lights where necessary for the safety of the traveling public. The convenience of the general public and residents, and the protection of persons and property are of prime importance and shall be provided for by CONTRACTOR in an adequate and satisfactory manner.

E. Excavations on project sites from which the public is excluded shall be marked or guarded in a manner appropriate for the hazard.

1.2 TRAFFIC CONTROL

A. For the protection of traffic in public or private streets and ways, CONTRACTOR shall provide, place, and maintain all necessary barricades, traffic cones, warning signs, lights, and other safety devices in accordance with the requirements of the "Manual on Uniform Traffic Control Devices for Streets and Highways, Part VI - Temporary Traffic Control," published by U.S. Department of Transportation, Federal Highway Administration. CONTRACTOR shall take all necessary precautions for the protection of the work and the safety of the public. All barricades and obstructions shall be illuminated at night, and all lights shall be kept burning from sunset until sunrise. CONTRACTOR shall station such guards or flaggers and shall conform to such special safety regulations relating to traffic control as may be required by the public authorities within their respective jurisdictions. All signs, signals, and barricades shall conform to the requirements of Subpart G, Part 1926, of the OSHA Safety and Health Standards for Construction.

B. If at any time the conditions indicate that CONTRACTOR's protective facilities and service are inadequate to assure the safety of the public or CONTRACTOR's workers, CONTRACTOR shall provide additional facilities or services as may be necessary to assure protection at no additional cost to OWNER.

C. Where required, CONTRACTOR shall obtain a traffic control permit from the governing agency prior to beginning work, and shall comply with all requirements of the permit.

1.3 MEASUREMENT AND PAYMENT

A. Traffic Control shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

SECTION 00 56 00
DUST CONTROL

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials and equipment as required to provide dust control for the project.

B. All materials and services shall comply with the requirements of the State of Utah, Department of Environmental Quality, Division of Air Quality and the City's Municipal Code.

PART 2 PRODUCTS

2.1 MATERIALS

A. Water. CONTRACTOR shall be responsible to arrange and pay for water for dust control.

B. Calcium chloride shall be added to the water used to provide dust control, if required by the City.

PART 3 EXECUTION

3.1 DUST CONTROL

A. CONTRACTOR shall comply with the requirements of the State of Utah Department of Environmental Quality, Air Quality Regulations (including R301-205 Emission Standards: Fugitive Emissions and Fugitive Dust, and R307-309 Fugitive Emissions and Fugitive Dust, of the Utah Air Conservation Rules (UACR). CONTRACTOR shall submit a Fugitive Dust Control Plan to the Utah Division of Air Quality, which meets the requirements of R307-309-4. CONTRACTOR shall obtain a permit from the Division of Air Quality.

B. CONTRACTOR shall execute Work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into the atmosphere. Give all unpaved streets, roads, detours, or haul roads used in the construction area an approved dust-preventive treatment or periodically water to prevent dust. Applicable environmental regulations for dust prevention shall be strictly enforced.

3.2 WATER PLACEMENT FOR DUST CONTROL

A. CONTRACTOR is responsible for placement of sufficient water to control dust on the project. Dust control is defined by the permit requirements of the State of Utah, Division of Environmental Quality, Division of Air Quality. Permit shall be obtained by CONTRACTOR.

3.3 WATER AND CALCIUM CHLORIDE MIXTURE FOR DUST CONTROL

A. CONTRACTOR may also use a water and calcium chloride solution to abate the dust for the project. The mixture of calcium chloride per 10,000-gallon truck shall be 10 pounds. The calcium chloride shall be added to the water truck container as the water is being put into the water truck in order to provide sufficient mixing.

B. In the absence of providing the water and calcium chloride mixture, CONTRACTOR shall meet the requirements of Subsection 3.2 of this document, or shall use other approved methods by OWNER that will allow CONTRACTOR to meet permit requirements.

- END OF SECTION -

SECTION 01 60 00
PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 PRODUCTS

A. Furnish products of qualified manufacturers suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise.

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

C. Furnish interchangeable components from same manufacturer for components being replaced.

1.2 PRODUCT DELIVERY REQUIREMENTS

A. Transport and handle products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.

C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.3 PRODUCT STORAGE AND HANDLING REQUIREMENTS

A. Store and protect products in accordance with manufacturers' instructions.

B. Store with seals and labels intact and legible.

C. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.

D. For exterior storage of fabricated products, place on sloped supports above ground.

E. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

F. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.

G. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

H. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.4 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Products of one of manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with Provision for Substitutions: Submit request for substitution for any manufacturer not named in accordance with the following article.

1.5 PRODUCT SUBSTITUTION PROCEDURES

A. ENGINEER will consider requests for Substitutions only after Notice of Award.

B. Substitutions may be considered when a product becomes unavailable through no fault of CONTRACTOR.

C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.

D. A request constitutes a representation that CONTRACTOR:

1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
2. Will provide same warranty for Substitution as for specified product.
3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to OWNER.
4. Waives claims for additional costs or time extension which may subsequently become apparent.
5. Will reimburse OWNER for review or redesign services associated with re-approval by authorities having jurisdiction.

E. Substitutions will not be considered when they are indicated or implied on Shop Drawing or Product Data submittals, without separate written request, or when acceptance will require revision to Contract Documents.

F. Substitution Submittal Procedure:

1. Submit four copies of request for Substitution for consideration to ENGINEER.
2. Submit Shop Drawings, Product Data, and certified test results attesting to proposed product equivalence. Burden of proof is on proposer.
3. ENGINEER may require CONTRACTOR to provide additional data about the proposed substitution.
4. ENGINEER will be the sole judge as to the type, function, and quality of any such substitution and ENGINEER’s decision shall be final.
5. ENGINEER will notify CONTRACTOR in writing of decision to accept or reject request.
6. Acceptance by ENGINEER of a substitution proposed by CONTRACTOR shall not relieve CONTRACTOR of the responsibility for full compliance with the Contract Documents and for the adequacy of the substitution.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION –

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SECTION 01 71 13
MOBILIZATION

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section is provided to cover CONTRACTOR's cost of general and miscellaneous responsibilities and operations not normally attributed to, or included in, any other single bid item. This shall include, but not necessarily be limited to, work described or enumerated in this section under the following subsections.

1.2 MOVING TO AND FROM THE JOB SITE

A. This shall include CONTRACTOR's preliminary arrangement for starting and stopping construction operations, work schedules, and transportation of equipment and personnel to and from the project.

1.3 CLEAN-UP

A. The cost of all clean-up Work as specified and not covered under other items shall be included in the Bid. Values shall be included in the Bid Schedule, lump-sum price, for "Mobilization".

1.4 TEMPORARY UTILITIES

A. The cost of water, power, etc. required by CONTRACTOR in performing the Work specified in the Contract shall be included in the Bid. Values shall be included in the Bid Schedule, lump-sum price, for "Mobilization".

1.5 PERFORMANCE BOND, PAYMENT BOND, AND INSURANCE

A. The cost of the Performance Bond, Payment Bond, and any required insurance and/or other miscellaneous cost associated with this Project shall be included with the Bid. Values shall be included in the Bid Schedule, lump-sum price, for "Mobilization”.

1.6 PERMITS

A. CONTRACTOR shall provide all necessary permits for completion of the Work. Values shall be included in the Bid Schedule, lump-sum price, for "Mobilization”.

1.7 PRE-CONSTRUCTION VIDEO RECORDS

A. CONTRACTOR is required to produce a preconstruction video recording of areas where Work is to be performed. The video record shall be of professional quality and the coverage shall be such, as to allow accurate determination of location, size, and conditions, etc. of existing features and improvements within the rights-of-way. CONTRACTOR shall provide OWNER with a copy of the preconstruction video in DVD format before construction begins.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

- END OF SECTION -

SECTION 01 78 20
OPERATION AND MAINTENANCE MANUALS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes: Preparation and submittal of Operation and Maintenance Manuals.

1.2 SUBMITTALS

A. Submit for Engineer review a complication of all operation and maintenance manuals (for all project facilities) with a .pdf electronic copy of the PROJECT Operations and Maintenance Manual.

B. Submit Operation and Maintenance Manuals before field quality control testing and before training of each piece of equipment or system.

C. Submit 3 hardcopy manuals for each piece of equipment or system.

D. Submit 1 electronic copy manuals for each piece of equipment or system.

E. Make manuals available at project site for use by construction personnel and ENGINEER.

F. Make additions and revisions to the manuals in accordance with ENGINEER's review comments.

1.3 OPERATION AND MAINTENANCE MANUALS

A. Furnish three (3) identical sets of Operations and Maintenance Manuals. Each set shall consist of one or more volumes, each of which shall be bound in a standard size, 3-ring, loose-leaf, vinyl, hard-cover binder suitable for bookshelf storage. Binder ring size shall not exceed 2.5 inches. A Table of Contents shall be provided which indicates all equipment and suppliers in the Operations and Maintenance Manuals.

B. Furnish to one copy of Operations and Maintenance Manuals in PDF electronic format.

C. Include in Operations and Maintenance manuals full details for care and maintenance for all visible surfaces as well as the following for each item of mechanical, electrical, and instrumentation equipment (except for equipment furnished by the Owner):

1. Complete operating instructions, including location of controls, special tools or other equipment required, related instrumentation, and other equipment needed for operation.
2. Preventative maintenance procedures and schedules
3. A description of proper maintenance activities
4. Complete parts lists, by generic title, identification number, and catalog number, complete with exploded views of each assembly.
5. Disassembly and reassembly instruction
6. Name and location of nearest supplier and spare parts warehouse

7. Name and location of manufacturer
8. Recommended troubleshooting and start-up procedures
9. Prints of the record drawings, including diagrams and schematics, as required under the electrical and instrumentation portions of these specifications.

D. All Operations and Maintenance manuals shall be submitted in final form to ENGINEER not later than the 75 percent of construction completion date. All discrepancies found by ENGINEER in the Operations and Maintenance manuals shall be corrected by CONTRACTOR prior to final acceptance of the project.

E. Preparation:

1. Provide hardcopy Operations and Maintenance Manuals in 3-ring binders with rigid covers. Utilize numbered tab sheets to organize information.
2. Provide electronic copy Operations and Maintenance Manuals in PDF Format.
3. Provide original and clear text on reproducible non-colored paper.
4. Provide all dimensions in English units.

F. Contents of Operation and Maintenance Manuals:

1. Cover page:
   a. Equipment name, equipment tag number, project name, OWNER's name, appropriate date.
2. Table of Contents:
   a. General description of information provided within each tab section.
3. Equipment Summary Form:
   a. Completed form in the format shown in Appendix A.
   b. The manufacturer's standard form will not be acceptable.
4. Lubrication information:
   a. Required lubricants and lubrication schedules.
5. Control diagrams:
   a. Internal and connection wiring, including logic diagrams, wiring diagrams for control panels, ladder logic for computer based systems, and connections between existing systems and new additions, and adjustments such as calibrations and set points for relays, and control or alarm contact settings.
   b. Complete set of 11-inch by 17-inch drawings of the control system.
   c. Complete set of control schematics.
6. Programming:
   a. Copies of all CONTRACTOR furnished programming.
7. Start-up procedures:
   a. Recommendations for installation, adjustment, calibration, and troubleshooting.
8. 8. Operating procedures:
   a. Step-by-step procedures for starting, operating, and stopping equipment under specified modes of operation.
   b. Include safety precautions and emergency operating shutdown instructions.
9. Preventative maintenance procedures:
   a. Recommended steps and schedules for maintaining equipment.
10. Overhaul instructions:

a. Directions for disassembly, inspection, repair and reassembly of the equipment; safety precautions; and recommended tolerances, critical bolt torques, and special tools that are required.

11. Parts list:
    a. Complete parts list for all equipment being provided.
    b. Catalog data for all products or equipment furnished including generic title and identification number of each component part of equipment. Include bearing manufacturer, model and ball or roller pass frequencies for every bearing.
12. Spare parts list:
    a. Recommended number of parts to be stored at the site and special storage precautions.
13. Drawings:
    a. Exploded view or plan and section views with detailed callouts.
    b. Complete set of 11-inch by 17-inch drawings of equipment.
    c. Provide electrical and instrumentation schematic record drawings.
14. Source (factory) quality control test results: Provide copies of factory quality control test reports for all equipment.
15. Field quality control test results: After field-testing is completed, insert field test reports for (piping, valving, equipment, and system startup tests), into O&M manual.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

- END OF SECTION –

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SECTION 01 78 50
PROJECT CLOSEOUT

PART 1 GENERAL

1.1 FINAL CLEANUP

A. CONTRACTOR shall promptly remove from the vicinity of the completed Work, all rubbish, unused materials, concrete forms, construction equipment, and temporary structures and facilities used during construction. Final acceptance of the Work by OWNER will be withheld until CONTRACTOR has satisfactorily complied with the foregoing requirements for final cleanup of the Project Site.

1.2 TOUCH-UP AND REPAIR

A. CONTRACTOR shall touch up or repair all finished surfaces on structures, equipment, fixtures, etc., that have been damaged prior to final acceptance. Surface on which such touch-up or repair cannot be successfully accomplished shall be completely refinished or in the case of hardware and similar small items, the item shall be replaced.

1.3 CLOSEOUT TIMETABLE

A. CONTRACTOR shall establish dates for equipment testing, acceptance periods and on-site instructional periods (as required under the Contract). Such dates shall be established not less than one week prior to beginning any of the foregoing items, to allow OWNER, ENGINEER, and their authorized representatives sufficient time to schedule attendance at such activities.

1.4 MAINTENANCE AND GUARANTEE

A. CONTRACTOR shall comply with the maintenance and guarantee requirements contained in Article 7 of the General Conditions, Section 00 70 00.

B. Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered as part of such required repair work, and any repair or resurfacing which becomes necessary by reason of such required repair work shall be completed by CONTRACTOR at no cost to OWNER.

C. CONTRACTOR shall make all repairs and replacements promptly upon receipt of written order from OWNER. If CONTRACTOR fails to make such repairs or replacement promptly, OWNER reserves the right to do the work and CONTRACTOR and his surety shall be liable to OWNER for the cost thereof.

D. CONTRACTOR shall obtain a signed release from the property owner approving restoration of work in the construction easements across or bordering private property.

1.5 BOND

A. CONTRACTOR shall provide a bond to guarantee performance of the provisions contained in Paragraph "Maintenance and Guarantee" above, and Article 6 of the General Conditions, Section 00 70 00.

1.6 FINAL ACCEPTANCE

A. Final acceptance and final payment shall not be made until all provisions of the General Conditions Section 00 70 00 Article 15 have been satisfied.

1.7 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:

1. Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other modifications to the Contract.
5. Reviewed Shop Drawings, Product Data, and Samples.
6. Manufacturer's instruction for assembly, installation, and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by OWNER.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress, not less than weekly.

E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:

1. Manufacturer's name and product model and number.
2. Product substitutions or alternates utilized.
3. Changes made by Addenda and modifications.

F. Record Drawings: Legibly mark each item to record actual construction including:

1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements
2. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work
3. Field changes of dimension and detail
4. Details not on original Contract drawings

G. Submit documents to ENGINEER with claim for final Application for Payment.

1.8 CONTRACT CLOSEOUT

A. As a condition precedent to final acceptance of the project, CONTRACTOR shall complete the following forms and submit the original and two copies of each form to the Project Representative.

1. Contractor’s Certificate of Substantial Completion
2. Contractor’s Certificate of Final Completion
3. Contractor’s Final Waiver of Lien
4. Consent of Surety for Final Payment
5. Affidavit of Payment
6. Affidavit of Release of Liens by the Contractor

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

CONTRACTOR'S CERTIFICATE OF SUBSTANTIAL COMPLETION

OWNER

TO: Name
Address
City, State, Zip Code

PROJECT: _____

ATTENTION: _____

FROM: _____
Firm or Corporation

This is to certify that I, _____ am an authorized official of _____ working in the capacity of _____ and have been properly authorized by said form or corporation to sign the following statements pertaining to the subject contract.

I know of my own personal knowledge, and do hereby certify, that the work of the Contract described above has been substantially performed, and materials used and installed to date in accordance with, and in conformity to, the Contract drawings and specifications. A list of all incomplete work is attached.

The Contractor hereby releases the Owner and its agents from all claims and liability to the Contractor for anything done or finished for or relating to the Work, as specified in the Project Manual, except demands against the Owner for the remainder of progress payments retained to date, and unresolved written claims prior to this date.

The Contract Work is now substantially complete, ready for its intended use, and ready for your inspection. You are requested to issue a Certificate of Substantial Completion.

Signature: _____

Date: _____

CONTRACTOR'S CERTIFICATE OF FINAL COMPLETION

OWNER

TO:
Name
Address
City, State, Zip Code

PROJECT: _____

ATTENTION: _____

FROM: _____
Firm or Corporation

This is to certify that I, _____ am an authorized official of _____ _____ working in the capacity of _____ _____ and have been properly authorized by said form or corporation to sign the following statements pertaining to the subject contract.

I know of my own personal knowledge, and do hereby certify, that the work of the Contract described above has been substantially performed, and materials used and installed to date in accordance with, and in conformity to, the Contract drawings and specifications.

The Contractor hereby releases the Owner and its agents from all claims and liability to the Contractor for anything done or finished for or relating to the Work. The Contract Work is now complete in all parts and requirements, ready for its intended use, excepting the attached list of minor deficiencies and the reason for each being incomplete to date, for which exemption from final payment requirements is requested (if no exemptions requested, write "none") _____. The Work is now ready for your final inspection. The following items are required from the Contractor prior to application for final payment and are submitted herewith, if any:

_____

_____

I understand that neither the issuance, by the Owner, or a Certificate of Final Completion, nor the acceptance thereof by the Owner, shall operate as a bar claim against the Contractor under the terms of the guarantee provisions of the Contract Documents.

Signature: _____
Date: _____

CONTRACTORS FINAL WAIVER OF LIEN

TO ALL WHOM IT MAY CONCERN:

WHEREAS, the undersigned has furnished labor and materials for (A) _____

_____

in the City of _____, County of _____, State of Utah, of which City of _____ is the Owner.

NOW THEREFOR, this _____ day of _____, 20_____, for and in consideration of the sum of (B) _____ dollars paid simultaneously herewith, the receipt whereof is hereby acknowledged by the undersigned, the undersigned does hereby waive and release any lien* right to, or claim of lien with respect to and on said above described premises, and the improvements thereon, and on the monies or other consideration due or to become due from the Owner, on account of labor, services, materials, fixtures, apparatus or machinery heretofore or which may hereafter be furnished by the undersigned to or for the above described premises by virtue of said contract.

(C) _____ (SEAL)
(Name of sole ownership, corporation or partnership)

(C) _____ (SEAL)
(Signature of Authorized Representative)

Title: _____

INSTRUCTION FOR FINAL WAIVER:

A. Project name.

B. Final Contract amount received (total amount of Contract as adjusted).

C. If the waiver is for a corporation, corporate name should be used, corporate seal affixed, and title of officer signing waiver should be set forth; if waiver is for a partnership, the partnership name should be used, partner should sign and designate himself/herself as partner.

* The word Lien as used herein shall include Stop Orders, Stop Notices, or Freeze Orders on monies or other consideration of the Owner which are due or are to become due on the Contract referenced above.

CONSENT OF SURETY FOR FINAL PAYMENT

Project Name: _____

Location: _____

Type of Contract: _____

Amount of Contract: _____

In accordance with the provisions of the above named contract between the Owner and the Contractor, the following named surety:

_____

_____

_____

on the Payment Bond of the following named Contractor:

_____

_____

_____

hereby approves of final payment to the Contractor, and further agrees that said final payment to the Contractor shall not relieve the Surety Company named herein of any of its obligations to the following named Owner (as set forth in said Surety Company's bond):

Owners Name
Owners Address
City, State, Zip Code

IN WITNESS WHEREOF, the Surety Company has hereunto set its hand and seal this _ day of _____, 20___.

_____
(Name of Surety Company)

_____
(Signature of Authorized Representative)

Title: _____

AFFIDAVIT OF PAYMENT

TO ALL WHOM IT MAY CONCERN:

WHEREAS, the undersigned has been employed by (Insert Owners Name) to furnish labor and materials under a contract dated _____ for the project named _____ _____ in the City of _____County of _____, State of Utah.

NOW THEREFORE, this _____ day of _____ , 20____, the undersigned, as the Contractor for the above named Contract pursuant to the conditions of the Contract, hereby certifies that, except as listed below, he has paid in full or has otherwise satisfied all obligations for all materials and equipment furnished, for all work, labor, and services performed, and for all known indebtedness and claims against the Contractor for damages arising in any manner in connection with the performance of the Contract referenced above for which the Owner or its property might in any way be held responsible.

EXCEPTIONS: (If none, write “none”. If required by the Owner, the Contractor furnish bond satisfactory to the Owner for each exception).

{AFFIX CORPORATE}
{SEAL HERE}

_____
Contractor (Name of sole ownership, Corporation or partnership)

_____
(Signature of Authorized Representative)

Title: _____

AFFIDAVIT OF RELEASE OF LIENS BY THE CONTRACTOR

TO ALL WHOM IT MAY CONCERN:

WHEREAS, the undersigned has been employed by (Insert Owners Name) to furnish labor and materials under a contract dated _____ for the project named _____ _____ in the City of _____County of , State of Utah.

NOW THEREFOR, this _____ day of _____ , 20_____, the undersigned, as the Contractor for the above named Contract pursuant to the conditions of the Contract, hereby certifies that to the best of his/her knowledge, information and belief, except as listed below, the Releases or Waivers of Lien* attached hereto include the Contractor, all subcontractors, all suppliers of material and equipment, and all performers of work, labor or services, who have or may have liens against any property of the Owner and on the monies or other consideration due to becomes due from the Owner arising in any manner in connection with the performance of the Contract referenced above.

EXCEPTIONS: (If none, write "none". If required by the Owner, the Contractor furnish bond satisfactory to the Owner for each exception).

ATTACHMENTS:

1. Contractor's Release or Waiver of Liens, conditional upon receipt of final payment.

2. Separate Release or Waiver of Liens from subcontractors and material suppliers.

{AFFIX CORPORATE}
{SEAL HERE}

_____
Contractor (Name of sole ownership, Corporation or partnership)

_____
(Signature of Authorized Representative)

Title: _____

* The word Lien as used herein shall include Stop Orders, Stop Notices, or Freeze Orders on monies or other consideration of the Owner which are due or are to become due on the Contract referenced above.

- END OF SECTION -

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SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers the work necessary to furnish, install, and complete, the concrete formwork.

1.2 RELATED WORK

A. Related Work in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 03 30 00 Cast-in-Place Concrete

1.3 MEASUREMENT AND PAYMENT

A. Concrete formwork shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

1.4 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

1. American Concrete Institute (ACI) -ACI 347R- Guide to Formwork for Concrete
2. American Hardboard Association (AHA) -AHA A135.4- Basic Hardboard
3. Department of Commerce (DOC) -DOC PS 1- Structural Plywood
4. ACI 350R-01 – Code Requirements for Environmental Engineering Concrete Structures and Commentary
5. NSF International (NSF) 61 - Drinking Water System Components - Health Effects

1.5 DESIGN

A. Formwork shall be designed in accordance with methodology of ACI 347R for anticipated loads, lateral pressures, and stresses. Forms shall be capable of producing a surface which meets the requirements of the finish specified in Section 03 30 00 Cast-in-Place Concrete. Forms shall be capable of withstanding the pressures resulting from placement and vibration of concrete.

1.6 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. The following shall be submitted:

1. Drawings showing details of forming, shoring and bracing for footings, walls, and floors shall be submitted to ENGINEER at least 3 weeks prior to their use. Drawings showing details of formwork shall include joints, supports, studding and shoring, and sequence of form and shoring removal.

2. If requested by ENGINEER, design analysis and calculations shall be submitted for form design and methodology used in the design. The analysis and calculations shall verify the selection of form ties, horizontal and vertical stiff-backs or braces for wall panels, forming and form openings, or any other part of forming, shoring or bracing which may be considered critical by ENGINEER.
3. Manufacturer's data including literature describing form materials, accessories, and form releasing agents.
4. Manufacturer's recommendation on method and rate of application of form releasing agent.

C. ENGINEER's review will not relieve CONTRACTOR from any responsibility as to the adequacy of the forming, shoring and bracing design. Any formwork installed by CONTRACTOR shall be solely at CONTRACTOR's risk. ENGINEER's review will not lessen or diminish CONTRACTOR's liability.

PART 2 PRODUCTS

2.1 FORM MATERIALS

A. Form surfaces shall be in "new and undamaged" condition and may be plywood, hard plastic finished plywood, overlaid waterproof particle board, and steel of sufficient strength and surface smoothness to produce the specified finish. CONTRACTOR shall verify that his types of form surfaces and panel sizes satisfy all requirements of these specifications.

B. The wall form design shall be such that wall sections can be poured full height without creating horizontal cold joints and without causing snapping of form ties which shall be of sufficient strength and number to prevent spreading of the forms during the placement of concrete and which shall permit ready removal of the forms without spalling or damaging the concrete.

2.2 FORM TIES

A. Form ties on exposed surfaces shall be located in a uniform pattern. Snap ties shall not be broken until the concrete has reached the design concrete strength. The use of tie wires as form ties will not be permitted. Snap ties, designed so that the ends must be broken off before the forms can be removed, shall not be used. Form ties shall be **Plastic Cone Snap Tie by Dayton-Superior, Wrench Head Snap Tie by MASCO Mason Supply,** or approved equal.

B. Taper ties with plastic or rubber plugs of an approved and proven design may also be used. The plugs must be driven into the hole with a steel rod, placed in a cylindrical recess made therefore in the plug. At no time shall plugs be driven on the flat area outside the cylindrical recess. Taper ties shall be **Taper Tie by Dayton-Superior, Taper-Tie by MASCO Mason Supply**, or approved equal.

2.3 FORM RELEASING AGENTS

A. Form releasing agents shall be commercial formulations that will not bond with, stain or adversely affect concrete surfaces. Agents shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.

B. Any agents used inside of the reservoir shall consist of products which are certified by laboratories approved by ANSI and shall comply with be NSF Standard 61 for approved use in potable water systems.

PART 3 EXECUTION

3.1 INSTALLATION

A. Forms shall be mortar tight, properly aligned and adequately supported to produce concrete surfaces meeting the surface requirements specified in Section 03 30 00 Cast-in-Place Concrete. Forms shall be used, whenever necessary, to confine the concrete, to shape the concrete to the required lines and grades, and to obtain a thoroughly compacted dense concrete through proper vibrating. The forms shall have sufficient strength and rigidity to hold the concrete and to withstand the necessary pressure, tamping and vibration, without deflection from the prescribed lines. Where forms for continuous surfaces are placed in successive units, care shall be taken to fit the forms over the completed surface so as to obtain accurate alignment of the surface and to prevent leakage of mortar.

B. The surfaces of all forms in contact with the concrete shall be clean, rigid, tight and smooth. All dirt, chips, sawdust, mud, water and other foreign matter shall be removed from within the forms or within the excavated areas, before any concrete is deposited therein.

C. Forms shall not be reused if there is any evidence of surface wear and tear or defects which would impair the quality of the surface. Surfaces of forms to be reused shall be thoroughly cleaned of mortar from previous concreting and of all other dirt and foreign matter before reuse. Form ties that are to be completely withdrawn shall be coated with a nonstaining bond breaker.

D. Bulkheads to form vertical wall joints shall be strong enough to withstand concrete pressures during pouring and vibrating, and shall be properly placed between the forms to avoid mortar seepage. Holes shall be provided in the bulkheads to permit passage of horizontal mild steel reinforcing where required by the Contract Drawings. Unless these are specifically called for on the Contract Drawings, no chamfer strips shall be placed in the corners of vertical construction joints.

3.2 COATING

A. Form inside surfaces shall be coated with a form releasing agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's printed or written instructions. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

3.3 ALIGNMENT AND TOLERANCES

Forms shall be properly aligned and adequately supported to produce concrete surfaces conforming to construction tolerance given in Table 03 10 00-1, Tolerances for Formed Surfaces.

TABLE 03 10 00-1
TOLERANCES FOR FORMED SURFACES

Condition	Measurement	Tolerance
1. Variations from the plumb:	In any 10 feet of length	1/4-inch
a. In the lines and surfaces of columns, piers, walls and in arises	Maximum for entire length	1 inch
b. For exposed corner columns, control-joint grooves, and other conspicuous lines	In any 20 feet of length Maximum for entire length	1/4-inch 1/2-inch
2. Variation from the level or from the grades indicated on the drawings	In any 10 feet of length In any bay or in any 20 feet of length	1/4-inch 3/8-inch
3. Variation of the linear building lines from established position in plan	In any 20 feet Maximum	1/2-inch 1-inch
4. Variation of distance between walls, columns, partitions	1/4-inch per 10 feet of distance, but not more than 1/2-inch in any one bay, and not more than 1-inch total variation	
5. Variation in the thickness of slabs and walls	Minus Plus	1/4-inch 1/2-inch

3.4 FORM REMOVAL

A. Forms shall be removed in a manner that will prevent injury to the concrete and ensure the complete safety of the structure. Forms shall not be removed until approval is given by ENGINEER. Formwork for columns, walls, side of beams and other parts not supporting the weight of concrete may be removed when the concrete has attained sufficient strength to resist damage from the removal operation but not before at least 24 hours has elapsed since concrete placement.

B. CONTRACTOR shall remove all wood splinters on concrete surfaces after stripping of wood forms.

- END OF SECTION -

SECTION 03 20 00
CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers the reinforcing steel bars, wire fabric or rod mats for cast-in-place concrete.

1.2 RELATED WORK

A. Related Work in other sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN CONCRETE INSTITUTE (ACI)

1.	ACI 301	Specifications for Structural Concrete
2.	ACI 315	Details and Detailing of Concrete Reinforcement
3.	ACI 318	Building Code Requirements for Structural Concrete and Commentary
4.	ACI 350R	Code Requirements for Environmental Engineering Concrete Structures and Commentary

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1.	ASTM A 184	Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
2.	ASTM A 615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
3.	ASTM A 767	Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
4.	ASTM A 775	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
5.	ASTM A 1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

D. CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

1.	CRSI (DA4)	Manual of Standard Practice (MSP-1)

1.4 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 - Submittal Procedures:

1. Drawings of Concrete Reinforcement System with details showing reinforcing steel schedules, sizes, grades, and splicing and bending details. Drawings shall show support details including types, sizes and spacing.
2. Reinforcing Steel with certified copies of mill reports attesting that the reinforcing steel furnished meets the requirements specified, prior to the installation of reinforcing steel.

1.5 DELIVERY AND STORAGE

A. Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports.

1.6 MEASUREMENT AND PAYMENT

A. Concrete reinforcement shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS

2.1 DOWELS

A. Dowels shall conform to ASTM A 615, Grade 60.

2.2 FABRICATED BAR MATS

A. Fabricated bar mats shall conform to ASTM A 184.

2.3 REINFORCING STEEL

A. Reinforcing steel shall be deformed bars conforming to ASTM A 615 grades and sizes as indicated. Cold drawn wire used for spiral reinforcement shall conform to ASTM A 1064. When no grade is indicated use 60 ksi grade steel. Special coated bars (epoxy and zinc) may be specified for use in a highly corrosive atmosphere where concrete cover is not considered sufficient. In which case reference to ASTM A 767 and A 775 will be included.

2.4 WELDED WIRE FABRIC

A. Welded wire fabric shall conform to ASTM A 1064.

2.5 WIRE TIES

A. Wire ties shall be 16-gauge or heavier black annealed steel wire.

2.6 SUPPORTS

A. Bar supports for formed surfaces shall be designed and fabricated in accordance with CRSI (DA4) MSP-1 and shall be steel or precast concrete blocks. Precast concrete blocks shall be not less than 4 inches square when supporting reinforcement on ground. Precast concrete block shall have compressive strength equal to that of the surrounding concrete.

B. Where concrete formed surfaces will be exposed to weather or where surfaces are to be painted, steel supports within ½ inch of concrete surface shall be plastic protected or of stainless steel. Concrete supports used in concrete exposed to view shall have the same color and texture as the finish surface. For slabs on grade, supports shall be precast concrete blocks, plastic coated steel fabricated with bearing plates, or specifically designed wire-fabric supports fabricated of plastic.

PART 3 EXECUTION

3.1 REINFORCEMENT

A. Reinforcement shall be fabricated to shapes and dimensions shown and shall conform to the requirements of ACI 318. Reinforcement shall be cold bent unless otherwise authorized. Bending may be accomplished in the field or at the mill. Bars shall not be bent after embedment in concrete.

B. Safety caps shall be placed on all exposed ends of vertical concrete reinforcement bars that pose a danger to life safety.

C. Placement:

1. Reinforcement shall be free from loose rust and scale, dirt, oil, or other deleterious coating that could reduce bond with the concrete.
2. Reinforcement shall be placed in accordance with ACI 318 at locations shown plus or minus one bar diameter. Reinforcement shall not be continuous through expansion joints and shall be as indicated through construction or contraction joints. Concrete coverage shall be as indicated or as required by ACI 318. If bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits or embedded items, the resulting arrangement of bars, including additional bars required to meet structural requirements, shall be approved before concrete is placed.

D. Splicing:

1. Splices of reinforcement shall conform to ACI 318 and shall be made only as required or indicated. Splicing shall be by lapping or by mechanical connection; except that lap splices shall not be used for bars larger than No. 11 unless otherwise indicated. Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 6-inches. Mechanical butt splices shall be in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be flame dried before butt splicing. Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

3.2 WELDED-WIRE FABRIC

A. Welded-wire fabric shall be placed in slabs as indicated. Fabric placed in slabs on grade shall be continuous between expansion, construction, and contraction joints. Lap

splices shall be made in such a way that the overlapped area equals the distance between the outermost crosswires plus 2 inches. Laps shall be staggered to avoid continuous laps in either direction. Fabric shall be wired or clipped together at laps at intervals not to exceed 4 feet. Fabric shall be positioned by the use of supports.

3.3 DOWELS

A. Dowels shall be installed in slabs on grade at locations indicated and at right angles to joint being doweled. Dowels shall be accurately aligned parallel to the finished concrete surface and rigidly supported during concrete placement. One end of dowels shall be coated with a bond breaker.

- END OF SECTION -

SECTION 03 25 00
EXPANSION JOINTS, CONSTRUCTION JOINTS AND WATERSTOPS

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section covers the work necessary to furnish, install and complete expansion and construction joints, including waterstops.

B. All waterstops and sealants in contact with potable water including waterstops embedded in concrete floors and walls of potable water tanks shall be NSF 61 certified.

1.2 RELATED WORK

A. Related Work in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 03 33 00 Cast-in-Place Concrete

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN CONCRETE INSTITUTE (ACI)

1. ACI 318 Building Code Requirements for Reinforced Concrete

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
2. ASTM D 412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
3. ASTM C 920 Standard Specification for Elastomeric Joint Sealants
4. ASTM D 570 Standard Test Method for Water Absorption of Plastics
5. ASTM D 624 Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
6. ASTM D 638 Standard Test Method for Tensile Properties of Plastics
7. ASTM D 746 Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
8. ASTM D 747 Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.
9. ASTM D 792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
10. ASTM D 1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
11. ASTM D 1752 Standard Specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

12. ASTM D 2240 Standard Test Method for Rubber Property-Durometer Hardness

D. FEDERAL SPECIFICATIONS (FS)

1. FS-TT-S-00227E Sealing Compound: Elastomeric Type, Multi-Component (For Calking, Sealing, and Glazing in Buildings and Other Structures)

E. NSF International (NSF)

1. NSF/ANSI 61 Drinking Water System Components – Health Effects

1.4 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 – Submittal Procedures:

1. Submit certificates of compliance stating that the joint filler and sealant materials and waterstops conform to the requirements specified. ENGINEER, may take samples of any materials and have them tested by an independent testing laboratory to verify their compliance with these Specifications. All such costs shall be borne by OWNER. If any materials should fail to meet these Specifications, all costs for further testing of the replacement material shall be borne by CONTRACTOR.
2. Samples of factory fabricated waterstop joints representing in all respects the material and workmanship of the material that will be furnished under this contract. Samples will be submitted and approved by ENGINEER prior to use of the factory joints in the field.
3. Manufacturer's catalog data and manufacturer's recommended instructions for splicing of waterstops.

1.5 OBSTRUCTIONS

A. CONTRACTOR shall pay particular attention to removing all obstructions such as concrete, nails, etc., from joints when movements of floor or wall sections can be expected under temperature and other conditions.

1.6 QUALITY ASSURANCE

A. Waterstop manufacturer shall demonstrate five years (minimum) continuous, successful experience in production of waterstops.

1.7 DELIVERY AND STORAGE

A. Material delivered and placed in storage shall be stored off the ground and protected from moisture, dirt, and other contaminants. Sealants shall be delivered in the manufacturer's original unopened containers. Sealants whose shelf life has expired shall be removed from the site.

1.8 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for expansion joints, construction joints, and waterstops. Full compensation for expansion joints, construction joints, and waterstops shall be considered as included in the Contract unit or lump sum prices for the various items of the Contract to which it relates.

PART 2 PRODUCTS

2.1 HORIZONTAL JOINT SEALANT

A. Horizontal joints not requiring waterstops or when so indicated on the Contract Drawings, shall be sealed using **Sikaflex-2c NS**, or approved equal, and shall meet the requirements of ASTM C-920, Type M, Grade NS, Class 25 and FS-TT-S-00227E, Type II, Class A, and shall be NSF 61 certified (Sikaflex 2c NS EZ) if in contact with potable water. Color shall match color of concrete.

2.2 VERTICAL JOINT SEALANT

A. Vertical joints not requiring waterstops or when so indicated on the Contract Drawings, shall be sealed using **Sikaflex-2c NS,** or approved equal, and shall meet the requirements of ASTM C-920, Type M, Grade NS, Class 25 and FS-TT-S-00227E, Type II, Class A, and shall be NSF 61 (Sikaflex 2c NS EZ) certified if in contact with potable water. Color shall match color of concrete.

2.3 JOINT PRIMER

A. All joints receiving a joint sealant shall be primed using **Sikaflex Primers 429/202**, or approved equal.

2.4 EXPANSION JOINTS

A. Expansion joints shall be composed of cellular fibers securely bonded together and uniformly saturated with asphalt. Joint shall be resilient, flexible, and non-extruding. Expansion joints shall meet the requirements of ASTM D 1751. Manufacturer shall be **Fibre Expansion Joint by W.R. Meadows, Fiberflex by JD Russel Company**, or approved equal.

2.5 PVC WATERSTOPS

A. Waterstops shall be of an approved type, supplied by an approved manufacturer and shall be plastic made of virgin polyvinylchloride (PVC) compound, shall be ribbed, uniform in dimensions, dense, homogeneous, free from porosity, and as detailed on the Contract Drawings. No reclaimed PVC shall be used in the compound. Waterstop in contact with potable water shall be NSF 61 certified.

B. The finished waterstop material shall meet the following minimum requirements:

Tensile strength	2,000 psi min.	(ASTM D 638)
Ultimate elongation	300% min.	(ASTM D 638)
Shore A hardness	75 ± 5	(ASTM D 2240)
Specific gravity	1.38 max	(ASTM D 792)
Stiffness in flexure	600 psi min.	(ASTM D 747)
Cold brittleness	No Failure at -35°F	(ASTM D 746)
Water absorption: 48 hours	0.15% max	(ASTM D 570)
Tear Resistance	290 lb./in. min.	(ASTM D 624)

C. Manufacturer, or approved equal:

1. Vinylex Waterstop & Accessories
2. Greenstreak, Inc. (Sika Corporation)
3. Durajoint Concrete Accessories

D. Factory made waterstop joints shall have a tensile strength across the joint equal to at least 600 psi. Field splices and joints shall be made in accordance with the waterstop manufacturer's instructions using a thermostatically-controlled heating iron.

2.6 HYDROPHILIC WATERSTOP

A. Non-bentonite rubber hydrophilic waterstop shall only be used where shown on the Contract Drawings or when approved by ENGINEER. Hydrophilic waterstop in contact with potable water including in potable water tank floor slabs and walls shall be NSF 61 certified. Size shall be as indicated on the Contract Drawings.

B. The hydrophilic waterstop shall meet the following physical properties:

Physical Property	Test Method	Result
Tensile Strength (Minimum)	ASTM D412	350 psi
Elongation (minimum)	ASTM D412	600 %
Hardness	ASTM D2240	52 +/-5 Shore A
Tear Resistance	ASTM D624	50 lb/in
Specific Gravity	ASTM D792	1.35 +/-5

C. Manufacturer, or approved equal:

1. Conseal CS-231
2. Sika Hydrotite CJ-1020-2K

PART 3 EXECUTION

3.1 WATERSTOPS

A. Waterstops shall be of the type indicated and shall be installed at the locations shown to form a continuous water-tight diaphragm. The waterstop shall be correctly positioned in the forms so that the center of the waterstop is centered on the joint. Waterstop shall be held in place in the forms by use of a split form or other approved method that will positively hold the waterstop in the correct position and to the correct alignment. Vibrate concrete to obtain impervious concrete in the vicinity of all joints. In horizontal joints, ensure that the areas below the water stop are completely filled with concrete.

B. Horizontal plastic waterstops shall be bent up during placing of concrete until the concrete has been brought to the level of the waterstop; additional concrete shall then be placed over the waterstop, after which the concrete shall be thoroughly vibrated. All horizontal and vertical waterstops, which are not accessible during pouring, shall be tied off in two directions every 12 inches in such a manner that bending over one way or another is prevented. A hog-ring or nail may be driven through both ends of the waterstop to facilitate placing and tying of waterstops to reinforcing steel forms or form-ties.

C. Adequate provision shall be made to support and completely protect the waterstops during the progress of the work. Any waterstop punctured or damaged shall be repaired or replaced. All waterstops shall be properly spliced and joints shall be checked for strength and pinholes after splicing. Splices shall be strong enough to develop a pulling force of 75 percent of the strength of the waterstop, and shall be watertight. Splices in waterstop shall be made in conformance with the recommendations of the waterstop manufacturer. Continuity of cross sectional features shall be maintained across the splice. Splices showing evidence of separation after bending shall be remade.

D. Install hydrophilic waterstop in accordance with the manufacturer's written instructions. Adhesives used on hydrophilic waterstop shall be NSF 61 certified. Adhesives shall meet the requirements of ASTM C 920 and shall be **Manus Bond 75-AM Lot NSF61**, **DAP Premium Polyurethane Construction Adhesive**, or approved equal.

3.2 JOINTS

A. Joints shall be installed at locations indicated and as authorized. Joints shall be constructed so as to produce straight joints, and shall be vertical or horizontal, except where walls intersect sloping floors.

B. Construction Joints

1. Prior to placing the abutting concrete for all construction joints, the contact surface shall be cleaned by approved means to remove all laitance and expose the aggregate. The exposed portion of the reinforcing steel shall be cleaned of all concrete. The cleaning method shall be conducted so as to not damage waterstop, if waterstop is present. Where the joint is to receive a sealant, a recess 3/4-inch deep shall be formed along the joint using a dressed-and-oiled wood strip or other method approved by ENGINEER. The wood strip shall be removed after the concrete has set.

C. Expansion Joints

1. Expansion joint filler shall be used where required on the Contract Drawings. The edges of the joint shall be neatly finished with an edging tool of 1/8-inch radius, except where a resilient floor surface will be applied. Where the joint is to receive a sealant, the filler strips shall be installed at the proper level below the finished floor with a slightly tapered, dressed-and-oiled wood strip temporarily secured to the top thereof to form a recess 3/4-inch deep to be filled with sealant. The wood strip shall be removed after the concrete has set. In lieu of the wood strip a removable expansion filler cap designed and fabricated for this purpose may be used.

D. Joint Sealant

1. The joint cavity shall be cleaned by sandblasting or power wire brushing and shall be blown clean of dust and sand with compressed air before the joint sealant may be applied. Joints must be frost-free, free of oils, grease, curing compound residues, and any other foreign matter that might prevent bond. A bond breaker tape shall be installed over the joint per manufacturer's instructions. After the joints have been prepared as described above, the joints shall be primed and the sealant shall be applied in accordance with the manufacturer's recommendations.

- END OF SECTION -

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers cast-in-place concrete mix design and placement.

B. CONTRACTOR shall provide cast-in-place concrete as indicated in the Specifications and the Contract Drawings.

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 01 45 00 Quality Control and Material Testing
3. Section 03 10 00 Concrete Forming and Accessories
4. Section 03 20 00 Concrete Reinforcement
5. Section 03 25 00 Expansion Joints, Construction Joints, and Waterstops
6. Section 09 90 00 Painting and Finishes
7. Section 31 23 23 Excavation and Backfill for Structures

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publications are referred to in the text by basic designation only.

B. AMERICAN CONCRETE INSTITUTE (ACI)

1. ACI 117 Specifications for Tolerances for Concrete Construction and Materials and Commentary
2. ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
3. ACI 301 Structural Concrete for Buildings
4. ACI 304 Guide for Measuring, Mixing, Transporting, and Placing Concrete
5. ACI 305R Hot Weather Concreting
6. ACI 306R Cold Weather Concreting
7. ACI 318 Building Code Requirements for Structural Concrete and Commentary
8. ACI 350R Code Requirements for Environmental Engineering Concrete Structures and Commentary

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM C 31 Standard Practice for Making and Curing Concrete Test Specimens in the Field
2. ASTM C 33 Standard Specification for Concrete Aggregates
3. ASTM C 39 Standard Test Method for Compressive Strength of Cylindrical

Concrete Specimens

4. ASTM C 42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
5. ASTM C 78 Standard Test Method for Flexural Strength of Concrete (Using Simple Beam With Third-Point Loading)
6. ASTM C 94 Standard Specification for Ready-Mixed Concrete
7. ASTM C 109 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)
8. ASTM C 143 Standard Test Method for Slump of Hydraulic-Cement Concrete
9. ASTM C 150 Standard Specification for Portland Cement
10. ASTM C 171 Standard Specification for Sheet Materials for Curing Concrete
11. ASTM C 172 Standard Specification for Sampling Freshly Mixed Concrete
12. ASTM C 173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
13. ASTM C 192 Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
14. ASTM C 231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
15. ASTM C 260 Standard Specification for Air-Entraining Admixtures for Concrete
16. ASTM C 309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
17. ASTM C 494 Standard Specification for Chemical Admixtures for Concrete
18. ASTM C 618 Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

D. NSF INTERNATIONAL (NSF)

1. NSF/ANSI 61 Drinking Water System Components - Health Effects.

1.4 DEFINITIONS

A. Average Strength (f_{cr}): The required average strength for 30 consecutive strength tests which statistically assures not more than the permissible proportions of tests will fall below Specified Strength.

B. Specified Strength (f_c'): The indicated strength.

1.5 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 – Submittal Procedures.

B. Provide catalog information for all products to be used as part of the submitted mix design.

C. The results of trial mix designs along with a statement giving the maximum nominal coarse aggregate size and the proportions of all ingredients that will be used in the manufacture of each strength of concrete, at least 14 days prior to commencing concrete placing operations. Aggregate weights shall be based on the saturated surface dry condition. The statement shall be accompanied by test results from an independent commercial testing laboratory, attesting that the proportions selected will produce

concrete of the qualities indicated. No substitutions shall be made in the materials used in the work without additional tests to show that the quality of the concrete is satisfactory. Indicate whether mixes have been designed for pumping. Include in the report the following information:

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

D. Preapproved Mix Design Data: If supplier has on record, an OWNER approved mix design, submit name and address of supplier for each mix design 1 day prior to using concrete mix.

E. Certified copies of laboratory test reports, including all test data, for aggregate, admixtures, and curing compound. These tests shall be made by an approved commercial laboratory or by a laboratory maintained by the manufacturers of the materials. Test reports shall meet the following requirements:

1. Date of mix design: No older than 365 days from the date of submission.
2. Physical properties of the aggregate: Test results shall not be older than 455 days from the date of submission. A new report will be required if aggregate source is changed.

F. Cementitious Materials showing Manufacturer's certification of compliance, accompanied by mill test reports attesting that the materials meet the requirements of the specification under which it is furnished, for cement and pozzolan.

G. Submit catalog information on the curing compound and the proposed location to be used.

1.6 QUALITY ASSURANCE

A. Do not change material sources, type of cement, air-entraining agent, water reducing agent, other admixtures, or aggregate without ENGINEER'S approval.

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

C. Do not change the quantity of cement per cubic yard for approved mix design without written approval of ENGINEER.

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

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

F. Tolerances for concrete construction and materials shall be in accordance with ACI 117.

1.7 PRODUCT STORAGE AND HANDLING

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

B. Stockpile aggregate to avoid segregation and prevent contamination.

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

1.8 MEASUREMENT AND PAYMENT

A. Cast-in-place concrete shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS

2.1 ADMIXTURES

A. Admixtures shall be approved by ENGINEER prior to use. Any admixtures to be used shall be included in proposed concrete mix designs.

B. Air Entrainment: ASTM C 260.

C. Later Reducing and Set Retarding Agents: ASTM C494.

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

* The relative durability factor of water reducing admixtures shall not be less than 80 and the chlorides content (as Cl^-) expressed as a percent of the cement shall not exceed 0.1 percent by weight.

D. Calcium Chloride: None allowed.

E. Pozzolan: Pozzolan conforming to the requirements of ASTM C 618, Class F, is allowed as a Portland cement replacing agent under the following conditions:

1. The maximum percentage of Portland cement replacement is:
   a. 15 percent, for concrete exposed to weather.
   b. 20 percent, for interior concrete.
2. Pozzolan should not exceed 25% by weight of the cement plus pozzolans.
3. The minimum cement content shall be used in the design formulas before replacement is made.
4. Loss of ignition of pozzolan is less than 3 percent and the water requirement does

not exceed 100 percent.

5. All other requirements of this section still apply.
6. Mix designs including trial batches are required for each aggregate source and for each concrete class.

F. Cementitious Materials showing Manufacturer's certification of compliance, accompanied by mill test reports attesting that the materials meet the requirements of the specification under which it is furnished, for cement and pozzolan.

2.2 CEMENTITIOUS MATERIALS

A. Cementitious materials shall each be of one type and from one source when used in concrete which will have surfaces exposed in the finished structure. Cementitious materials shall each be of one type and from one source when used in concrete which will have surfaces exposed in the finished structure. Cementitious materials shall conform to one of the following:

1. Cement: Use Portland cement, ASTM C 150, Type II, Type IIA, or Type V, low alkali, unless noted otherwise.
2. Portland - Pozzolan Cement: ASTM C-595, Type IP-A(MS). Do not use Pozzolan cement unless approved by ENGINEER

B. Only one brand of cement from one manufacturing plant may be used.

2.3 AGGREGATES

A. Aggregates shall be natural aggregates, free from deleterious coatings, and shall conform to the requirements of ASTM C 33, except as modified herein. Aggregates shall not be potentially reactive as defined in Appendix XI of ASTM C 33. CONTRACTOR shall import nonreactive aggregates if local aggregates are reactive.

B. Fine Aggregates

1. Fine aggregate shall consist of clean, sharp, natural sand and shall conform to the requirements of ASTM C 33. Fine aggregate shall be graded as follows:

FINE AGGREGATES	
Sieve Size	Percent Passing by Weight
3/8 inch	100
#4	95-100
#8	80-100
#16	50-85
#30	25-60
#50	10-30
#100	2-10

2. Fine aggregates shall have no more than two percent by weight passing #200 sieve.

C. Coarse Aggregate

1. Coarse aggregate shall be washed gravel or crushed stone, or a combination of

these materials, consisting of hard, tough, durable particles free from adherent coatings. It shall contain no more than 15 percent flat or elongated particles. A thin, flat or elongated particle is defined as a particle having a maximum dimension in excess of five times its minimum dimension. Aggregate which has disintegrated or weathered badly under exposure conditions similar to those which will be encountered in the work under consideration shall not be used. Coarse aggregate shall be graded as follows (ASTM C 33):

COARSE AGGREGATES	
Sieve Size	Percent Passing by Weight
1-1/2 inch	100
1 inch	95-100
½ inch	25-60
#4	0-10
#8	0-5

2. Coarse aggregates shall have no more than 1.75 percent by weight passing #200 sieve. Proof of gradation will be provided to ENGINEER by CONTRACTOR.

2.4 ACI MIX DESIGN

A. The amount by which the average strength (f_{cr}) of a concrete mix exceeds the specified compressive strength (f'_c) shall be based upon no more than 1 in 100 random individual strength tests falling more than 500 psi below the specific strength.

B. Proportion the materials in accordance with ACI 211.1, 211.2 or 211.3 as applicable to produce concrete having the properties or limitations of Table No. 03 30 00-A.

2.5 HAND MIXING

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

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

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

2.6 HEATING, WATER AND AGGREGATE

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

B. Heat mixing water to maximum temperature of 150 degrees F. Heat aggregates uniformly.

C. Do not mix cement with water and aggregate at a mix temperature greater than 100 degrees F.

2.7 WATER

A. Water shall be potable, except that non-potable water may be used if it produces mortar cubes having 7- and 28-day strengths at least 90 percent of the strength of similar

specimens made with water from a municipal supply. The strength comparison shall be made on mortars, identical except for mixing water, prepared and tested in accordance with ASTM C 109. Water for curing shall not contain any substance injurious to concrete, or which causes staining.

2.8 PROPORTIONS OF MIX

A. Mixture Proportioning, Normal Weight Concrete: All concrete that must be watertight and resistant to freeze-thaw cycles and to naturally occurring or commonly used chemicals should be air entrained. All materials should be proportioned to produce a well-graded mixture of high density and maximum workability with a minimum specified 28 day compressive strength of concrete classification. Trial batches shall contain materials proposed to be used in the project. Trial mixtures having proportions, consistencies and air content suitable for the work shall be made based on methodology described in ACI 211.1, using at least three different water-cement ratios. Trial mixes shall be proportioned to produce concrete strengths specified. In the case where ground iron blast-furnace slag is used, the weight of the slag will be substituted in the equations for the term P which is used to denote the weight of pozzolan. Trial mixtures shall be designed for maximum permitted slump and air content. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192. They shall be tested at 7 and 28 days in accordance with ASTM C 39. From these test results a curve shall be plotted showing the relationship between water-cement ratio and strength. Maximum water-cement or water-cement plus pozzolan Ratio: 0.45.

B. Average Strength: In meeting the strength requirements specified, the selected mixture proportion shall produce an average compressive strength exceeding the specified strength by the amount indicated below. Where a concrete production facility has test records, a standard deviation shall be established. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected; shall represent concrete produced to meet a specified strength or strengths within 1,000 psi of that specified for proposed work; and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at other test age designated for determination of the specified strength.

TABLE NO. 03 30 00-A

CONCRETE MIX PROPERTIES (e)			
CONCRETE PROPERTIES	CONCRETE CLASSIFICATION(S)		
	Class 4000	Class 3500	Class 3000
Specified Compressive Strength $f_{c'}$ at 28 days, min., psi	4,000	3,500 (d)	3,000 (d)
Compressive Strength at 7 days, min., psi (a)	2,680	2,345	2,010
Cement content (94 lb. sacks of cement per cubic yard of concrete), min. (b)	6.0	5.75	5.5
Entrained air content, (% by volume).	6±1	6±1	6±1
Slump Range, in. (c)	1 - 4 (f)	2 - 4	2 - 4
Maximum Water Cement Ratio	0.45	0.45	0.45

(a) Used for monitoring purposes only.
(b) May include pozzolan replacements if approved by ENGINEER.
(c) Not more than 8 inches after adding high range water reducing admixture (super-plasticizer) at site.
(d) Not allowed if concrete is exposed to freezing and thawing temperatures. Use Class 4000 or higher compressive strength and 6±1.0 percent air entrainment.
(e) All mix designs must be approved by ENGINEER.
(f) 1-3" for footings, sub-structural walls and 1-4" for slabs, beams, reinforced walls and columns.

2.9 CURING MATERIALS

A. Normal Curing Compound

1. Curing compound shall be white pigmented and shall conform to ASTM C 309, Type 2 Class B.
2. Sodium silicate compounds cannot be used.
3. Manufacturer, or approved equal:
   a. 1200-White by W.R. Meadows
   b. White Resin Cure J10W by Dayton Superior
   c. Safe-Cure 2000 by ChemMasters
   d. Aqua Kure White by Lambert Corporation

B. Dissipating Curing Compound

1. When the curing compound must be removed for finishes or grouting, compounds shall be of a dissipating type, conforming to the requirements of ASTM C 309, Type 1 or Type 2, Class B

2. Manufacturer, or approved equal:
   a. 1100-Clear by W.R. Meadows
   b. Kurez DR VOX by Euclid Chemical Company
   c. Clear Cure VOC J7WB by Dayton Superior
   d. Safe-Cure Clear DR by ChemMasters

PART 3 EXECUTION

3.1 GENERAL

A. CONTRACTOR shall inform ENGINEER at least 72 hours in advance of time and places at which CONTRACTOR intends to place concrete. All preparation work for concrete placements shall be substantially completed at least 2 workdays prior to the scheduled start of concrete placement to allow for ENGINEER's review and any necessary corrections.

3.2 PREPARATION OF SURFACES

A. Surfaces to receive concrete shall be clean and free from frost, ice, mud, and water. Conduit and other similar items shall be in place and clean of any deleterious substance.

B. Foundations: Earthwork shall be as specified. Flowing water shall be diverted without washing over freshly deposited concrete. Rock foundations shall be cleaned by high velocity air-water jets, sandblasting, or other approved methods. Debris and loose, semi-detached or unsound fragments shall be removed. Rock surfaces shall be moist but without free water when concrete is placed. Semi porous subgrades for foundations and footings shall be damp when concrete is placed. Pervious subgrades shall be sealed by blending impervious material with the top 6 inches of the in-place pervious material or by covering with an impervious membrane.

C. Preparation of Previously Placed Concrete: Concrete surfaces to which other concrete is to be bonded shall be roughened in an approved manner that will expose sound aggregate uniformly without damaging the concrete. Laitance and loose particles shall be removed. Surfaces shall be moist but without free water when concrete is placed.

3.3 INSTALLATION OF EMBEDDED ITEMS

A. Embedded items shall be free from oil, loose scale or rust, and paint. Embedded items shall be installed at the locations indicated and required to serve the intended purpose. Voids in sleeves, slots and inserts shall be filled with readily removable material to prevent the entry of concrete.

B. Reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms at locations as indicated or shown on the Contract Drawings. Proper placement and locations shall be the responsibility of CONTRACTOR.

3.4 BATCHING, MIXING AND TRANSPORTING CONCRETE

A. Ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C 94, except as otherwise specified. Truck mixers, agitators, and non-agitating units shall comply with NRMCA TMMB-1. Ready-mix plant equipment and facilities shall

be certified in accordance with NRMCA-QC 3.

B. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quantity and quality of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by ENGINEER.

C. Truck mixers and their operation must be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than 1 inch when the specified slump is 3 inches or less, or more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

D. Admixtures: Admixtures shall be batched within an accuracy of 3 percent. Where two or more admixtures are used in the same batch, they shall be batched separately and must be compatible. Retarding admixture shall be added within one minute after addition of water is complete or in the first quarter of the required mixing time, whichever is first. Superplasticizing admixtures shall be added at the project site, and the concrete with the admixture shall be mixed 4 to 5 minutes before placing as recommended by manufacturer. Concrete that shows evidence of total collapse or segregation caused by the use of admixture shall be removed from the site.

E. Control of Mixing Water: No water from the truck system or elsewhere shall be added after the initial introduction of mixing water for the batch. No water shall be added at the jobsite without the approval of ENGINEER.

3.5 SAMPLING AND TESTING

A. Sampling and Testing of the concrete will be as defined in Section 01 45 00 – Quality Control and Material Testing.

1. Aggregates: Aggregates for normal weight concrete shall be sampled and tested in accordance with ASTM C 33.
2. Sampling of Concrete: Samples of concrete for air, slump, unit weight, and strength tests shall be taken in accordance with ASTM C 172.
    a. Air Content: Test for air content shall be performed in accordance with ASTM C 173 or ASTM C 231. A minimum of 1 test shall be conducted each time a slump test is made.
    b. Slump: At least 1 slump test shall be made on randomly selected batches of each mixture of concrete for every 100 cubic yards of ready-mixed concrete delivered to the job site. Also note the time batched at the plant and the starting time when unloading began at the site. Tests shall be performed in accordance with ASTM C 143.

c. Temperature: Concrete and air temperatures shall be measured and recorded with each set of cylinders and the air temperature shall also be recorded when the air temperature at the site is 40 degrees F or below and/or 90 degrees F or above.

3. Evaluation and Acceptance of Concrete
   a. Frequency of Testing: Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, nor less than once for each 100 cubic yards of concrete, nor less than once for each 3,000 square feet of surface area for slabs or walls. If this sampling frequency results in less than 5 strength tests for a given class of concrete, tests shall be made from at least 5 randomly selected trucks or from each truck if fewer than 5 truck loads are used. Field cured specimens for determining form removal time or when a structure may be put in service shall be made in numbers directed to check the adequacy of curing and protection of concrete in the structure. The specimens shall be removed from the molds at the age of 24 hours and shall be cured and protected, insofar as practicable, in the same manner as that given to the portion of the structure the samples represent.
   b. Testing Procedures: Cylinders for acceptance tests shall be molded and cured in accordance with ASTM C 31. Cylinders shall be tested in accordance with ASTM C 39. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at another specified test age.
   c. Evaluation of Results: Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength and no individual strength test result falls below the required strength by more than 500 pounds per square inch.
   d. Unless noted otherwise, make a minimum of five (5) concrete cylinders each time a test is required. When concrete is being placed in suspended slabs, beams and retaining walls make two (2) extra cylinders which must be cured on site. The extra cylinders will be used to determine when to remove forms and/or when to backfill.

B. Investigation of Low-Strength Test Results: When any strength test of standard-cured test cylinder falls below the specified strength requirement by more than 500 pounds per square inch, or if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that load-carrying capacity of the structure is not jeopardized. Nondestructive testing in accordance with ASTM C 597, ASTM C 803 or ASTM C 805 may be permitted by ENGINEER to determine the relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests, unless properly calibrated and correlated with other test data, shall not be used as a basis for acceptance or rejection. When strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores shall be determined by ENGINEER to least impair the strength of the structure. If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 60 to 80 degrees F, relative humidity less than 60 percent) for seven days before testing and shall be tested dry. If the concrete in the structure will be more than superficially wet under service conditions,

the cores shall be tested after moisture conditioning in accordance with ASTM C 42. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to or at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement. If the core tests are inconclusive or impractical to obtain, or if structural analysis does not confirm the safety of the structure, load tests may be directed by ENGINEER in accordance with the requirements of ACI 318. Concrete work evaluated by structural analysis or by results of a load test and found deficient shall be corrected in a manner satisfactory to ENGINEER. All investigations, testing, load tests, and correction of deficiencies shall be performed, and approved by ENGINEER, at the expense of CONTRACTOR.

3.6 CONVEYING CONCRETE

A. Concrete shall be conveyed from mixer to forms as rapidly as possible and within the time interval specified in paragraph 3.6 CONCRETE PLACEMENT by methods which will prevent segregation or loss of ingredients. Conveying concrete shall be in accordance with the requirements of ACI 304.

1. Chutes: When concrete can be placed directly from a truck mixer or other transporting equipment, chutes attached to this equipment may be used. Separate chutes will not be permitted except when specifically approved.
   a. Use metal or metal lined chutes with a maximum length of 20-feet.
   b. The minimum slopes of chutes shall be such that concrete of the indicated consistency will readily flow in them.
2. Buckets: Bucket design shall be such that concrete of the required slump can be readily discharged. Bucket gates shall be essentially grout tight when closed. The bucket shall provide means for positive regulations of the amount and rate of deposit of concrete in each dumping position.
3. Pumps: Concrete may be conveyed by positive displacement pumps when approved. Pump shall be the piston or squeeze pressure type. Pipeline shall be steel pipe or heavy duty flexible hose. Inside diameter of the pipe shall be at least three times the maximum size of the coarse aggregate. Distance to be pumped shall not exceed the limits recommended by the pump manufacturer. Concrete shall be supplied to the pump continuously. When pumping is completed, the concrete remaining in the pipeline shall be ejected without contaminating the concrete in place. After each use, the equipment shall be thoroughly cleaned. Flushing water shall be wasted outside the forms.

3.7 CONCRETE PLACEMENT

A. Mixed concrete which is transported in truck mixers or agitators or concrete which is truck mixed, shall be discharged within 1-1/2 hours or before the drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates. These limitations may be waived by ENGINEER if the concrete is of such slump after the 1-1/2 hour time or 300 revolution limit has been reached that it can be placed, without the addition of water to the batch. When the concrete temperature exceeds 85 degrees F, the time shall be reduced to 45 minutes. Concrete shall be placed within 15 minutes after it has been discharged from the truck.

1. Placing Operation: Concrete shall be handled from mixer to forms in a continuous manner until the approved unit of operation is completed. Adequate scaffolding, ramps and walkways shall be provided so that personnel and equipment are not supported by in-place reinforcement. Placing will not be permitted when the sun, heat, wind, or limitations of facilities furnished by CONTRACTOR prevent proper consolidation, finishing and curing. Concrete shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 4 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Concrete should not be allowed to drop through a cage of reinforcing steel. Depositing of the concrete shall be so regulated that it will be effectively consolidated in horizontal layers not more than 12 inches thick, except that all slabs shall be placed in a single layer. Concrete to receive other construction shall be screened to the proper level to avoid excessive shimming or grouting.
    a. Additional requirements for depositing concrete in walls include, but are not limited to:
        1) Deposit concrete in a continuous operation until section is completed.
        2) Place concrete in approximately horizontal layers 2 ft maximum thickness.
        3) Each layer of concrete shall be plastic when covered with following layer.
        4) Rate of vertical rise not more than 4 ft per hour.
        5) Pump concrete or use a tremie having varying lengths for placing concrete in columns and walls to prevent free fall of more than 4 ft.
        6) Allow concrete to thoroughly settle before top is finished. Remove all laitance, debris, and surplus water from surfaces at tops of forms by screeding, scraping, or other effective means.
    b. Additional requirements for depositing concrete in slabs include, but are not limited to:
        1) Deposit concrete in a continuous operation until section is completed.
        2) Concrete shall be deposited as nearly as practicable to its final position to avoid segregation due to rehandling or flowing.
        3) In sloping slabs, proceed uniformly from the bottom of the slab to the top for the full width of the placement.
2. Consolidation: Immediately after placing, each layer of concrete shall be consolidated by internal vibrators, except for slabs 4 inches or less. The vibrators shall at all times be adequate in effectiveness and number to properly consolidate the concrete; a spare vibrator shall be kept at the jobsite during all concrete placing operations. The vibrators shall have a frequency of not less than 8,000 vibrations per minute, and the head diameter and amplitude shall be appropriate for the concrete mixture being placed. Vibrators shall be inserted vertically at uniform spacing over the area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator so that the area being vibrated will overlap the adjacent just-vibrated area by a few inches. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding layer if there is such. Vibrator shall be held stationary until the concrete is consolidated and then withdrawn slowly. The use of form vibrators must be specifically approved. Vibrators shall not be used to transport concrete within the forms. Slabs 4 inches and less in thickness shall be consolidated by properly designed vibrating screeds or other approved technique.

B. Cold Weather Requirements: Cold weather requirements shall conform to ACI 306 and

this Specification. Special protection measures, approved by ENGINEER, shall be used if freezing temperatures are anticipated before the expiration of the specified curing period. Provisions should be made to keep the concrete at a minimum temperature of 50 degrees F for 7 days. The ambient temperature of the air where concrete is to be placed and the temperature of surfaces to receive concrete shall be not less than 32 degrees F. No concrete shall be placed on frozen ground. The temperature of the concrete when placed shall be not less than 55 degrees F nor more than 75 degrees F. Heating of the mixing water or aggregates will be required to regulate the concrete placing temperature. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals or other materials shall not be incorporated in the concrete to prevent freezing. Calcium chloride shall not be used.

C. Hot Weather Requirements: Hot weather requirements shall conform to ACI 305 and this Specification. The temperature of the concrete placed during hot weather shall not exceed 85 degrees F except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. In no case shall the placing temperature exceed 95 degrees F.

3.8 CONSTRUCTION JOINTS

A. Construction joints shall be located as indicated on the Contract Drawings. Where concrete work is interrupted by weather, end of work shift or other similar type of delay, location and type of construction joint shall be subject to approval of ENGINEER. Unless otherwise indicated and except for slabs on grade, reinforcing steel shall extend through construction joints. Construction joints in slabs on grade shall be keyed or doweled as shown. Concrete columns, walls, or piers shall be in place at least 2 hours, or until the concrete is no longer plastic, before placing concrete for beams, girders, or slabs thereon. In walls having door or window openings, lifts shall terminate at the top and bottom of the opening. Other lifts shall terminate at such levels as to conform to structural requirements or architectural details. Where horizontal construction joints are required, a strip of 1-inch square-edge lumber, beveled and oiled to facilitate removal, shall be tacked to the inside of the forms at the construction joint. Concrete shall be placed to a point 1 inch above the underside of the strip. The strip shall be removed 1 hour after the concrete has been placed, and any irregularities in the joint line shall be leveled off with a wood float, and all laitance shall be removed. Prior to placing additional concrete, horizontal construction joints shall be prepared as specified in paragraph 3.1, PREPARATION OF SURFACES.

3.9 FINISHING CONCRETE

A. Formed Surfaces

1. Repair of Surface Defects: Surface defects shall be repaired within 24 hours after the removal of forms. Honeycombed and other defective areas shall be cut back to solid concrete or to a depth of not less than 1 inch, whichever is greater. Edges shall be cut perpendicular to the surface of the concrete. The prepared areas shall be dampened and brush-coated with neat cement grout. The repair shall be made using mortar consisting of not more than 1 part cement to 2-1/2 parts sand. The mixed mortar shall be allowed to stand to stiffen (approximately 45 minutes), during which time the mortar shall be intermittently remixed without the addition of water. After the mortar has attained the stiffest consistency that will permit placing, the patching mix

shall be thoroughly tamped into place by means approved by ENGINEER and finished slightly higher than the surrounding surface. For Class A and Class B finished surfaces the cement used in the patching mortar shall be a blend of job cement and white cement proportioned to produce a finished repair surface matching, after curing, the color of adjacent surfaces. Holes left after the removal of form ties shall be cleaned and filled with patching mortar. Holes left by the removal of tie rods shall be reamed and filled by dry-packing. Repaired surfaces shall be cured as required for adjacent surfaces. The temperature of concrete, mortar patching material, and ambient air shall be above 50 degrees F while making repairs and during the curing period. Concrete with defects which affect the strength of the member or with excessive honeycombs will be rejected, or the defects shall be corrected as directed by ENGINEER.

2. Class A Finish: Where a Class A finish is indicated, fins shall be removed. A mortar mix consisting of one-part Portland cement and two parts well-graded sand passing a No. 30 sieve, with water added to give the consistency of thick paint, shall be prepared. White cement shall be used to replace part of the job cement. After the surface has been thoroughly wetted and allowed to approach surface dryness, the mortar shall be vigorously applied to the area by clean burlap pads or by cork or wood-floating, to completely fill all surface voids. Excess grout shall be scraped off with a trowel. As soon as it can be accomplished without pulling the mortar from the voids, the area shall be rubbed with burlap pads until all visible grout film is removed. The rubbing pads shall have on their surfaces the same sand-cement mix specified above but without any mixing water. The finish of any area shall be completed in the same day, and the limits of a finished area shall be made at natural breaks in the surface. The surface shall be continuously moist cured for 48 hours. The temperature of the air adjacent to the surface shall be not less than 50 degrees F for 24 hours prior to, and 48 hours after, the application. In hot, dry weather the smooth finish shall be applied in shaded areas.
3. Class B Finish: Where a Class B finish is indicated, fins shall be removed. Concrete surface shall be smooth with a texture at least equal to that obtained through the use of Grade B-B plywood forms.
4. Class C Finish: Where a Class C finish is indicated, fins shall be removed. Concrete surfaces shall be relatively smooth with a texture imparted by the forms used.
5. Class D Finish: Where a Class D finish is indicated, fins exceeding 1/4 inch in height shall be chipped or rubbed off. Concrete surfaces shall be left with the texture imparted by the forms used.
6. See Specification Section 09 90 00 Painting and Finishes for required finishes.

B. Unformed Surfaces: In cold weather, the air temperature in areas where concrete is being finished shall not be less than 50 degrees F in accordance with ACI 306R. In hot windy weather when the rate of evaporation of surface moisture, as determined by methodology presented in ACI 305R, may reasonably be expected to exceed 0.2 pounds per square foot per hour; coverings, windbreaks, or fog sprays shall be provided as necessary to prevent premature setting and drying of the surface. The dusting of surfaces with dry materials or the addition of water during finishing will not be permitted. Finished surfaces shall be plane, with no deviation greater than 5/16-inch when tested with a 10-foot straightedge. Surfaces shall be pitched to drains.

1. Rough-Slab Finish: Slabs to receive fill or mortar setting beds shall be screened with straightedges immediately after consolidation to bring the surface to the required

finish level with no coarse aggregate visible.

2. Float Finish: Slabs to receive a steel trowel finish and slabs where indicated shall be given a float finish. Screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. After the concrete has stiffened to permit the operation and the water sheen has disappeared, it shall be wood floated. Concrete that portrays stickiness shall be finished with a magnesium float in lieu of a wood float, and left free of ridges and other projections. Float finish is normally specified for surfaces that will receive other treatment such as built-up roofing, nonslip surfacing material. Float Finish shall not be used on wearing surfaces.
3. Trowel Finish: Slabs where indicated, shall be given a trowel finish immediately following floating. Surfaces shall be trowelled to produce smooth, dense slabs free from blemishes including trowel marks. In lieu of hand finishing, an approved power finishing machine may be used in accordance with the directions of the machine manufacturer. A final hard steel troweling shall be done by hand. Trowel finish shall be used on wearing surfaces and where a smooth finish is required.
4. Broom Finish: After floating, slabs where indicated, shall be lightly troweled, and then broomed with a fiber-bristle brush in a direction transverse to that of the main traffic.
5. See Specification Section 09 90 00 Painting and Finishes for required finishes.

3.10 CURING AND PROTECTION

A. General: All concrete shall be cured by an approved method for the period of time given below:

Concrete with Type III cement	3 days
Concrete with Type II or IIA, or V, low alkali cement	7 days
Concrete with Type IP-A(MS) cement blended with pozzolan	10 days

B. Immediately after placement, concrete shall be protected from premature drying extremes in temperatures, rapid temperature change, mechanical injury and injury from rain and flowing water. Air and forms in contact with concrete shall be maintained at a temperature above 50 degrees F for the first 3 days and at a temperature above 32 degrees F for the remainder of the specified curing period. Exhaust fumes from combustion heating units shall be vented to the outside of the enclosure and heaters and ducts shall be placed and directed so as not to cause areas of overheating and drying of concrete surfaces or to create fire hazards. All materials and equipment needed for adequate curing and protection shall be available and at the site prior to placing concrete. No fire or excessive heat shall be permitted near or in direct contact with the concrete at any time. Curing shall be accomplished by any of the following methods, or combination thereof, as approved.

C. Moist Curing: Concrete to be moist-cured shall be maintained continuously wet for the entire curing period. If water or curing materials used stains or discolors concrete surfaces which are to be permanently exposed, the concrete surfaces shall be cleaned. When wooden forms are left in place during curing, they shall be kept wet at all times. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Horizontal surfaces shall be cured by

ponding, by covering with a 2-inch minimum thickness of continuously saturated sand, or by covering with waterproof paper, polyethylene sheet, polyethylene-coated burlap or saturated burlap. Once the moist curing has started the concrete surface must not be allowed to become surface dry for the entire curing period.

D. Membrane Curing:

1. Normal membrane curing compound shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete. Use a Dissipating curing compound for surfaces which are to be painted or are to receive bituminous roofing or waterproofing, or floors that are to receive adhesive applications of resilient flooring.
2. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing or flooring specified. Membrane curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam.
3. Curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface.
4. Surfaces shall be thoroughly moistened with water and the curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period.
5. Compound shall be applied in a one-coat continuous operation by mechanical spraying equipment, at a uniform coverage in accordance with the manufacturer's printed instructions.
6. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified.
7. On surfaces permanently exposed to view, the surface shall be shaded from direct rays of the sun for the duration of the curing period.
8. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

3.11 QUALITY CONTROL TESTING

A. Quality Control Testing shall be in accordance with Section 01 45 00 – Quality Control and Material Testing.

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SECTION 03 31 05

CONTROLLED LOW STRENGTH MATERIAL (CLSM or FLOW FILL)

PART 1 GENERAL

1.1 REQUIREMENTS

A. CONTRACTOR shall provide Controlled Low Strength Material (all called CLSM or Flow Fill), complete and in place, in accordance with the Contract Documents.

B. CLSM shall be placed where indicated and may be used, if ENGINEER approves, for the following purposes:

1. Normal CLSM with high slump, non-segregating consistency that readily flows and fills voids and difficult to reach places: pipe zone fill, trench zone fill, pipe abandonment, structure backfill, and structure cavity fill.
2. Foundation CLSM is used where higher early strengths are required and future excavation is not likely to be required.

1.2 RELATED WORK

A. Related work in other sections includes but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 31 23 15 Excavation and Backfill for Buried Pipelines

1.3 REFERENCES

A. The latest edition of the following publications form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM C 33 Standard Specification for Concrete Aggregates
2. ASTM C 94 Standard Specification for Ready-Mixed Concrete
3. ASTM C 138 Standard Test Method for Density (Unit Weight), Yield and Air Content (Gravimetric) of Concrete
4. ASTM C 150 Standard Specification for Portland Cement
5. ASTM C 260 Standard Specification for Air-Entraining Admixtures for Concrete.
6. ASTM C 403 Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
7. ASTM C 494 Standard Specification for Chemical Admixtures for Concrete
8. ASTM C 618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
9. ASTM C 803 Standard Test Method for Penetration Resistance of Hardened Concrete
10. ASTM D 4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
11. ASTM D 4832 Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

1.4 SUBMITTALS

A. Submittals shall be furnished in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings:

1. CLSM mix designs which show the proportions and gradations of all materials proposed for each type of CLSM indicated. Each mix design shall be accompanied by independent laboratory test results of the indicated properties.
2. If Contractor proposes to provide lower strength CLSM with aggregates that do not conform to ASTM C 33, Shop Drawings shall include a testing program that will be used to control the variability of the aggregates. The testing program shall be acceptable to ENGINEER.

1.5 QUALITY ASSURANCE:

A. All testing will be done by a testing laboratory at CONTRACTOR'S expense, except as otherwise indicated.

B. If tests of the CLSM show non-compliance with the specifications, CONTRACTOR shall make changes as may be required to achieve compliance. Performing and paying for subsequent testing to show compliance shall be CONTRACTOR's responsibility.

C. Correlation Tests

1. CONTRACTOR shall perform a field correlation test for each mix of CLSM used in pipe zone, trench zone, or backfill used in amounts greater than 100 cubic yards or when CLSM is required to support traffic or other live loads on the fill less than 7 days.
2. Field correlation tests shall be performed in a test pit similar in cross section to the WORK and at least 10-feet long at a location near the WORK. The proposed location shall be acceptable to ENGINEER.
3. Laboratory and field tests shall be performed on samples taken from the same CLSM batch mix. All tests shall be performed by a laboratory at CONTRACTOR's expense.
4. Testing shall be performed once each 2-hours during the first 8 hours, once each 8-hours during the first week, and once each 24-hours until the CLSM mix reaches the maximum design strength.
    a. Compression testing shall be in accordance with ASTM D 4832.
    b. Setting test shall be in accordance with ASTM C 403.
    c. Density tests shall be in accordance with ASTM C 138.

PART 2 PRODUCTS

2.1 CONTROLLED LOW STRENGTH MATERIAL

A. CLSM shall be a mixture of cement, pozzolan, coarse and fine aggregate, admixtures, and water, mixed in accordance with ASTM C 94.

B. Composition: The following parameters shall be within the indicated limits and as necessary to produce the indicated compressive strengths.

1. The actual mix proportions and flow characteristics shall be determined by the producer of the CLSM to meet requirements for compressive strength as specified for Normal CLSM or Foundation CLSM.
2. Entrained air content shall be between 15 percent minimum and 30 percent maximum.
3. Water reducing agent content as necessary.

C. Properties

1. Density shall be between 120 PCF minimum and 145 PCF maximum.
2. Slump shall be as required by CONTRACTOR methods, but shall not promote segregation, nor shall slump exceed 10 inches.
3. Compressive strength at 28 days:
   a. Normal CLSM: Between 100 psi minimum and 300 psi maximum. Unless specifically indicated otherwise, all CLSM shall be Normal CLSM.
   b. Foundation CLSM: 500 psi to 1,000 psi.

2.2 CEMENT

A. Cement shall be Type ll in accordance with ASTM C 150.

2.3 POZZOLAN

A. Pozzolan shall be Type F or C in accordance with ASTM C 618. Pozzolan content, by weight, in Normal CLSM, shall not be greater than 90 percent.

2.4 AGGREGATE

A. Aggregate shall consist of a well graded mixture of crushed rock, soil, or sand, with a nominal maximum size of 3/8-inch. One hundred percent shall pass the 1 inch sieve; no more than 30 percent shall be retained on the 3/8-inch sieve; and no more than 12 percent shall pass the number 200 sieve. If more than 5 percent of the aggregate passes the number 200 sieve, the material passing the number 200 sieve shall have a plasticity index of less than 0.73(liquid limit-20), when tested in accordance with ASTM D 4318. All aggregate shall be free from organic matter and shall not contain more alkali, sulfates, or salts than the native materials at the Site.

2.5 ADMIXTURES

A. Air entraining admixtures shall be in accordance with ASTM C 260.

B. Water reducing admixtures shall be in accordance with ASTM C 494.

2.6 WATER

A. Water shall be potable, clean, and free from objectionable quantities of silt, organic matter, alkali, salt, and other impurities.

PART 3 EXECUTION

3.1 PREPARATION

A. Subgrade and compacted fill to receive CLSM shall be prepared according to Section 31 23 15 Excavation and Backfill for Buried Pipelines.

3.2 BATCHING, MIXING AND DELIVERY

A. Batching, mixing, and delivery of CLSM shall conform to ASTM C 94. CLSM shall be mixed at a batch plant acceptable to the ENGINEER and shall be delivered in standard transit mix trucks.

3.3 PLACEMENT

A. CLSM shall be placed by tailgate discharge, conveyor belts, pumped, or other means acceptable to the ENGINEER. CLSM shall be directed in place by vibrator, shovel, or rod to fill all crevices and pockets. Avoid over-consolidation which causes separation of aggregate sizes.

B. CLSM shall be continuously placed against fresh material unless otherwise approved by ENGINEER. When new material is placed against existing CLSM, the placement area shall be free from all loose and foreign material. The surface of the existing material shall be soaked a minimum of one hour before placement of fresh material but no standing water shall be allowed when placement begins.

C. CLSM placement for piping. Pipe shall be placed on soil pads and bedding placed under the pipe from one side and vibrated, as necessary, so that the CLSM flows to the opposite side. CLSM shall then be added to both sides of the pipe and vibrated until it fills the space between the pipe and the excavated trench bottom. CLSM shall be deposited in such a manner as to avoid uplift and deposited in its final position to avoid disturbing the pipe trench causing foreign material to mix with the cement slurry.

D. Pipe zone backfill shall not be placed or compacted until the CLSM has reached initial set. Pipes placed on steep slopes may require a stiffer mix to prevent CLSM from flowing down the trench. Vibration may be required to ensure that the CLSM fills all voids.

E. Temperature of the CLSM shall be between 50 and 90 degrees F, when placed. CLSM shall not be placed when the air temperature is below 40 degrees F. No CLSM shall be placed against frozen subgrade or other materials having temperature less than 32 degrees F.

3.4 FINISHING

A. The finish surface shall be smooth and to the grade indicated or directed by the ENGINEER. Surfaces shall be free from fins, bulges, ridges, offsets, and honeycombing. Finishing by wood float, steel trowel, or similar methods is not required.

3.5 CURING

A. CLSM shall be kept damp for a minimum of 7 days or until final backfill is placed.

3.6 PROTECTION

A. CLSM shall be protected from freezing for 72 hours after placement.

B. No fill or loading shall be placed on CLSM until probe penetration resistance, as measured in accordance with ASTM C 803 exceeds 650 psi.

C. CLSM shall be protected from running water, rain, and other damage until the Material has been accepted and final fill completed.

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SECTION 03 60 00
GROUT

PART 1 GENERAL

1.1 REQUIREMENTS

A. CONTRACTOR shall provide grout, complete and in place, in accordance with the Contract Documents.

B. Unless indicated otherwise, grouts shall be provided as listed in this Section whether indicated on the Contract Drawings or not.

C. The following types of grout are covered in this Section:

1. Cement Grout
2. Non-Shrink Grout – Class I (cement based)
3. Non-Shrink Grout – Class II (cement based)
4. Non-Shrink Epoxy Grout
5. Epoxy Anchor Grout for Adhesive Anchors
6. Topping Grout and Concrete/Grout Fill

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 01 60 00 Product Requirements
3. Section 03 30 00 Cast-in-Place Concrete

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. American Society for Testing Materials (ASTM)

1. ASTM C 33 Standard Specification for Concrete Aggregates
2. ASTM C 136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
3. ASTM C 150 Standard Specification for Portland Cement
4. ASTM C 307 Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings
5. ASTM C 494 Standard Specification for Chemical Admixtures for Concrete
6. ASTM C 496 Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
7. ASTM C 531 Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
8. ASTM C 579 Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

9. ASTM C 580 Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
10. ASTM C 827 Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
11. ASTM C 881 Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
12. ASTM C 882 Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear
13. ASTM C 939 Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
14. ASTM C 942 Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory
15. ASTM C 1090 Standard Test Method for Measuring Changes in Height of Cylindrical Specimens of Hydraulic-Cement Grout
16. ASTM C 1107 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
17. ASTM C 1339 Standard Test Method for Flowability and Bearing Area of Chemical-Resistant Polymer Machinery Grouts
18. ASTM D 648 Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
19. ASTM D 695 Standard Test Method for Compressive Properties of Rigid Plastics

1.4 CONTRACTOR SUBMITTALS

A. Submittals shall be furnished in accordance with Section 01 33 00 – Submittal Procedures.

B. Provide the following submittals for each type of grout used on the project:

1. Test reports accompanied by a manufacturer’s statement that previously tested material is of similar type, quality, and manufacture as that which is proposed for use on this project shall be submitted for:

    a. Cement
    b. Aggregates
    c. Retardants
    d. Bonding compounds
    e. Epoxy Resin

2. Certifications that grouts used on the project contain no chlorides or other chemicals that cause corrosion.
3. Manufacturer’s literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each type of grout used in the WORK, and location of use. ICBO/ES report shall be submitted for epoxy anchor grout for adhesive anchors.

4. Manufacturer’s certification that non-shrink grout does not contain aluminum, zinc, or magnesium powders as a method of expansion.
5. Submit manufacturer's written warranty as indicated herein.

6. Name and telephone number of grout manufacturer's representative who will give on-Site service. The representative shall have at least one year of experience with the indicated grouts.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Grout and grout materials shall be stored in a dry shelter, protected from moisture, and for prepackaged grout, maintained in accordance with the manufacturer's recommendations.

1.6 QUALITY ASSURANCE

A. The work shall be subject to inspection at all times by OWNER and ENGINEER for the purpose of determining that the work is properly executed in accordance with this specification. Failure to detect defective workmanship or material during any interim inspection shall not constitute acceptance of workmanship and materials.

B. All testing will be done by a testing laboratory at CONTRACTOR'S expense, except as otherwise indicated.

C. Field Tests

1. Compression test specimens will be taken from the first placement of each type of grout, and at intervals thereafter selected by ENGINEER.
2. Compression tests and fabrication of specimens for cement grout and cement based non-shrink grout will be performed in accordance with ASTM C 1107, at intervals during construction selected by ENGINEER. A set of 3 specimens will be made for testing at 7 Days, 28 Days, and each additional time period as appropriate.
3. Compression tests and fabrication of specimens for topping grout and concrete/grout fill will be performed in accordance with Section 03 31 00 - Cast-in-Place Concrete, at intervals during construction selected by ENGINEER.
4. Compression tests and fabrication of specimens for epoxy grouts will be performed in accordance with ASTM C 579, Method B, at intervals during construction selected by ENGINEER. A set of 3 specimens will be made for testing at 7 Days and each earlier time period as appropriate.

D. Construction tolerances shall be as indicated in Section 03 31 00 Cast-in-Place Concrete unless noted otherwise.

PART 2 PRODUCTS

2.1 MATERIALS

A. Cement: Portland cement shall be ASTM C 150 Type II of Type V.

B. Aggregate:

1. General: Aggregate shall be non-reactive and shall be washed before use. When sources of aggregate are changed, test reports shall be provided for the material from the new source prior to commencing grout work.

2. Fine Aggregate: Fine aggregate shall be sand or crush stone conforming to ASTM C 33 as modified herein. When tested in accordance with ASTM C 136, gradation shall be such that 100 percent by weight passes a No. 8 sieve and not less than 45 percent by weight passes a standard No. 40 sieve. Variation from the specified gradation in individual tests will be accepted if the average of three consecutive tests is within the following variation:

Standard Sieve	Permissible Variation in Individual Test
No. 30 or coarser	2% by weight
No. 50 or finer	0.5% by weight

C. Admixtures

1. General: Admixtures shall be compatible with the grout and shall comply with the manufacturer's recommendations. Admixtures shall be added to the grout mix separately.
2. Water Reducing Retarder: Water reducing retarder shall comply with ASTM C 494, Type D and shall be **Master Builders (BASF) MasterSet R 300, Sika Corporation Plastiment**, or approved equal.
3. Lubricant: Lubricant additive for cement pressure grouting shall be **Sika Intraplast**, or approved equal.

D. Water:

1. Water for washing aggregate, for mixing and for curing shall be potable, shall not contain more than 1,000 mg/L of chlorides as Cl, nor more than 1,300 mg/L of sulfates as SO_4, and shall not contain impurities which may change the setting time by more than 25 percent or a reduction of more than 5 percent of the compressive strength of the grout at 14 days when compared to the results for grout made with distilled water.

2.2 CEMENT GROUT

A. Application: Surface repairs of concrete.

B. Cement grout shall be composed of one part cement, 3 parts sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white Portland cement shall be blended with regular cement as needed. The minimum compressive strength at 28 Days shall be 4000 psi.

C. Cement grout materials shall be as indicated in Section 03 31 00 Cast-in-Place Concrete.

2.3 NON-SHRINK GROUT

A. General

1. Non-shrink cementitious grout shall be a flowable, prepackaged, inorganic, non-metallic, cement type grout requiring only the addition of water. Cement from kilns burning metal-rich hazardous waste fuel shall not be used. The manufacturer shall have at least 10 years' experience in the manufacture of cement based grouts. The

manufacturer shall provide technical services and provide a representative at the jobsite for product training prior to product installation.
2. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout shall be as recommended by the manufacturer for the particular application.
3. Grout shall not contain chlorides or additives that may contribute to corrosion.
4. Grout shall be formulated to be used at any consistency from fluid to plastic.
5. Cement-based non-shrink grout shall have the following minimum properties when tested at a fluid consistency, at 28 Days:
   a. Minimum tensile splitting strength of 500 psi per ASTM C 496.
   b. Minimum flexural strength of 1,000 psi per ASTM C 580.
   c. Minimum bond strength (concrete to grout) of 1,900 psi per modified ASTM C 882.
   d. Grout shall be certified for use in freeze/thaw environments.

B. Class I Non-Shrink Grout

1. Application: Anchor bolts and reinforcing steel required to be set in grout in which the average working or operating temperature will be over 100 degrees F or in high fire risk areas; Beam and column (1 or 2 story) base plates less than 16-inches in the least dimension; Storage tanks and other non-motorized equipment and machinery under 30 horsepower; Filling blockout spaces for embedded items such as railing posts, gate guide frames, etc.; Repair of holes and defects in concrete members which are not water bearing and not in contact with soil or other fill material; and any other location not specifically listed in this Section or on the Contract Drawings.
2. Class I non-shrink grout shall have a minimum 28 Day compressive strength of 5,000 psi when mixed at a fluid consistency.
3. Class I non-shrink grout shall meet the requirements of ASTM C 1107, Grade B or C, when mixed to fluid, flowable, and plastic consistencies.
4. Grout shall have a maximum early age height change of 4.0% expansion, and shall have no shrinkage (0.0%) in accordance with ASTM C 827. The grout when tested shall not bleed or segregate at maximum allowed water.
5. Grout shall have no shrinkage (0.0%) and a maximum of 0.3% expansion in the hardened state when tested in accordance with ASTM C 1090.
6. Furnish certification that the non-shrink property of grout is not based on gas production or gypsum expansion.
7. Class I Non-Shrink Grout shall be **Five Star Grout by Five Star Products, Sikagrout 212 by Sika Corporation, CB-G PG by Hilti**, or equal.

C. Class II Non-Shrink Grout

1. Application: Column base plates (greater than 2 story or larger than 16-inches in the least dimension); under precast concrete elements; and repair of holes and defects in concrete members which are water bearing or in contact with soil or other fill materials.
2. Class II non-shrink grout shall be a high precision, fluid, extended working time, grout. The minimum 28-Day compressive strength shall be 7,500 psi, when mixed at a fluid consistency.
3. Grout shall have a maximum early age height change of 4.0% expansion, and shall have no shrinkage (0.0%) in accordance with ASTM C 827.

4. Grout shall have no shrinkage (0.0%) and a maximum of 0.3% expansion in the hardened state when tested in accordance with ASTM C 1090.
5. Class II non-shrink grout shall have an extended working time of 30 minutes minimum when mixed to a fluid consistency as defined in ASTM C 827 at temperature extremes of 45 to 90 degrees F in accordance with ASTM C 1107.
6. Class II non-shrink grout shall meet the requirements of ASTM C 1107, Grade B or C when tested using the amount of water needed to achieve fluid consistency per ASTM C 939.
7. The grout when tested shall not bleed or segregate at maximum allowed water content.
8. Provide certification that its non-shrink property is not based on gas production or gypsum expansion.
9. Class II non-shrink grout shall be **Five Star Fluid Grout 100 by Five Star Products**, **Crystex by L&M Construction Chemicals**, or equal.

2.4 NON-SHRINK EPOXY GROUT

A. Application: Pumps over 1,000 horsepower, unless indicated otherwise.

B. Non-shrink epoxy grout shall be a flowable, non-shrink, 100 percent solids system. The epoxy grout system shall have 3 components: resin, hardener, and specially blended aggregate, each premeasured and prepackaged. The resin component shall not contain any non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged.

C. Epoxy grout shall have a maximum early age height change of 4.0% expansion, and shall have no shrinkage (0.0%) in accordance with ASTM C 827, (modified for epoxy grouts by using an indicator ball with a specific gravity between 0.9 and 1.1).

D. Epoxy grout shall have a negligible (less than 0.0006 in/in) length change after hardening, and a coefficient of thermal expansion less than $18x10^{-6}$ in/in F when tested according to ASTM C 531.

E. The epoxy grout shall develop a minimum compressive strength of 9,000 psi in 24 hours and 13,000 psi in seven days when tested in accordance with ASTM C 579, method B.

F. The mixed epoxy grout shall have a minimum working life of 90 to 120 minutes at 70 degrees F.

G. The effective bearing area shall be a minimum of 95 percent EBA in accordance with ASTM C 1339.

H. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application. Do not reduce aggregate loading or add solvents to increase flowability.

I. Non-shrink epoxy grout shall have the following minimum properties when tested at 7 Days:

1. Minimum bond strength to concrete of 3,000 psi per ASTM C 882 modified.
2. Minimum bond strength to steel of 1,700 psi per ASTM C 882 modified.
3. Minimum flexural strength of 2,500 psi per ASTM C 580.
4. Minimum tensile strength of 2,000 psi per ASTM C 307.

J. Non-shrink epoxy grout shall be **Five Star DP Epoxy Grout by Five Star Products, Inc., Sikadur 42 Grout-Pak by Sika Corporation**, or equal.

2.5 EPOXY ANCHOR GROUT

A. Application: Anchor bolts and reinforcing steel required to be set in grout that is not in high temperature or high fire risk areas.

B. Epoxy anchor grout shall conform to ASTM C 881, Type IV, Class A, B, and C, Grade 3 with the exception of gel time.

C. Heat deflection temperature shall be a minimum of 139 °F per ASTM D 648.

D. Manufacturer shall certify that the epoxy anchor grout will maintain 90 percent of its strength up to a temperature of 125 °F.

E. Grout shall come in a 2 chambered cartridge with a metering system that provides the proper ratio of hardener and resin. The grout shall also come with a static mixer nozzle to thoroughly mix the hardener and resin together.

F. Epoxy anchor grout shall be capable of being used in submersed applications once cured.

G. Minimum compressive strength shall be 12,000 psi per ASTM D 695.

H. Overhead anchors and anchors in fire-resistive construction shall be cast-in anchors.

I. Embedment of adhesive anchors/rebar shall be deep enough to develop the anchor/rebar. Embedment shall not exceed 67 percent of the member depth.

J. Epoxy anchor grout shall be **Epcon C6+ by ITW Ramset/Red Head, Power-Fast Epoxy Injection Gel by Powers Fasteners, RE 500 by Hilti**, or equal.

2.6 TOPPING GROUT AND CONCRETE/GROUT FILL

A. Where fill is thicker than 3-inches, structural concrete as indicated in Section 03 31 00 - Cast-in-Place Concrete, may be used when accepted by ENGINEER.

B. Grout for topping of slabs and concrete/grout fill for built-up surfaces of tank, channel, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and be mixed as indicated. Materials and procedures indicated for normal concrete in Section 03 31 00 - Cast-in-Place Concrete, shall apply unless indicated otherwise.

C. Topping grout and concrete/grout fill shall contain a minimum of 564 pounds of cement per cubic yard with a maximum water cement ratio of 0.45. Topping grout in clarifiers shall contain between 750 and 800 pounds of cement per cubic yard with a maximum water cement ratio of 0.42.

D. Coarse aggregate shall be graded as follows:

U.S. Standard Sieve Size	Percent By Weight Passing
1/2 in	100
3/8 in	90-100
No. 4	20-55
No. 8	5-30
No. 16	0-10
No. 30	0

E. Final mix design shall be as determined by trial mix design as indicated in Section 03 30 00 - Cast-in-Place Concrete.

F. Topping grout and concrete grout/fill shall contain air-entraining agent per Section 03 30 00 – Cast-in-Place Concrete.

G. **Strength:** Minimum compressive strength of topping grout and concrete/grout fill at 28 Days shall be 4,000 psi.

2.7 CONSISTENCY

A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is defined such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as indicated herein for the particular application.

B. The slump for topping grout and concrete/grout fill shall be adjusted to match placement and finishing conditions but shall not exceed 4-inches.

PART 3 EXECUTION

3.1 PREPARATION

A. Remove defective concrete, laitance, dirt, oil, grease and other foreign material from concrete surfaces by brushing, hammering, chipping or other similar means until sound, clean concrete surface is achieved.

B. Rough concrete lightly, but not enough to interfere with placement of grout.

C. Remove foreign materials from metal surfaces in contact with grout.

D. Align, level, and maintain final positioning of components to be grouted.

3.2 GENERAL

A. CONTRACTOR shall arrange for the manufacturer of prepackaged grouts to provide on-Site technical assistance within 72 hours of request, as part of the WORK.

B. Grout shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by ENGINEER.

C. When cementitious grouts are used on concrete surfaces, the concrete surface shall be saturated with water for 24 hours prior to placement. Upon completion of the saturation period, excess water shall be removed. Concrete substrate shall not be wet prior to placement of epoxy grouts.

D. Surface preparation, curing, and protection of cement grout shall be in accordance with Section 03 30 00 – Cast-in-Place Concrete. The finish of the grout surface shall match that of the adjacent concrete unless otherwise indicated.

E. Surfaces that will be in contact with grout shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.

F. Shade the WORK from sunlight for at least 24 hours before and 48 hours after grouting.

G. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

3.3 GROUTING PROCEDURES

A. **General:** Mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

B. Structural, equipment, tank, and piping support bases shall be grouted, unless indicated otherwise.

1. The original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum one-inch thickness of grout or other thickness if indicated.
2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout through a headbox of appropriate size. The mixture shall be of a fluid consistency and poured continuously into the space between the plate and the base concrete. Forms for grout shall be tight against retaining surfaces, and joints shall be sealed as recommended by the grout manufacturer to be liquid-tight. Forms shall be coated as recommended by the grout manufacturer for easy form release. Where this method of placement is not practical or where required by ENGINEER, alternate grouting methods shall be submitted for acceptance by ENGINEER.
3. Concrete equipment pads for equipment bases that will be epoxy-grouted shall be sized so that, when the equipment base is fully grouted, the epoxy grout is stopped not less than 4-inches from the edge of the pad.

C. Drilled Anchors and Reinforcing Bars

1. General
   a. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions. Holes shall be roughened with a brush on a power drill, and cleaned. Drilled anchors shall not be installed until the concrete has reached the required 28 Day compressive strength. Anchors shall not be loaded until the grout has reached its indicated strength in accordance with the manufacturer's instructions.

b. CONTRACTOR shall identify position of reinforcing steel and other embedded items prior to drilling holes. Care shall be exercised in coring and drilling to avoid damaging existing reinforcing or embedded items. Notify ENGINEER if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and communications conduit, and piping.

2. Epoxy Adhesive Anchors
   a. Grout shall be proportioned and mixed with automatic equipment.
   b. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the manufacturer's ICBO/ES report, but shall not be less than 8 diameters for threaded rod or 12 diameters for reinforcing or smooth bars.
   c. Holes required for grouting shall be blown or vacuumed clean and are to be free of dust and standing water. Horizontal holes for grouting are to be drilled at a slight downward angle and with the inserted dowel or bolt bent to match.
3. Cement Based Non-Shrink Grout
   a. In places of high temperature or fire hazard, anchor bolts shall be grouted in using cement based non-shrink grout, Class I.
   b. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the manufacturer's ICBO/ES report, but shall not be less than 16 diameters for threaded rod or 24 diameters for reinforcing or smooth bars.
   c. When the bolt diameter is one-inch or less, the hole diameter should be a minimum of 2-inches. When the bolt diameter is greater than one-inch, the hole diameter should be at least twice the bolt diameter.
   d. Drilled holes shall be saturated with water for not less than 24 hours before installation of anchor/rod/rebar.
   e. The non-shrink grout should be placed in the holes in a non-sag (trowelable) consistency. The grout should be placed in the holes before the anchor and then the anchor inserted and vibrated to ensure proper coverage.

D. Topping Grout and Concrete/Grout Fill

1. Mechanical, electrical, and finish WORK shall be completed prior to placement of topping or concrete/grout fill. To ensure bonding to the base slab, the base slab shall be given an exposed aggregate finish. Alternatively, where accepted by ENGINEER, the base slab shall be given a roughened textured surface by a close-spaced rake while the surface is green. After curing, high pressure washing shall expose the aggregates and produce not less than a 3/16-inch amplitude roughness. Jackhammers or chipping hammers shall not be used.
2. The minimum thickness of grout topping and concrete/grout fill shall be one-inch. Where the finished surface of concrete/grout fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3-1/2 inches wide by 1-1/2 inches deep.
3. The base slab shall be thoroughly cleaned and wetted to saturated surface dry (SSD) condition per the International Concrete Repair Institute (ICRI) -- Technical Guide for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays, prior to placing topping and fill. No topping concrete shall be placed until the slab is completely free from standing pools or ponds of water. A thin coat of neat cement grout shall be broomed into the surface

of the slab just before topping or fill placement. The neat cement grout shall not be allowed to dry before topping placement. If it does dry, it must be immediately removed using wet stiff brooms and reapplied. The topping and fill shall be compacted by rolling or thorough tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade. Coat surface with evaporation retardant as needed to prevent plastic shrinkage cracks.

4. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.
5. The surface shall be tested with a straight edge to detect high and low spots that shall be immediately eliminated. When the topping or fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement, or mixture of dry cement and sand shall be applied to the surface.
6. As soon as topping or fill finishing is completed, coat surface with curing compound. After the topping is set and sufficiently hard in clarifiers and where required by ENGINEER, the tank shall be filled with sufficient water to cover the entire floor for 14 days.

3.4 CONSOLIDATION

A. Grout shall be placed in such a manner, for the consistency necessary for each application, to assure that the space to be grouted is completely filled.

3.5 CURING

A. Cement based grouts shall be cured per 03 30 00 – Cast-in-Place Concrete and per the manufacturer's recommendations.

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SECTION 04 22 00
REINFORCED UNIT MASONRY

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section covers reinforced unit masonry and appurtenant work.

1.2 RELATED WORK

A. Related Work in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 03 20 00 Concrete Reinforcement
3. Section 03 30 00 Cast-in-place Concrete
4. Section 07 21 00 Insulation
5. Section 07 92 00 Joint Sealants
6. Section 09 90 00 Painting and Finishes

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICA CONCRETE INSTITUTE (ACI)

1. ACI SP-66 ACI Detailing Manual
2. ACI 530 Building Code Requirements for Masonry Structures
3. ACI 530.1 Specifications for Masonry Structures

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 641 Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
2. ASTM A 951 Standard Specification for Steel Wire for Masonry Joint Reinforcement
3. ASTM A 1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
4. ASTM C 90 Standard Specification for Load-Bearing Concrete Masonry Units
5. ASTMC 140 Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
6. ASTM C 144 Standard Specification for Aggregate for Masonry Mortar
7. ASTM C 150 Standard Specification for Portland Cement
8. ASTM C 207 Standard Specification for Hydrated Lime for Masonry Purposes
9. ASTM C 270 Standard Specification for Mortar for Unit Masonry
10. ASTM C 404 Standard Specification for Aggregates for Masonry Grout
11. ASTM C 476 Standard Specification for Grout for Masonry
12. ASTM C 578 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
13. ASTM C 652 Standard Specification for Hollow Brick (Hollow Masonry Units Made From Clay or Shale)

14. ASTM C 1019 Standard Test Method for Sampling and Testing Grout
15. ASTM C 1314 Standard Test Method for Compressive Strength of Masonry Prisms
16. ASTM C 1384 Standard Specification for Admixtures for Masonry Mortars
17. ASTM D 226 Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
18. ASTM D 2000 Standard Classification System for Rubber Products in Automotive Applications
19. ASTM D 2287 Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
20. ASTM E 514 Standard Test Method for Water Penetration and Leakage Through Masonry
21. ASTM E 518 Standard Test Methods for Flexural Bond Strength of Masonry

D. NATIONAL CONCRETE MASONRY ASSOCIATION (NCMA)

1. NCMA-TEK 45 Removal of Stains from Concrete Masonry Walls

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Product Data: Submit manufacturer's product data for each type of masonry unit, accessory, and other manufactured products, including certifications that each type complies with specified requirements and color samples. Include in the submittal dimensioned drawings for each type of block to be used on the project including, but not limited to, standard field block, lintel block, end block, caps, etc. Submit certificates showing compliance to the specifications for reinforcing steel, manufacturer’s literature for anchor ties and any other accessories used, grout and mortar mix design, samples for mortar color selection, and manufacturer’s literature for mortar and grout admixtures used along with CONTRACTOR’s proposed usage details.

C. Three sample specimens of the masonry units proposed for incorporation into the project shall be submitted to ENGINEER.

D. Shop Drawings: Submit shop drawings for fabrication, bending, and placement of reinforcement bars, complying with ACI SP-66. Show bar schedules, diagrams of bent bars, stirrup, spacing, lateral ties, and other components required for fabrication and placement of masonry reinforcement.

E. Submit product data for premolded control joint strips and joint sealant.

F. A minimum 4-ft square free-standing sample panel shall be prepared for approval before starting masonry work. The panel shall remain at the site for reference until masonry work is completed.

1.5 QUALITY ASSURANCE

A. Masonry units shall be sampled and tested in accordance with ASTM C 140.

B. CONTRACTOR shall have mortar and grout tested to assure compliance with the Specifications and the governing codes by a testing laboratory approved by ENGINEER. The test reports shall be submitted to ENGINEER.

1. Tests shall be taken at the following times:
   a. At commencement of masonry work, at least 2 samples each of mortar and grout shall be taken on 3 successive days.
   b. At any change in materials or job conditions, at least 2 samples of each modified material, grout and mortar shall be tested.
   c. Make four (4) random tests each of mortar and grout. The random test samples shall be taken when requested by ENGINEER.
   d. The costs of tests shall be paid by CONTRACTOR as part of the work. The costs of additional tests, when required to verify compliance when requested by OWNER or ENGINEER, will be paid by OWNER. When tests do no verify compliance, the cost of additional tests shall be paid by CONTRACTOR.
2. Samples shall be stored in a moist environment until tested, unless directed otherwise by ENGINEER or the testing laboratory. Testing for mortar shall be in accordance with ASTM C 270. Testing for grout shall be in accordance with ASTM C 1019.

C. CONTRACTOR shall test the masonry units to assure compliance with the specifications and governing codes. Testing will be by a laboratory approved by ENGINEER.

1. Testing will be made of the following items:
   a. At the time of the construction of the sample panel, at least 3 masonry units shall be tested for each type of block, except separate tests are not required for block which only varies by texture.
   b. At any change in materials during construction, at least 3 masonry units shall be tested.
   c. Additional sets of at least 3 masonry units shall be tested whenever, in the judgment of ENGINEER, additional tests are necessary to determine the quality of the material.
   d. CONTRACTOR shall submit a letter of certification from the masonry unit supplier at the time of, or prior to, delivery of the materials to the site that the materials used in construction are representative of the materials used to construct the prisms.
2. The masonry units shall be sampled and tested in accordance with ASTM C 140

D. Whenever required under the provisions of the Building Code, the work shall be subject to inspection by a Special Inspector selected by ENGINEER and approved by the local building code representative having jurisdiction. Costs of such inspections will be paid by OWNER. The Special Inspector will work under the supervision of ENGINEER.

E. Cold weather construction shall be per ACI 530.1, IBC Section 2104.3, and the local code requirements, whichever is more stringent.

1.6 DELIVERY, STORAGE, AND HANDLING

A. CONTRACTOR shall be responsible to deliver, handle, and store masonry units by means which will prevent mechanical damage and deterioration due to moisture, temperature changes, and corrosion. CONTRACTOR shall provide protection which will limit moisture absorption of concrete masonry units to the maximum percentage

specified for Type I units for the average relative humidity at the project site, as reported by the nearest National Weather Service station.

B. Cementitious materials shall be stored off the ground and protected from moisture.

C. Aggregates shall be stored in a manner which will preserve grading characteristics.

D. Masonry accessories shall be stored to prevent corrosion, dirt accumulation, and other deterioration.

1.7 PROJECT CONDITIONS

A. Cold Weather Protection: Do no lay masonry units when outside air temperature is below 40 degrees F.

1. Grouted construction: On any day when the minimum anticipated nighttime temperature is 32 degrees F or less, in addition to complying with general procedures above, grout materials shall be heated to 90 degrees F to produce an in-place grout temperature of not less than 70 degrees F at end of work day. Protective blankets or enclosures shall remain in place for not less than 48 hours after placement of masonry units.
2. Water: Water for mortar or grout shall not be heated to more than 160 degrees F.

B. Hot-Weather Protection: Cover or shade masonry units and mortar materials and use cool water for mortar whenever ambient air temperature is 90 degrees F or greater. At air temperatures of 85 degrees F or above, if relative humidity is less than 30 percent or wind is in excess of 15 miles per hour, provide protection by immediately covering newly constructed walls by providing windbreaks, or by using fog spray to reduce rate of evaporation.

1.8 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for reinforced unit masonry. Full compensation for all reinforced unit masonry shall be considered as included in the contract unit or lump sum bid prices for the various items of the contract to which reinforced unit masonry relates.

PART 2 PRODUCTS

2.1 CONCRETE MASONRY UNITS

A. Concrete Block: Comply with referenced standards for types required, and as follows:

1. Unit, Grade and Type: Masonry units shall conform to the requirements of the following table:

Unit	ASTM	Grade	Type	Min Net Area[(1)] Compressive Strength (psi)
Concrete Masonry Unit (CMU)	C 90	Medium Weight	per Drawings	2,000
Note: (1) Average of 3 units				

2. Size: The size of masonry units shall be as indicated on the Contract Drawings. Special shapes and sizes shall be provided as required, whether or not specifically indicated on the Contract Drawings as special.
3. Surfaces: Special surface texture or architectural faces shall be provided where indicated on the Contract Drawings.
4. Color: Where the finished surface will be visible, masonry units shall have colors as indicated on the Contract Drawings. Where colors are not specified, OWNER shall determine colors to be provided.

2.2 MATERIALS

A. Portland Cement: ASTM C 150, Type II or IIA.

1. Type III may be substituted during cold-weather construction.

B. Hydrated Lime: ASTM C 207, Type S.

C. Aggregate for Mortar: Sand conforming to ASTM C 144.

D. Aggregate for Grout: ASTM C 404.

E. Admixture for grout, if used, shall be **Sika Grout Aid by Sika Corp.**,or approved equal.

F. Water: Clean and potable.

G. Masonry cleaner shall be a non-acidic cleaner, **SafEtch by Prosoco, Inc.**, or approved equal.

H. Accelerating Admixture: Non-chloride admixture for use in mortar mixes during cold weather, proportioned and mixed to comply with directions of manufacturer.

1. Products: The following products, provided they comply with requirements of ASTM C 1384 and the contract documents, will be among those considered acceptable.
   a. MORSET by Grace Construction Products
   b. or approved equal

I. Water-repellant and efflorescence control admixture.

1. All exterior masonry units shall utilize a water-repellant and efflorescence control admixture as recommended by the manufacturer to obtain ASTM E 514 test extended to 72 hours, class E rating.
2. Admixtures shall be MasterPel 240 (Rheopel Plus) by BASF, Eucon Blocktite by Euclid Chemical Company, or approved equal.

J. Integral water repellant admixture is required for mortar for exterior masonry units and shall be **MasterPel 240MA** (**Rheopel Plus Mortar Admixture) by BASF, Blocktite Mortar Admixture by Euclid Chemical Company,** or approved equal.

2.3 REINFORCEMENT AND ANCHORAGE

A. Reinforcing Bars shall be in accordance with Section 03 20 00 – Concrete Reinforcement.

B. Joint Reinforcement and Anchorage Materials: shall comply with ASTM A 951 and the following general requirements for materials required in joint reinforcement and anchorage devices.

1. Steel wire: ASTM A 1064.

a. Zinc coating: ASTM A 641 Class 1.
b. Application: Use at interior locations.

C. Joint Reinforcement: Provide welded-wire units prefabricated into straight lengths of not less than 10 feet, with deformed continuous side rods and plain cross rods, and as follows:

1. Width: Approximately 1-1/2 inches less than nominal wall width, providing not less than 1/2 inch mortar coverage on each exposure.
2. Wire sizes:
   a. Side rod diameter: 0.1483 inch.
   b. Cross rod diameter: 0.1483 inch.
3. Configuration:
   a. Applications of single unit width: Ladder design, cross rods at not more than 16 inches on center.
   b. Corners: Provide prefabricated L- and T-shaped units.

2.4 MISCELLANEOUS MASONRY ACCESSORIES

A. Premolded Control Joints Strips: Joints designed to fit standard sash block and to maintain lateral stability in masonry wall, of size and configuration indicated or as required for conditions, and as follows:

1. Styrene-butadiene rubber compound complying with ASTM D 2000, 2AA-805, or
2. Polyvinyl chloride complying with ASTM D 2287, Type PVC 654-4.

B. Bond Breaker Strips: Asphalt-saturated organic roofing felt complying with ASTM D 226, Type 1 (No. 15 asphalt).

C. Joint Sealant: Provide joint sealants in accordance with Section 07 92 00

2.5 MORTAR AND GROUT MIXES

A. General: Do not use admixtures unless indicated and approved by ENGINEER. Do not use calcium chloride in mortar or grout mixture.

B. Mixing: Combine and thoroughly mix ingredients in a mechanical batch mixer; comply with referenced ASTM standards for mixing time and water content.

C. Mortar for Unit Masonry: Comply with ASTM C 270 and IBC Section 2103.7, Proportion Specification, for types of mortar required, unless otherwise indicated.

1. Limit cementitious materials in mortar to Portland cement and lime.
2. Use Type S mortar for reinforced masonry. Compressive strength: 1800 psi @ 28 days.

3. Mortar for use with colored masonry units shall have the integral color as approved by OWNER.

D. Grout: Comply with ASTM C 476 and IBC 2103.10 for grout used in construction of unit masonry elements. Use grout of consistency indicated or as required at time of placement to fill completely all spaces intended to receive grout. Compressive strength: 2000 psi @ 28 days.

1. Use fine grout in spaces less than 2 inches in least horizontal dimension, unless otherwise indicated.
2. Use coarse grout in spaces 2 inches or more in least horizontal dimension, unless otherwise indicated.
3. Mortar for use with colored masonry units shall have the integral color as approved by OWNER.

2.6 MASONRY SEALERS

A. Sealers shall be as noted in Section 09 90 00 - Painting and Finishes.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION PROCEDURES

A. Concrete Masonry Units: Do not wet concrete masonry units prior to laying.

B. Measurements for mortar and grout shall be accurately made. Shovel measurements are not acceptable. Mortar proportions shall be accurately controlled and maintained.

C. Reinforcing: Before placing masonry reinforcing, remove loose rust, dirt, and other coatings.

D. Masonry Thickness: Build masonry elements to full thickness shown.

1. Build single-wythe walls to actual thickness of masonry units, using units of size indicated.

E. Chases and Recesses: Build masonry to accommodate the work of other trades, including chases and recesses as shown or required. Provide not less than 8 inches of masonry between jambs of openings and chases and recesses.

F. Leave openings for equipment to be installed in masonry. After installation of equipment, complete masonry work to match work immediately adjacent to opening.

G. Cutting Masonry Units: Use motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining work. Use dry cutting saws to cut concrete masonry units.

H. Add insulation to open cells if required on the Contract Ddrawings. See Section 07 21 00 - Insulation.

I. Work shall be performed in accordance with ACI 530 and ACI 530.1, the latest edition of the IBC, and local governing codes for reinforced concrete hollow-unit masonry.

J. CONTRACTOR shall set or embed anchors, bolts, reglets, sleeves, conduits, and other items as required.

3.2 CONSTRUCTION TOLERANCES

A. Variation from Plumb: Do not exceed the following construction tolerances in vertical elements, including surfaces of walls, columns, and arises:

1. 1/4 inch to 10 feet
2. 3/8 inch to one story height, or 20 feet, whichever is less, except 1/4 inch for external corners, expansion joints, and other highly conspicuous vertical elements
3. 1/2 inch for 40 feet or more
4. Plus or minus 1/4 inch in 10 feet, 1/2 inch maximum, for vertical alignment of head joints.

B. Variation from Level: Do not exceed the following construction tolerances for bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous horizontal elements:

1. 1/4 inch in one bay or in 20 feet maximum
2. 1/2 inch in 40 feet or more

C. Variation from Plan Lines: Do not exceed the following horizontal construction tolerances for related portions of columns, walls, and partitions:

1. 3/8 inch in any bay of 16 feet maximum
2. 1/2 inch in 32 feet or more

D. Variation in Cross Section: Do not exceed the following masonry elements:

1. Minus 1/4 inch
2. Plus 1/2 inch

E. Variation in Mortar Joint Thickness: Do not exceed the following construction tolerances for thickness of mortar joints:

1. Bed joints: Plus or minus 1/8 inch
2. Head joints: Plus or minus 1/8 inch

3.3 MASONRY CONSTRUCTION - GENERAL

A. Layout: Lay out masonry for accurate pattern bond, for uniform joint widths, and for accurate location of specific features before beginning actual construction. Avoid use of masonry units of less than 1/2 size. Do not use units with less than nominal 4 inch horizontal face dimensions at corners and jambs.

B. Pattern Bond: Lay exposed masonry in 1/2 running bond with vertical joints in each course centered on units in course above and below except where other bonds are indicated at special features.

1. Lay concealed masonry with all units in a wythe in running bond.
2. Bond and interlock each course of each wythe at corners.

C. Reinforced Concrete Unit Masonry: Maintain vertical continuity of core or cell cavities. Keep cavities clear of mortar, including bed area of first course, to provide minimum clear dimension indicated, to provide minimum clearance and grout coverage for vertical reinforcement bars, and to provide direct grout contact with supporting surfaces.

D. Stopping and Resuming Work: Lay masonry in proper sequence to avoid toothing. Rack walls back in each course at end of each day. Before resuming, clean exposed surfaces and remove loose masonry units and mortar.

E. Built-in Work: As work progresses, build in items indicated for installation in masonry, filling around built-in items solidly with masonry.

1. Fill spaces between metal frames and masonry elements solidly with mortar, unless otherwise indicated.

F. Install lintels of types indicated at all openings.

1. Bearing: Provide not less than 8 inches of bearing at each jamb unless otherwise indicated.
2. Reinforcement: At masonry openings greater than one foot in width, install horizontal joint reinforcement in 2 horizontal joints approximately 8 inches apart immediately above lintel and immediately below sill. Extend reinforcement which is in addition to required continuous joint reinforcement not less than 24 inches beyond jambs of the opening, except at control joints.

G. Formwork: Provide temporary formwork and shores as required for temporary support of reinforced masonry elements. Construct formwork to shape line, and dimensions shown. Make sufficiently tight to avoid leakage of mortar and grout.

1. Brace, tie, and support as required to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other reasonable temporary loads that may be placed on them during construction.

3.4 MORTAR BEDDING AND JOINTING

A. Lay hollow masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be grouted or filled with concrete.

B. Maintain joint widths indicated, except for minor variations required to maintain bond alignment. Except as otherwise indicated, maintain joint widths of 3/8 inch.

C. Cut joints flush for masonry walls which are concealed or covered by other materials, unless otherwise indicated.

D. Tool exposed joints slightly concave, using a jointer larger than joint thickness unless otherwise indicated.

E. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners of jambs to shift adjacent stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar, and reset in fresh mortar.

3.5 HORIZONTAL JOINT REINFORCEMENT OF SINGLE-WYTHE WALLS

A. General: Provide continuous horizontal joint reinforcement for all single-wythe masonry walls, unless otherwise indicated. Lap reinforcing a minimum of 6 inches.

B. Install joint reinforcing in mortar joints at not more than 16 inches on center vertically.

C. Cut or interrupt joint reinforcement at control and expansion joints.

D. Provide continuity at corners and wall intersections by means of prefabricated L- and T-shaped sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.6 INSTALLATION OF REINFORCEMENT

A. Preparation: Do not use reinforcement bars with kinks or bends not shown on Contract Drawings or final shop drawings. Do not use bars with cross section reduced due to excessive rusting and other causes.

B. Placement: Position reinforcement bars accurately at spacings indicated. Support and secure vertical bars against displacement. Horizontal bars may be placed as the work progresses. Provide not less than the greater of either the bar diameter or 1 inch clear between bars. For columns, piers, and pilasters, provide a clear distance between vertical bars as indicated, but not less than 1-1/2 times the nominal bar diameter or 1-1/2 inches, whichever is greater.

C. Splicing: Provide lapped splices at locations shown; do not splice at other points or by other methods, unless approved by ENGINEER. Provide not less than minimum lap indicated, or as required by governing code.

3.7 GROUTING

A. Grouting Technique:

1. Provide minimum clear dimension of 2 inches and minimum clear area of 8 square inches in vertical cores to be grouted. Place vertical reinforcement prior to laying concrete masonry units, extending above elevation of maximum pour height as required for splicing. Support in position at vertical intervals not exceeding 192 bar diameters or 10 feet, whichever is less.
2. Grout shall be placed in all open areas of the masonry block as specified herein.
3. Lay masonry units to maximum pour height, not to exceed 4 feet.
4. Pour grout using chute or container with spout. Vibrate grout during placement. Place grout continuously; do not interrupt pouring operation for more than 1 hour. Terminate pour 1-1/2 inches below top of highest course in pour, except at tops of walls.

5. Stop grout in vertical cells 1-1/2 inches below bond beam course. Place horizontal reinforcement in bond beams; lap at corners and intersections as shown. Place grout in bond beam course before filling vertical cores above bond beams.

3.8 REPAIR AND POINTING

A. Repair: Remove and replace masonry units which are loose, chipped, broken, stained, or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units, and install in fresh mortar or grout pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of mortar joints, enlarge any holes or voids except weep holes and completely fill with mortar. Point up all joints, including corners, openings, and adjacent work, to provide a neat and uniform appearance.

3.9 CLEANING AND PROTECTION

A. Clean masonry as follows after mortar is thoroughly set and cured:

1. Remove large mortar particles by hand, using wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel, leaving half of panel uncleaned for comparison.
3. Clean concrete unit masonry to comply with directions of masonry manufacturer and as recommended by NCMA in Tek Bulletin No. 45.

B. Protection: CONTRACTOR shall protect all masonry until such time as the Work is completed and accepted by ENGINEER.

3.10 FINISH

A. Block shall be finished as per Section 09 90 00 - Painting and Finishes.

- END OF SECTION –

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SECTION 05 45 00
MECHANICAL METAL SUPPORTS (PIPE SUPPORTS)

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section covers materials and installation of mechanical metal supports, pipe supports, hangers, guides, anchors and appurtenances as specified and indicated.

B. CONTRACTOR shall provide mechanical metal supports in accordance with this Section whether shown on the Contract Drawings or not.

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1.	Section 01 33 00	Submittal Procedures
2.	Section 05 50 00	Miscellaneous Metals
3.	Section 09 90 00	Painting and Finishes
4.	Section 33 05 03	Copper Pipe
5.	Section 33 05 05	Ductile Iron Pipe
6.	Section 33 05 07.1	PVC Pressure Pipe (ASMT 1785)
7.	Section 33 12 00	Mechanical Appurtenances
8.	Section 40 05 13.13	Steel Process Piping

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTING INDUSTRY (MSS)

1.	MSS SP-58	Pipe Hangers and Supports – Materials Design and Manufacture
2.	MSS SP-69	Pipe Hangers and Supports – Selection and Application
3.	MSS SP-89	Pipe Hangers and Supports – Fabrication and Installation Practices
4.	MSS SP-127	Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application

C. AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

1.	ASME B 31.1	Power Piping

D. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1.	ASTM A 36	Standard Specification for Carbon Structural Steel
2.	ASTM A 47	Standard Specification for Ferritic Malleable Iron Castings
3.	ASTM A 48	Standard Specification for Gray Iron Castings
4.	ASTM A 123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
5.	ASTM A 153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and

Steel Hardware

6. ASTM A 575 Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
7. ASTM A 576 Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. CONTRACTOR shall submit complete shop drawings of mechanical supports, pipe supports, hangers and guides. Provide scaled shop drawings showing locations of the supports and detailed drawings for each support. Identify each type of hanger or support by the manufacturer's part number of figure on the drawing.

C. Provide installation drawings and manufacturer's catalog information on each type of hanger and support.

D. Provide structural calculations for special supports and anchors, stamped and signed by a professional engineer registered in the State of Utah.

PART 2 MATERIALS

2.1 GENERAL

A. All pipe hanger and supports shall be manufactured to comply with MSS-SP-58, MSS-SP-569, MSS-SP-89 except as modified herein. Where applicable, design and manufacture must also conform to ANSI/ASME B31.1. Supports for plumbing or fire piping shall be in accordance with the latest edition of the applicable plumbing or fire code and the requirements of the local jurisdiction.

B. Hangers, supports, anchors and restraints must be designed in accordance with MSS-SP-127 to withstand all static and dynamic loading conditions which act upon the piping system and associated equipment. Piping supports and equipment must be considered as a total system and appropriate balance calculations made to determine load forces at critical stress points. Loading conditions to be considered may include, but are not limited to:

1. The total load of pipe, fittings, valves, insulation and any expected contents of the pipe.
2. Thermal expansion and contraction
3. Stress from cycling of equipment or process.
4. Vibration transmitted to or from equipment or terminal connection.
5. Wind, snow or ice loading on outdoor piping
6. Loading due to seismic forces

C. Static and dynamic forces at points of attachments must be considered to help ensure structural integrity of buildings or equipment. Hanger and supports must be selected so as to minimize the effect of piping system loading on the structure.

D. In general, piping shall be supported from structural members, such as walls, beams, columns and slabs, using approved structural attachments. In situations where

approved attachments cannot be used, alternative attachments or substructure assemblies must receive approval by ENGINEER prior to installation. Prior approval by ENGINEER must be given before any cutting or drilling of building structural steel. Damage to the structure through welding, cutting or drilling will not be permitted if it reduces the structures strength below the established safety factor for the structure. Any additional structural steel required to properly support piping or equipment shall be furnished and installed by CONTRACTOR at no additional cost to OWNER.

2.2 SUPPORT MATERIALS

A. Pipe supports, hangers, guides, etc. shall be hot-dip galvanized carbon steel, unless noted otherwise on the Drawings. Steel shall be in accordance with ASTM A 36, ASTM A 575, or ASTM A 576. Hot-dip galvanizing shall be in accordance with ASTM A 123 or ASTM A 153. Bases, rollers, and anchors shall be steel as described above or may be cast iron conforming to ASTM A 48. Pipe clamps shall be steel as described above or may be malleable iron conforming to ASTM A 47.

B. Submerged supports, as well as piping in hydraulic structures within 24 inches of the high water level, shall have supports, including hardware and anchors constructed of Type 316 stainless steel, unless noted otherwise on the Drawings.

C. Piping in chemical or corrosive areas shall have supports, including hardware and anchors constructed of Type 316 stainless steel or fiberglass reinforced plastic (FRP), unless noted otherwise on the Drawings.

D. Supports fabricated from other materials specified on the Drawings shall have a protective coating in accordance with the requirements of Section 09 90 00 – Painting and Coatings.

2.3 FLOOR MOUNTED SUPPORTS

A. Floor mounted pipe supports shall be the adjustable saddle support with stanchion, base and U-bolt or adjustable flange support type with stanchion and base. Pipe supports with stanchion and base plate shall be sized for the pipe or mechanical appurtenance it supports. All pipe supports shall have a 1-inch-high grouted pad to be used as a leveling base. Pipe supports shall be secured to the floor. An EPDM Rubber insulation pad shall be provided between the pipe and the U-Bolt.

2.4 SPRING-TYPE HANGERS

A. Spring-type hangers shall be provided for piping subject to vibration or vertical expansion/contraction such as engine exhaust piping. Design the spring-type hangers per the manufacturer’s recommendations.

2.5 CONCENTRATED LOADS

A. Concentrated loads, such as meters, valves, and equipment, on PVC piping systems shall have supports on each side of the concentrated load.

2.6 CONCRETE ANCHORS

A. Anchors shall be in accordance with Section 05 50 00 – Miscellaneous Metals.

2.7 MANUFACTURERS

A. Mechanical Metal Support (pipe support) manufacturers shall be **Anvil International Inc., B-Line by Eaton (Cooper Industries), Utility Coatings & Fabrication, Piping Technology & Products, Inc. (PT&P),** or approved equal. To be considered an approved equal, materials must be of similar diameter, thickness, and strength to the product specified

2.8 PIPE SUPPORTS FOR COPPER PRELUBE PIPE

A. Submit, furnish and install acceptable pipe support clamps for copper pipes. For attaching (copper) well prelube water pipe to DIP and connections to CLA valves, use **Erico ET 0050HD**, or acceptable equal. Submit acceptable attachments to attach (copper) well prelube pipe and valves to wellhead

PART 3 EXECUTION

3.1 GENERAL

A. Mechanical metal supports, pipe supports, hangers, guides, etc. shall be installed per the manufacturer's instructions and ASME B31.1 – Power Piping.

B. Pipe supports shall be positioned in order to produce an orderly, neat piping system. Hanger rods shall be vertical without offsets.

C. Hangers shall be adjusted to line up groups of pipes at the proper grade for drainage and venting as close to ceilings or roods as possible and without interference with other work.

D. Hangers shall be installed in a manner to prevent obstructing ladders, manhole covers, and access hatches.

E. Set embedded inserts accurately in position and support them rigidly before concrete is placed and prevent displacement during and after placement of concrete.

F. Provide separate hangers or supports at valves, meters, elbows, tees, and other equipment. Provide separate hangers on each both sides of each non-rigid joint or flexible coupling.

G. Install piping without springing, forcing, or stressing the pipe or any connecting valves, pumps, or other pipe to which the pipe is connected.

H. Hangers and supports for rigid plastic pipe shall be provided with a support shield to spread the load bearing surface.

I. Use of wire hangers, perforated strap, hanging from unreinforced metal deck and cellular roof deck are not permitted.

J. Repair or replace metal items damaged during installation. Follow the manufacturer's procedures for repairing damaged surfaces.

K. Galvanizing Field Repairs

1. Surface preparation shall consist of removing oil, grease, soil, and soluble material by cleaning with water and detergent (SSPC SP1) followed by brush-off blast cleaning (SSPC SP7) over an area extending at least 4 inches into the undamaged area.
2. The coating shall be applied to at least 3 mils dry film thickness and shall be **Zinc-Clad XI by Sherwin-Williams, Galvax by Alvin Products, Galvite by ZRC Worldwide**, or approved equal.

3.2 SUPPORT LOCATION AND SPACING

A. Supports for horizontal piping shall be spaced to prevent excessive sag, bending and stresses in the piping. Spacing shall not exceed the maximum indicated spans.

B. Maximum spans indicated in the tables below are for ambient temperatures or the temperatures listed for the materials and pipe wall thicknesses shown. Adjust the span spacing for different temperatures and/or pipe wall thicknesses per the manufacturer's recommendations.

C. Install pipe supports on horizontal and vertical runs at the spacing shown or detailed on the Drawings. If no spacing or rod sizes are given on the Drawings or in the specifications for a particular piping system, use the following tables or the recommendations of the support or pipe manufacturer.

1. Support Spacing for Steel Pipe (Section 40 05 13.13 – Steel Process Piping) Schedule 40 and Schedule 80:

Pipe Size (inches)	Maximum Span Water Service (feet)	Maximum Span Vapor Service (feet)	Minimum Hanger Rod Size (inches)
3/8 and smaller	4	5	3/8
1/2 through 1	6	8	3/8
1-1/4 through 2	8	10	3/8
2-1/2 through 3	10	14	1/2
3-1/2 through 4	10	15	5/8
6	12	20	3/4
8	12	24	3/4
Note: These spacings do not apply where span calculations are made or where there are concentrated loads between supports such as flanges, valves, specialties, etc. or changes in direction requiring additional supports.			

2. Support Spacing for Copper Pipe (Section 33 05 03 – Copper Pipe) per MSS-SP-69, Table 3:

Pipe Size (inches)	Maximum Span Water Service (feet)	Maximum Span Vapor Service (feet)	Minimum Rod Size (inches)
1/2	5	6	3/8
3/4	5	7	3/8
1	6	8	3/8
1-1/4	7	9	3/8
1-1/2	8	10	3/8
2	8	11	3/8

2-1/2	9	12	1/2
3	10	14	1/2
3-1/2	11	15	1/2
4	12	16	5/8
Note: These spacings do not apply where span calculations are made or where there are concentrated loads between supports such as flanges, valves, specialties, etc. or changes in direction requiring additional supports.			

3. Support Spacing for PVC Pipe (Section 33 05 07.1 – Polyvinyl Chloride Pipe) Schedule 40 and Schedule 80. The table below is meant as a general guideline and it is recommended that the pipe manufacturer be consulted for specific spacing recommendations relating to their pipe, load conditions, operating temperatures, and service conditions.

Pipe Size (inches)	Maximum Span Schedule 40 (feet)				Maximum Span Schedule 80 (feet)			
	60°F	80°F	100°F	120°F	60°F	80°F	100°F	120°F
1/2	4.5	4.5	4	2.5	5	4.5	4.5	3
3/4	5	4.5	4	2.5	5.5	5	4.5	3
1	5.5	5	4.5	3	6	5.5	5	3.5
1-1/4	5.5	5.5	5	3	6	6	5.5	3.5
1-1/2	6	5.5	5	3.5	6.5	6	5.5	3.5
2	6	5.5	5	3.5	7	6.5	6	4
2-1/2	7	6.5	6	4	7.5	7.5	6.5	4.5
3	7	7	6	4	8	7.5	7	4.5
4	7.5	7	6.5	4.5	9	8.5	7.5	5
6	8.5	8	7.5	5	10	9.5	9	6
8	9	8.5	8	5	11	10.5	9.5	6.5
10	10	9	8.5	5.5	12	11	10	7
12	11.5	10.5	9.5	6.5	13	12	10.5	7.5
Note: These spacings do not apply where span calculations are made or where there are concentrated loads between supports such as flanges, valves, specialties, etc. or changes in direction requiring additional supports.								
Data taken from Anvil International, Inc. Catalog PH-2006, page PH-213 and is based on continuous span and for un-insulated line carrying fluids of specific gravity up to 1.00.								

4. Supports for Ductile Iron Pipe (Section 33 05 05 – Ductile Iron Pipe) should be installed in locations shown on the Drawings with a minimum of one support per 20-foot length of pipe. If longer spans are required, the supports should be designed in accordance with DIPRA – Design of Ductile Iron Pipe on Supports and the pipe manufacturer's recommendations. Supports should be cradle type with a saddle angle of 120 degrees. The table below shows the recommended maximum spans per US Pipe – Long Span and Bridge Crossing Pipe guidelines.

Pipe Size (inches)	Maximum Span Water Service (feet)
6	28
8, 10	30
12, 14	35

16, 18	42
20 to 64	45
Note: These spacings do not apply where span calculations are made or where there are concentrated loads between supports such as flanges, valves, specialties, etc. or changes in direction requiring additional supports.	

5. Support Spacing for ABS Pipe (Section 33 05 01 – ABS Pipe) Schedule 40. The table below is meant as a general guideline and it is recommended that the pipe manufacturer be consulted for specific spacing recommendations relating to their pipe, load conditions, operating temperatures, and service conditions.

Pipe Size (inches)	Maximum Span Schedule 40 (feet)				
	60°F	80°F	100°F	120°F	140°F
1-1/2	6	6	5.5	3.5	3
2	6	6	5.5	3.5	3
3	7	7	7	4	3.5
4	7.5	7.5	7	4.5	4
6	8.5	8.5	8	5	4.5
Note: Plumbing code may require a maximum horizontal spacing of 4 feet for all pipe sizes. Verify requirement with the local governing agency.					

6. Support spacing for other pipe materials shall be based on recommendations from the pipe manufacturer.
7. Provide sway bracing for hangers where shown on the Drawings. If no bracing is shown, provide bracing at 10 foot maximum center-to-center intervals.

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SECTION 05 50 00
MISCELLANEOUS SPECIALTIES

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers materials, fabrication, and installation of miscellaneous metals, specialties, and appurtenances as specified and indicated.

1.2 RELATED SPECIFICATIONS

A. Fabrication and erection of the platforms, ladders and stairs shall be in accordance with the Specification for the Design, Fabrication and Creation of Structural Steel for Buildings of the latest edition of the A.I.S.C. Manual, and Section 1910.27 of the latest edition of the OSHA standards, except as specified herein.

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

1. Manual of Steel Construction

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 36 Standard Specification for Carbon Structural Steel
2. ASTM A 53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
3. ASTM A 123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
4. ASMT A 153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
5. ASTM A 276 Standard Specification for Stainless Steel Bars and Shapes
6. ASTM A 307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength
7. ASTM A 615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
8. ASTM F 593 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
9. ASTM F 594 Standard Specification for Stainless Steel Nuts

D. NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

E. AMP 510 Metal Stairs Manual

1.4 RELATED WORK

A. Related Work in other sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 09 90 00 Painting and Finishes

1.5 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. CONTRACTOR shall submit complete shop drawings of fabricated items, such as vents, ladders, stairs, platforms, beams, pipe supports, and miscellaneous metals for approval to Engineer.

C. Shop drawings shall conform to AISC recommendations and specifications, and shall show holes, and the like, as may be required for other parts of the work.

D. Shop drawings shall include complete details of members and connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams for the sequence of erection.

E. Submit manufacturer's catalog data and dimensional drawings for lifting eyebolts and inserts; ladder safety posts, manhole covers and frames, and anchor bolts.

F. Submit ICC ES Evaluation Reports for adhesive and wedge anchors and installer qualifications and procedures.

1.6 QUALITY ASSURANCE

A. Field Measurements: Take field measurement prior to preparation of Shop Drawings and fabrication to ensure proper fitting of the Work.

B. Shop Assembly: Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the project site. Disassemble units to the extent necessary for shipping limitations.

C. Fabricator Qualifications: Fabricators shall be regularly engaged in the manufacture of the types of steel specialties they are providing and shall have at least 5 years of experience in this specialty.

D. Qualifications: Qualify welding operators in accordance with requirements of current AWS Standard. Provide certification that all welders employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within the previous 12 months. Ensure that all certifications are kept current.

PART 2 MATERIALS

2.1 CARBON STEEL

A. Materials for bolted or welded steel construction shall conform to ASTM A 36.

2.2 STAINLESS STEEL

A. All bolts, expansion bolts, nuts, washers, and expansion sleeve inserts used to attach metal supports shall be stainless steel Type 316.

B. All interior tank ladders, wall conduits, louvers, vents and other items required shall be stainless steel unless noted otherwise.

2.3 HOT-DIPPED GALVANIZED

A. All steel vault vents, stairs, vault ladders, handrail, guardrail, stringers, beams and miscellaneous items shall be galvanized (zinc coated) unless noted otherwise.

B. Zinc coating for plates, bolts, anchor bolts, and threaded parts shall in in accordance with ASTM A 153. Structural steel shall be zinc coated in accordance with ASTM A 123.

2.4 BOLTS

A. Steel anchor and connection bolts for non-corrosive service shall conform to ASTM A 307, Grade A or B, unless otherwise noted. Bolts shall be hot-dip galvanized and provided with self-locking nuts or lock washers and plain nuts.

B. Steel anchor and connection bolts for corrosive service shall be fabricated from stainless steel, unless indicated otherwise in the specifications or on the Contract Drawings. Corrosive service locations are as listed below.

1. Buried locations
2. Submerged locations
3. Locations subject to occasional flooding
4. Inside hydraulic structures
5. Chemical handling areas
6. Inside buried manholes, vaults, and structures that do not have a gravity drain or sump pump
7. Inside trenches, containment walls, and curbed areas.

C. The nuts shall be capable of developing the full strength of the bolts. Bolts and cap screws shall have hexagon heads and nuts shall be heavy hexagon series. Bolts and nuts shall be installed with washers from material matching the base material of bolts. Lock washers fabricated from the material matching the bolts shall be installed where indicated.

D. The length of the bolts shall be such that the bolt extends at least 1/8 inch beyond the outside face of the nut before tightening, except for anchor bolts which shall be flush with the face of the nut before tightening.

2.5 LIFTING EYEBOLTS

A. Locate eyebolts and inserts over the centerline of the piping at locations shown on the Drawings. Eyebolts and inserts shall have a minimum safety factor of 3 and be rated for a working load of 3,000 pounds.

B. Provide inserts of the ferrule wing nut design with threads to match the eyebolts. Cast inserts in the roof slab of the vault at the locations identified on the Contract Drawings.

2.6 THREADED INSERTS

A. Threaded inserts shall be of ductile iron construction with standard National Course (NC) or United National Course (UNC) threads. Inserts shall be cast-in-place at the locations

shown on the Contract Drawings. Inserts shall be fabricated by **Meadow Burke**, or approved equal.

2.7 ADHESIVE ANCHORS

A. Unless otherwise indicated, drilled concrete or masonry anchors shall be adhesive anchors. No substitutions will be considered without an ICC ES Report verifying strength and material equivalency. Anchors used inside potable water reservoirs shall be ANSI/NSF 61 certified.

B. Adhesive anchors shall be a two component system consisting of an all threaded anchor rod with nut and washer, and the adhesive capsule. Anchor rods shall be Type 304 stainless steel conforming to ASTM F 593 with nuts conforming to ASTM F 594. The adhesive capsules shall contain a polyvinyl or urethane methacrylate-based resin and accelerator within a sealed dual chamber foil capsule. Adhesive anchors shall be **Hilti HVU2 Capsule Adhesive Anchoring System**, or approved equal.

2.8 WEDGE ANCHORS

A. Wedge type anchors shall be used only where indicated on the Contract Drawings. Wedge anchors shall be a stud type expansion anchor, torque controlled, with impact section to prevent thread damage. Stud and wedge shall be Type 304 or Type 316 stainless steel conforming to ASTM A 276. Nut shall be Type 304 or Type 316 stainless steel conforming to ASTM F 594 with washer of similar material. Wedge anchor bolts shall be **Hilti Kwik Bolt 1,** or approved equal. Anchors installed in non-submerged or non-corrosive environments may be carbon steel and be **Simpson Titen HD or Strong-Bolt 2**, or approved equal.

2.9 STEEL PIPE

A. Pipe for guard posts shall be Schedule 40 and pipe for vault vents shall be Schedule 10 conforming to ASTM A 53, unless noted otherwise on the Contract Drawings, and shall be hot-dip galvanized.

2.10 STEEL VENTS

A. Fabricate steel vents as shown on the Contract Drawings. Vents shall be welded steel construction and hot-dip galvanized after fabrication. Coating shall be in accordance with Section 09 90 00 – Painting and Finishes.

2.11 COVERS AND FRAMES

A. Manhole covers and frames shall be cast iron and designed for AASHTO HS-20 loading, unless otherwise indicated. Castings shall be smooth, clean and free from blisters, blowholes, and shrinkage. Covers shall seat firmly into the frames without rocking. Covers and frames shall fit together evenly such that the cover fits flush with the surrounding finished surface.

2.12 POLYPROPYLENE STEPS

A. Polypropylene steps shall have a 1/2-inch ASTM A 615 grade 60 steel reinforcement rod encased in polypropylene copolymer plastic. Steps shall have a tread width of 14-inches

nominal.

B. Steps shall be manufactured by **American Step Company, Inc., M.A. Industries, D & L Supply No. F-1981,** or approved equal.

2.13 GRATING

A. Grating shall be supported around all sides of an opening with support members. Unless otherwise indicated, grating supported on concrete shall have embedded angles that match the grating material. Grating shall be serrated bar grating, unless noted otherwise on the Contract Drawings.

B. Grating shall be completely banded at edges and cutouts and banding shall be welded to each cut bearing bar. Banding material and cross-section shall be same as bearing bars.

C. Grating pieces shall be fastened to each support at a minimum of 2 locations.

D. Grating deflection shall not exceed 1/4 inch or the span divided by 180, whichever is less.

E. For standard duty grating, the loading to be used for determining stresses and deflections shall be the uniform load of the adjacent floor or 100 psf, whichever is greater, or a concentrated load of 1000 pounds. For heavy duty grating the loading used shall be in accordance with AASHTO HS-20.

F. Standard duty grating shall be fabricated from steel and hot-dip galvanized, unless noted otherwise. Standard duty grating that will be submerged, partially submerged, or in a corrosive environment shall be fabricated entirely of Type 316 stainless steel. No single piece of standard duty grating shall weigh more than 80 pounds, unless noted otherwise on the Drawings. All crossbars shall be welded into position.

G. Heavy duty grating shall be fabricated from welded steel and hot-dip galvanized after fabrication. All crossbars shall be welded into position.

H. Bar dimensions shall be 1-1/4 inch by 3/16 inch, minimum and shall be manufactured by **McNICHOLS, AMICO, Robertsons Grating Products**, or approved equal.

PART 3 EXECUTION

3.1 GENERAL

A. Except as otherwise shown, the design, fabrication, and erection of structural steel shall conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction".

B. Install miscellaneous specialties as indicated on the Contract Drawings or as recommended by the manufacturer.

C. Store materials above ground on platforms, skids or other supports. Keep material free from dirt, grease, and other foreign matter and protect from corrosion.

D. Clean surfaces of metalwork to be in contact with concrete of rust, dirt, grease, and other

foreign matter before placing concrete.

E. Set embedded metalwork accurately in position and support it rigidly before concrete is placed and prevent displacement during and after placement of concrete.

F. Repair or replace metal items damaged during installation. Follow the manufacturer's procedures for repairing damaged surfaces.

G. Welding shall be performed by metal-arc method or shielded metal arc method as per the American Welding Society's (AWS) "Welding Handbook". During welding component parts shall be adequately clamped or supported. Avoid irregular surface, non-uniform bead pattern, and high crown. Upon completion of welding, remove weld splatter, flux, slag, and burrs. Accomplish repair, chipping, and grinding of welds in a manner that will not gouge, groove, or reduce the base metal thickness.

H. Adhesive Anchors. Do not install anchors until the concrete has reached the required 28-day compressive strength. Drill hole in concrete by means of a percussion hammer drill. Hole shall be roughened with a brush on a power drill and then cleaned and dried. Install anchor in accordance with the manufacturer's instructions. Do not load the anchor until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

I. Wedge Anchors. Do not install anchors until the concrete has reached the required 28-day compressive strength. Drill hole in concrete by means of a percussion hammer drill. Hole shall be roughened with a brush on a power drill and then cleaned and dried. Install anchor in accordance with the manufacturer's instructions.

J. Galvanizing Field Repairs:

1. Surface preparation shall consist of removing oil, grease, soil, and soluble material by cleaning with water and detergent (SSPC SP1) followed by brush-off blast cleaning (SSPC SP7) over an area extending at least 4 inches into the undamaged area.
2. The coating shall be applied to at least 3 mils dry film thickness and shall be **Zinc-Clad XI by Sherwin-Williams, Galvax by Alvin Products, Galvite by ZRC Worldwide**, or approved equal.

- END OF SECTION -

SECTION 06 10 00
ROUGH CARPENTRY

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section covers the rough carpentry work which includes wood framing, plates, joists, rafters, purlins, wood trusses, blocking, furring, backing, nailers, plywood sheathing, siding, and similar elements, material and accessories, complete and in place according to the contract documents.

1.2 REFERENCES

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN PLYWOOD ASSOCIATION (APA)

1. APA AFG-01 Adhesives for Field-Gluing Plywood to Wood Framing
2. APA Form E30 Design/Construction Guide, Residential and Commercial

C. AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

1. AWPA M4 Standard for the Care of Preservative-Treated Wood Products

D. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 psi Tensile Strength
2. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
3. ASTM D 3498 Standard Specification for Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems
4. ASTM F 1667 Standard Specification for Driven Fasteners: Nails, Spikes, and Staples

E. AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

1. AWPA U1-13 Use Category System: User Specification for Treated Wood

F. NATIONAL FOREST PRODUCTS ASSOCIATION (NFOPA)

1. NFOPA-01 National Design Specification for Wood Construction
2. NFOPA-02 Manual for Wood Frame Construction

G. TRUSS PLATE INSTITUTE (TPI)

1. TPI TPI-85 Design Specification for Metal Plate Connected Wood Trusses
2. TPI QST 88 Quality Standard for Metal Plate Connected Wood Trusses Addendum to TPI-85

H. WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

1. WWPA-01 Western Lumber Grading Rules

1.3 RELATED WORK

A. Related work in other sections includes but is not limited to:

1. Section 01 33 00 Submittal Procedures

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Manufacturer’s catalogs showing rough hardware conforming to or equivalent to hardware indicated on the Drawings.

C. Structural and Miscellaneous Wood Members: Design analysis and calculations of fabricated wood trusses shall show design criteria used to accomplish the applicable analysis. Calculations and drawings shall be stamped by a Professional Engineer licensed in the State of Utah.

D. Shop Drawings: Drawings of fabricated wood trusses shall indicate materials and shop and field erection details including methods of fastening.

E. Manufacturer's Certificates: Manufacturer's certificates attesting that lumber and material not normally grade marked or exempt from being grade marked meets the specified requirements.

1.5 DELIVERY AND STORAGE

A. Materials shall be delivered to the site in undamaged condition, stored off ground in fully covered, well ventilated areas, and protected from extreme changes in temperature and humidity.

1.6 QUALITY ASSURANCE

A. Materials and assembly shall be inspected to determine compliance with the Building Code.

B. At completion of fabrication of the trusses, the fabricator shall submit a certificate of compliance to Engineer stating that the work was performed in accordance with the contract documents.

1.7 MEASUREMENT AND PAYMENT

A. Rough carpentry shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS

2.1 LUMBER AND SHEATHING

A. Grading and Marking: Materials shall bear the grademark, stamp or other identifying marks indicating grades of material and rules or standards under which produced. Such identifying marks on material shall be in accordance with the rule or standard under which the material is produced, including requirements for qualifications and authority of the inspection organization, usage of authorized identification, and information included in the identification. The inspection agency for lumber shall be certified by the Board of Review, American Lumber Standards Committee, to grade species used. Except for plywood and lumber; bundle marking will be permitted in lieu of marking each individual piece. Surfaces that are to be architecturally exposed to view shall not bear grademarks, stamps, or other types of identifying marks.

B. Sizes: Lumber and material sizes shall conform to requirements of the rules or standards under which produced. Unless otherwise specified, lumber shall be surfaced on four sides. Size references, unless otherwise specified, are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced.

C. Trussed Rafters: Rafters shall be a prefabricated design. Connections shall be made with light-metal plate-connectors. Light-metal-plate-connected wood trusses shall be designed in conformance with TPI TPI-85 and fabricated in conformance with TPI QST-88.

D. Plywood: Plywood shall be APA performance rated, Grade C-D with exterior glue. Sheathing for roof without corner bracing of framing shall have a span rating of 16/0 or greater for supports 16 inches on center and a span rating of 24/0 or greater for supports 24 inches on center.

E. Wood: Provide dressed lumber, S4S, unless otherwise indicated. Provide seasoned lumber with 19 percent maximum moisture. For structural framing use No. 2 grade Douglas-fir or Larch or any species or grade meeting the following requirements:

1. Fb: 900 psi
2. E: 1,600,000 psi

2.2 TRUSSES

A. Marking: Each truss shall be marked or have permanently affixed thereto the following information near the center of the span on the bottom chord: truss manufacturer’s name and address, design load, and spacing of the trusses.

B. Connector plates shall be designed by the truss manufacturer in accordance with TPI Standards. Structural plates shall be structural quality steel and hot-dip galvanized according to ASTM A 653. Connector plates shall be provided on both sides of the truss, i.e. 2 plates per joint.

2.3 PRESERVATIVE TREATMENT

A. The treatment of lumber, timber, and plywood shall meet the requirements of AWPA UC3B for above ground use only. All products shall bear the appropriate AWPB Quality Mark. The wood shall then be dried to the moisture content specified and marked with the word "Dry." Surfaces of lumber that will be exposed shall not be incised. Exposed areas of treated wood that are cut or drilled after treatment shall receive a field treatment in accordance with AWPA M4. Wood preservative shall be **Wolman AG by Arch Treatment Technologies, Preserve CA by Viance**, or approved equal. Unless otherwise specified the following items will always be treated:

1. All wood members used in built-up roofing systems.
2. All wood members set into concrete regardless of location, including flush-with-deck wood nailers for roofs.
3. All wood members used for rough framing of openings in exterior concrete or masonry walls.
4. Nailing strips or nailers used in conjunction with roof systems.

2.4 ACCESSORIES AND NAILS

A. Anchor Bolts shall conform to ASTM A 307, size as indicated, complete with nuts and washers.

B. Expansion Shields shall be the Type and size best suited for intended use.

C. Joist Hangers and Truss Clips shall be steel or iron, zinc-coated, size to fit members where used, sufficient strength to develop the full strength of supported member, complete with any special nails or bolts required. Framing devices shall be manufacturer by **Simpson Strong-Tie Company, Inc., USP Structural Connectors**, or approved equal.

D. Nails and Staples shall be of the size and type best suited for purpose and shall conform to the requirements of ASTM F 1667. For sheathing, length of nails shall be sufficient to extend 1 inch into supports. In general, 8-penny or larger nails shall be used for nailing through 1-inch thick lumber and for toe nailing 2-inch thick lumber; 16-penny or larger nails shall be used for nailing through 2-inch thick lumber. Nails used with treated lumber and sheathing shall be galvanized.

PART 3 EXECUTION

3.1 INSTALLATION OF FRAMING AND MISCELLANEOUS WOOD MEMBERS

A. General: Members shall be closely fitted, accurately set to required lines and levels, and rigidly secured in place. Nailing shall be in accordance with the recommended Nailing Schedule as contained in NFOPA-02. Where detailed nailing requirements are not specified, nail size and nail spacing shall be sufficient to develop an adequate strength for the connection without splitting the members. Installation of timber connections shall conform to applicable requirements of NFOPA-01. Members shall be framed for passage of ducts and pipes shall be cut, notched, or bored in accordance with applicable requirements of NFOPA-02. Rafters, purlins, and joists shall be set with crown edge up. Leveling of joists, beams, and girders on masonry or concrete shall be with slate or steel; on wood or metal leveling shall be without shims.

B. Cutting and Notching: Wood members shall not be cut, notched or bored more than 1/4 of their depth without adequate and approved reinforcing.

C. Sill Plates: Sill plates shall be set level and square and anchor bolted at not more than 2 feet 8 inches on centers and not more than 12 inches from end of each piece. A minimum of two anchors shall be used for each piece. Sill plates and other wood resting on or embedded in concrete or masonry shall be pressure treated.

D. Wall Framing: Wall studs shall be installed at a spacing of 16-inches on center unless otherwise indicated on the Drawings. A single plate shall be provided at the bottom and a double plate at the top of wall framing unless noted otherwise. Joints in the top plates shall be staggered not less than 4 feet.

E. Roof Framing or Rafters: Tops of supports or rafters shall form a true plane. Valley, ridge, and hip members shall be of depth equal to cut on rafters where practicable, but in no case less than depth of rafters. Valleys, hips, and ridges shall be straight and true intersections of roof planes. Necessary crickets and watersheds shall be formed. Rafters, except hip and valley rafters, shall be spiked to wall plate and to ceiling joists with no less than three 8-penny nails. Rafters shall be toe-nailed to ridge; valley, or hip members with at least three 8-penny nails. Rafters shall be braced to prevent movement until permanent bracing, decking or sheathing is installed. Hip and valley rafters shall be secured to wall plates by clip angles. Openings in roof shall be framed with headers and trimmers. Unless otherwise indicated, headers carrying more than two rafters and trimmers supporting headers carrying more than one rafter shall be double. Hip rafters longer than the available lumber shall be butt jointed and scabbed. Valley rafters longer than the available lumber shall be double, with pieces lapped not less than 4 feet and well spiked together. Trussed rafters shall be installed in accordance with TPI TPI-85.

F. Blocking and Backing: Blocking and backing shall be nominal 2-inch thick material and shall be provided as necessary to meet the latest codes for lateral bracing and for application of siding, sheathing, subflooring, wallboard, and other materials or building items, and to provide fire stopping. Blocking and backing shall be cut to fit between framing members and rigidly nailed thereto.

3.2 INSTALLATION OF SHEATHING

A. Plywood: Sheathing shall be applied in accordance with APA standards and with edges 1/8 inch apart at side and end joints, and nailed at supported edges at 6 inches on center and at intermediate supports 12 inches on center. Nailing of edges shall be 3/8 inch from the edges. Wall sheathing shall extend over top and bottom plates, and if applied horizontally the vertical joints shall be made over supports and staggered. Roof sheathing shall be applied with long dimension at right angles to supports, end joints made over supports, and end joints staggered.

3.3 INSTALLATION OF ROOF TRUSSES

A. Contractor shall be responsible for field erection of the trusses, including proper handling, safety precautions, temporary bracing to prevent toppling, and other safeguards which are consistent with good workmanship and building erection practices.

B. Contractor shall comply with all applicable requirements and recommendations of TPI.

C. Contractor shall not field repair, cut or otherwise alter trusses without consulting the truss manufacturer.

- END OF SECTION -

SECTION 06 20 23
INTERIOR FINISH CARPENTRY

PART 1 GENERAL

1.1 DESCRIPTION

A. Work of this Section, as shown or specified, shall be provided by the Interior Contractor and shall be in accordance with the requirements of the Contract Documents.

B. This Section covers the finish carpentry work which includes coordination, fabrication, and installation of all interior exposed wood members shown on Contract Drawings and specified herein, including but not limited to the following:

1. Lumber
2. Standing and Running Trim
3. Moldings
4. Wood Shelving
5. Plastic Laminate
6. Paneling
7. Plywood
8. Miscellaneous Items

1.2 REFERENCES

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN HARDWOOD ASSOCIATION (AHA)

1. AHA A 135 Hardboard Plywood

C. AMERICAN WOODWORK INSTITUTE (AWI)

1. AWI 0620 Finish Carpentry/Installation

D. AMERICAN PLYWOOD ASSOCIATION (APA)

1. APA AFG-01 Adhesives for Field-Gluing Plywood to Wood Framing

E. AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

1. AWPA M4 Standard for the Care of Preservative-Treated Wood Products
2. AWPA U1-13 Use Category System: User Specification for Treated Wood

F. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials

G. HARDWOOD PLYWOOD AND VENEER ASSOCIATION (HPVA)

1. HPVA HP-1 American National Standard for Hardwood and Decorative Plywood

H. NATIONAL FOREST PRODUCTS ASSOCIATION (NFOPA)

1. NFOPA-01 National Design Specification for Wood Construction
2. NFOPA-02 Manual for Wood Frame Construction

I. NATIONAL HARDWOOD LUMBER ASSOCIATION (NHLA)

1. NHLA Rules Rules for the Measurement and Inspection of Hardwood and Cypress

J. WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

1. WWPA-01 Western Lumber Grading Rules

1.3 RELATED WORK

A. Related Work in other sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 09 90 00 Painting and Finishes

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit the following items of finish carpentry:

1. Shop Drawings, indicating fabrication and installation methods, to include plans and elevations and details. Indicate required anchorage and blocking, accessory items, field dimensions, materials and finishes. Indicate compliance with specification requirements. Indicate weight of any materials or systems to be suspended or which require support from structure.
2. Manufacturer's Product Data for all specialty items not manufactured by the Finish Carpentry Fabricator.
3. Two samples of each species and finish of wood specified. Samples shall be minimum 12-inch by 12-inch finished as specified on one face, one edge, and one end. Samples shall be fire retardant treated wood where such has been specified or required by codes. Review will be for color and texture only; compliance with other requirements is the responsibility of Interior Contractor. Samples of finishes shall be applied on the appropriate wood or base material as will occur in the final Finish Carpentry item when installed.
4. Product data for each type of process, factory and non-factory fabricated product. Indicate component materials, dimensions, profiles, textures, colors and include construction and application details.
5. Where variations in wood and finish may occur, a minimum of three variations showing the extremes which may be expected of any and all wood and finishes as specified shall be submitted to ENGINEER for approval. Minimum size: 12-inch by 20-inch.

6. Where required by OWNER or ENGINEER, the Interior Contractor shall provide full size mockup of panel or woodwork assembly.
7. Interior Contractor shall submit to ENGINEER three samples 20-inch minimum length of all moldings or molding assemblies to be used for the Project. These shall be full size and finished as specified in the Contract Documents.

1.5 DELIVERY AND STORAGE

A. Materials shall be delivered to the site in undamaged condition, stored off ground in fully covered, well ventilated areas, and protected from extreme changes in temperature and humidity.

B. Protect materials against weather and contact with damp or wet surfaces. Stack lumber, plywood and other panels flat with spacers between each bundle to provide air circulation. Provide for air circulation within and around stacks and under temporary coverings.

C. Deliver interior finish carpentry materials only when environmental conditions meet requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

D. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.6 QUALITY ASSURANCE

A. Comply with applicable provisions for Premium Grade as defined in the latest edition of the AWI Quality Standards for all materials, fabrication and workmanship for all work of this Section.

B. All Work of this Section shall be performed by skilled mechanics of the trade and shall be of the highest quality. Comply with applicable Industry Standards for all Work and materials as specified.

C. The Interior Contractor shall be responsible for obtaining and complying with all code and regulatory agency requirements for materials and methods.

D. The Interior Contractor shall be responsible for accurately obtaining all field dimensions related to his/her work prior to fabrication. Where discrepancies are found, he/she shall notify ENGINEER immediately in writing.

E. Protect sanded and finished surfaces from soiling and damage during handling and installation.

F. Provide temporary protection of all Finish Carpentry as required to protect Work from damage.

1.7 MEASUREMENT AND PAYMENT

A. Finish carpentry shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS

2.1 MATERIALS

A. All woodwork materials shall be new and shall conform to the Premium Grade requirements of the AWI Quality Standards, latest edition.

B. All lumber shall be kiln-dried to the average moisture content as recommended by the AWI Quality Standards latest edition appropriate for the climatic conditions of the Site.

C. All solid wood elements shall be clear, straight-grain lumber of the best grade of specified species as listed by the NHLA. Lumber shall be free of any defects which might impair serviceability, aesthetics, and/or finish. Solid wood elements shall also be according to the following, unless indicated otherwise on Contract Drawings and/or Specifications:

1. Specie of Face Woods receiving transparent finishes shall be as specified on the Contract Drawings and shall be selected for specified grain with uniform color and grain suitable for use with the finished plywood with which it is used.
2. Face Woods receiving opaque finishes shall be Birch, Poplar or custom grade but otherwise shall have same specification as solid stock for Face Woods above.
3. Unexposed woods shall be Custom grade Poplar, kiln dried.

D. All veneer core elements shall be clear straight-grain lumber of the best grade of the specified species as listed by the NHLA Lumber shall be free of any defects which might impair serviceability, aesthetics, and/or finish. Where veneer differs on two sides, veneers shall be of similar thickness, density, and characteristics to prevent any warpage. Veneer core elements shall also be according to the following, unless indicated on Contract Drawings or Specifications:

1. Adhesives shall be water-resistant resin or approved equal; process shall be hot plate method using the following number of plys to achieve specified thickness:
   a. 1/4-inch overall thickness shall be of 3- ply veneer core construction.
   b. 3/8-inch overall thickness shall be of 5- ply veneer core construction.
   c. 1/2-inch overall thickness shall be of 5- ply veneer core construction.
   d. 3/4-inch overall thickness shall be of 7- ply veneer core construction.
   e. 1-inch overall thickness shall be of 9-ply veneer core construction.
2. Where burl paneling is specified, core must be cross banded with poplar prior to applying burl veneer.
3. Provide Douglas Fir or Poplar V-type solid edge trim on all exposed edges of plywood not designated to be surfaced by plastic laminate.
4. For Face Woods receiving transparent finishes, Species shall be as specified on drawings; faces shall be selected and matched by the Interior Contractor with respect to cutting lengths, uniformity of color, figure, and grain character. Face veneers shall not contain open joints, face depressions, glue stain or other manufacturing irregularities.
5. Face Woods receiving opaque finishes shall have custom grade (face veneer) Birch or Poplar select, but otherwise shall have same specification as Plywood for Face Woods (Paragraph 2.1.D.1).
6. Unexposed woods shall be Birch, Poplar or Douglas Fir, rotary cut, Unselect, good one side, interior type plywood, one side Grade A and one side Grade B; Grade A faces shall not contain plugs, knots, pitch pockets, splits, rough grain or other open defects.

7. Wood for plastic lamination shall be minimum 3/4-inch Mahogany face core plywood, good one side.

E. All particle board shall be resin impregnated wood flakes of high-density construction as manufactured by **Boise Cascade Corporation, Roseburg**, or approved equal and shall be 3/4-inch minimum thickness, unless otherwise specified.

1. For Enameled Face Woods: High density particle board may be substituted for plywood panels, unless specified otherwise on Contract Drawings.
2. For Unexposed Woods: High density particle board may be substituted for plywood panels, unless specified otherwise on Contract Drawings.

F. All masonite shall be 1/8-inch thick tempered, as manufactured by **Masonite Corporation**, or an approved equal.

G. All Finish Carpentry shall be finished as indicated on Contract Drawings and Specifications. Transparent and Opaque Finishes shall match approved samples submitted according to Section 01 33 00 and Paragraph 1.4 above. All plastic laminate finishes shall be of the quality, color and finish as indicated on the Contract Drawings and Specifications.

2.2 SOFTWOOD PLYWOOD

A. Each sheet of plywood must bear the mark of a recognized association or independent inspection agency that maintains continuing control over the quality of the plywood.

B. The mark must identify the plywood by species group or identification index, and show glue type, grade, and compliance with PS1.

C. Plastic Laminate Plywood Cores to be exterior type in any species and in Grade A or as required per the Contract Documents.

D. Shelving Plywood to be interior type in any species and in grade or as required per Architect.

2.3 HARDWOOD PLYWOOD

A. Comply with AHA A 135.

B. Each sheet of hardwood plywood must bear the mark of a recognized association or independent inspection agency that maintains continuing control over the quality of the plywood. The mark must identify the plywood by species group or identification index, and show glue type, grade, and compliance with HP-1.

C. Hardwood plywood type to meet minimum standards and must comply with specifications.

2.4 PLASTIC LAMINATE

A. Exposed decorative surfaces including countertops, cabinet doors, and for items having plastic laminate finish type to be per specification.

B. Cabinet Interiors including Shelving: Both of following options to comply with NEMA CLS Grade, as a minimum.

C. Cover exposed edges with plastic laminate, except where aluminum, stainless steel, or plastic molded edge strips are shown or specified.

D. Provide Douglas Fir or Poplar V-type solid edge trim on all exposed edges of plywood not designated to be surfaced by plastic laminate.

2.5 PANELING

A. Hardwood Veneer Plywood Paneling: Manufacturer's stock hardwood plywood panels complying with HPVA HP-1, made without urea-formaldehyde adhesive. Manufacturers Subject to compliance with requirements,

B. For Face Woods receiving transparent finishes, Species shall be as specified on Contract Drawings; faces shall be selected and matched by the Interior Contractor with respect to cutting lengths, uniformity of color, figure, and grain character. Face veneers shall not contain open joints, face depressions, glue stain or other manufacturing irregularities.

C. Where burl paneling is specified core must be cross banded with poplar prior to applying burl veneer.

2.6 MISCELLANEOUS MATERIALS

A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.

B. All required hardware and accessories shall be furnished and installed by Interior Contractor and shall be as indicated on Contract Drawings and Specifications. Where specific products are not specified in the Contract Documents, the Interior Contractor shall recommend hardware to provide the function or condition indicated in the Contract Documents. Hinges, screws, clips and other mounting, attachments or fasteners to be concealed unless otherwise noted on Contract Drawings.

C. Interior Contractor shall submit samples of each hardware item/type and accessory item/type to ENGINEER for approval according to Paragraph 1.4 above and Section 01 33 00.

D. Paneling Adhesive: Comply with paneling manufacturer's written recommendations for adhesives. VOC levels shall not exceed what is approved for Project.

E. All Finish Carpentry hardware and accessories shall be installed in accordance with manufacturer's recommendations.

2.7 OTHER MATERIALS

A. Interior Contractor shall be responsible for providing and installing all items and materials as indicated on Contract Drawings and Specifications comprising all or part of the Finish Carpentry shown. Such items and materials shall be fabricated and/or installed according to manufacturer's recommendations and comply with applicable AWI Quality Standards and Industry Standards.

B. All paint and other finish material shall be pure, unadulterated and best quality from specified manufacturer as indicated on the Contract Drawings and Specifications. (See Section 09 90 00 – Painting and Finishes).

C. All finish materials shall be flame retardant or treated with flame-retardant process where required by local code. Should flame-retardant process cause change in color and effect on finish material, Interior Contractor shall notify ENGINEER.

D. All finishes and processes shall be in compliance with code requirements for the location of installation.

E. All transparent finishes shall be alcohol, water and burn resistant.

PART 3 EXECUTION

3.1 EXAMINATION OF CONDITIONS

A. The Interior Contractor shall be responsible for examination of the substrate and the conditions under which the Work under this section is to be performed, and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work under this section until unsatisfactory conditions have been corrected.

B. Verify surfaces and substrates are prepared to receive products of this section.

C. If substrate preparation is the responsibility of another installer, notify ENGINEER of unsatisfactory preparation before proceeding Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative metal.

D. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.

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

3.2 PREPARATION

A. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the Project conditions.

B. Clean surfaces thoroughly prior to installation.

C. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours.

3.3 FABRICATION

A. All Work shall be performed in such manner as to fulfill the intent of the Contract Drawings and Specifications.

B. All items to be mill fabricated per AWI Premium Grade specifications and according to the sizes and designs indicated on the Contract Drawings and Specifications, and assembled in single and complete units insofar as the dimensions thereof will permit shipment to and installation at the building. Large pieces requiring sectional construction shall have their

several parts accurately fitted and aligned with each other and be provided with ample screws, glue and bolt blocks, tongues, grooves and splines, dowels, mortises and tenons, screws, bolts, or suitable means of concealed fastening, as required to render the Work substantial, rigid and permanently secured in proper position to each related section.

C. Where necessary to fit at site provide ample allowance for cutting and fitting. Sufficient additional material shall be allowed to permit accurate scribing to walls, floors and related work; and due allowance made wherever possible for such shrinkage as may develop after installation. All single and sectional units shall be provided with adequate cleating, blocking, crating and other forms of protection as required to preclude damages thereto during shipping and handling and installation.

D. Framing and blocking members shall be assembled with bolted and screwed connections, and shall be secured to the structural backings with expansion screws, or toggle bolts, as required, spaced and installed so as to insure ample strength and rigidity. Rails and stiles shall be mortised and tenoned, work neatly mitered and membered, all butt joints made flush and smooth, and all permanent joints made up with water-resistant glue. All fixtures shall be assembled without face screws or nails, except where it may be necessary to attach trim items. All face screws or nails which are necessary to attach trim items shall be countersunk and plastic wood or wood plugs used to cover heads, and the plug neatly touched up to match finish. The heads of all screws used in any assembly shall be countersunk below the surface.

E. All items where paint is required shall be shop spray finished, except where impractical or otherwise specified.

F. Backsides of all Finish Carpentry concealed by the building shall be given a prime coat of paint, color to closely approximate the value and hue of the face finish.

G. All shelving shall be adjustable unless indicated otherwise on Contract Drawings and Specifications. Shelving standards shall be concealed unless otherwise noted.

H. Plastic Laminate edges shall be square, self-edged, or postformed as indicated on drawings. Metal trim is not acceptable. Edges shall be neatly beveled, joints shall be minimized in quantity and be made to a smooth hairline and puttied. Appearance of unsightly or excessive joints will be cause for rejection.

3.4 INSTALLATION

A. Installation at the Project shall be by skilled mechanics supervised by the Interior Contractor in accordance with accepted standards.

B. Install in accordance with the manufacturer’s recommendations and the approved shop drawings and in proper relationship with adjacent construction.

C. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.

D. Install all Finish Carpentry straight, plumb, level and in true alignment except where otherwise indicated. Fit all joints closely and fasten all pieces rigidly in place. Nails shall be finish or casing nails. Countersink nail heads and leave ready for putty. Joints shall be neatly matched and mitered. Fill exposed joints prior to jointing.

1. Finished size shall be as indicated on the Contract Drawings.
2. Surfaces shall be left free from hammer marks, free from warp, twist, open joints or other defects and shall be cleaned, scraped and sanded ready for finishing.
3. Lengths of all running trim shall be as long as practical.
4. Shim as required using concealed shims.

E. Cut Finish Carpentry to fit unless specified to be shop fabricated or shop-cut to exact size. Where Finish Carpentry abuts other finished work, scribe and cut for accurate fit. Before making cutouts, drill pilot holes at corners.

F. Distribute defects allowed in the quality grade specified to the best overall advantage, when installing job assembled items.

G. Attach Finish Carpentry securely in place with uniform joints providing for thermal and building movements. Attach to substrates by anchoring and fastening as shown, as required by recognized standards, and as follows:

1. Nailing: Blind nail where possible. Use fine finishing nails where exposed. Set exposed nail heads for filling except for exterior wood which is to receive a natural finish (if any).
2. Anchoring: Secure Finish Carpentry to anchors or blocking built-in or directly attached to substrates.

H. For standing and running trim, install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches long, except where necessary. Stagger joints in adjacent and related standing and running trim. Cope at returns and miter at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.

1. Install trim after gypsum board joint finishing operations are completed.
2. Drill pilot holes in hardwood before fastening to prevent splitting. Fasten to prevent movement tor warping. Countersink fastener heads on exposed carpentry work and fill holes.
3. Cope moldings at returns, miter interior angles and corners.

I. Where finishes are applied at job site, clean items and fill nail holes in preparation for finishes application. Where work is to receive a transparent finish, use matching wood filler.

J. For Fire-Retardant Finish Carpentry, handle, store and install in accordance with manufacturer's direction and as required to meet the required classification or rating. Provide special fasteners, adhesives and other accessories as tested and listed for the type of fire-retardant work indicated. Re-coat any and all cut surfaces with a heavy brush coating of the same compound used for wood treatment.

K. Fit Finish Carpentry to other work; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds and similar supports to allow proper support.

L. Paneling: Select and arrange panels on each wall to minimize noticeable variations in grain character and color between adjacent panels. Leave 1/4-inch gap to be covered with trim at top, bottom, and openings. Install with uniform tight joints between panels.

1. Attach panels to supports with manufacturer's recommended panel adhesive and fasteners. Space fasteners as recommended by panel manufacturer.
2. Conceal fasteners to greatest practical extent.

M. Adjust all hardware for smooth operation.

N. Coordinate with plumbing and electrical work for installation of fixtures and service connections in millwork items.

3.5 CLEANING AND PROTECTION

A. Clean shop finished work, touch-up finish as required and remove and refinish damaged or soiled areas of finish.

B. Protect installed Finish Carpentry from damage by Work of other trades until OWNER's acceptance of the Work. Subcontractor to advise Interior Contractor of procedures and precautions for protection of materials and installed work from damage and of the required temperature/humidity conditions which must be maintained during the remainder of the construction period in areas of Finish Carpentry installations.

C. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

D. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.

1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

- END OF SECTION -

SECTION 07 11 00
MOISTURE PROTECTION

PART 1 GENERAL

1.1 SUMMARY

A. This Section provides specifications for all waterproofing and damp proofing of the buried or below grade concrete surfaces, including moistureproof underlays for concrete slabs.

1.2 RELATED WORK

A. Related Work in other sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures

1.3 QUALITY ASSURANCE

A. Performance and Design Requirements. Prior to application of waterproofing, CONTRACTOR shall cause a representative of the manufacturer of the materials to inspect and certify that the surfaces to be waterproofed are in a condition suitable for application of the waterproofing. Following application of the waterproofing, CONTRACTOR shall cause a representative of the manufacturer of the materials to inspect and certify that the materials were applied in complete accordance with the manufacturer's current recommendations.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM D 450 Standard Specification for Coal-Tar Pitch Use in Roofing, Dampproofing, and Waterproofing
2. ASTM D 882 Test Method for Tensile Properties of Thin Plastic Sheeting
3. ASTM D 1668 Standard Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing.
4. ASTM E 1643 Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slab
5. ASTM F 1249 Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor

C. PRESSURE SENSITIVE TAPE COUNCIL (PSTC)

1. PSTC 101 International Standard for Peel Adhesion of Pressure-Sensitive Tape

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit manufacturer product data, cut sheets, and recommended installation instructions.

C. Prior to acceptance of the work, CONTRACTOR shall deliver to ENGINEER two copies of the specified certifications for material application.

PART 2 PRODUCTS

2.1 WATERPROOF COATING

A. Waterproof coating shall be coal tar epoxy resin. Acceptable products are **Bitumastic 300M by Carboline, Targuard Low VOC Coal Tar Epoxy by Sherwin Williamns, PorterTuf 2000 HB Coal Tar Epoxy by Porter Coating, Series 46H-413 HB Tneme-Tar by Tnemec, Amercoat 78HB by PPG Protective & Marine Coatings**, or approved equal.

2.2 MOISTUREPROOF COATING

A. Moistureproof coating shall be coal tar solution. Acceptable products are **Bitumastic 50 by Carboline, Corothane I Coal Tar by Sherwin Williams, Series 46-465 HB Tnemecol by Tnemec, HE107 by Henry**, or approved equal.

2.3 WATERPROOF MEMBRANE

A. Water-roof Pitch: Waterproof pitch shall be coal tar pitch.

B. Membrane Fabric: Membrane fabric shall be coal tar pitch coated open mesh fabric per paragraph 1.2 B.

C. Reglets: Reglets for anchoring membrane shall be fabricated of 16-ounce copper.

D. Protective Board: Protective board shall be 2-inch Celotex insulation board treated to prevent decay.

2.4 MOISTUREPROOF UNDERLAY

A. Plastic Membrane. Plastic membrane for moistureproof underlay shall be an ASTM E 1745 Class A membrane manufactured from virgin polyolefin resins having a minimum film thickness of 10 mils. Plastic membrane shall meet the following specifications:

1. Water Vapor Permeance: 0.05 perms maximum (perm unit = grains/(ft2*hr*in-Hg)) in accordance with ASTM F 1249.
2. Tensile Strength: 50 lbf/in (minimum) per ASTM D 882.

B. Acceptable membranes are **Stego Wrap Class A by Stego Industries, Perminator by W. R. Meadows, Vapor Barrier Blue VB10 by Americover**, or approved equal.

C. Pressure Sensitive Tape. Pressure sensitive tape shall be minimum 3-inch wide, 6 mil pressure sensitive polyethylene tape with acrylic, pressure-sensitive adhesive. Manufacturers shall be **Stego Tape by Stego Industries, Perminator Tape by W.R. Meadows, VTW Vapor Tape by Americover**, or approved equal.

PART 3 EXECUTION

3.1 WATERPROOF COATING

A. Location. Waterproof coating shall be applied to the water side of walls and bottoms of channels or tanks which are common with areas to be occupied by equipment, piping or personnel. Waterproof coating shall not be applied to those surfaces to receive liquid waterproofing.

B. Surface Preparation. New concrete to be waterproofed shall have aged at least 60 days and shall have a moisture content of less than 14%. Concrete surface shall be brush treated with a 10% muriatic acid solution and thoroughly flushed with water after 10 minutes.

C. Walls of existing channels and tanks shall be steam cleaned prior to application of waterproofing material.

D. Application. Prime coat shall be thinned and applied at the rate of approximately 200-300 square feet per gallon depending on surface condition. Finish coats shall be applied at the rate of 100 square feet per gallon. Final coat shall be black. Total dry film thickness shall be minimum 20 mils. Drying time between coats shall be as recommended by the paint manufacturer.

E. Application Procedures. Following the manufacturer’s application instructions and these application procedures for waterproofing products as listed in paragraph 2.1 are as follows:

1. Prime coat shall consist of one coat of coal tar epoxy resin coating, black. Finish coats shall consist of two coats of coal tar epoxy resin coating, alternating red and black colors.

3.2 MOISTUREPROOF COATING

A. Location. Moistureproof coating shall be applied to below grade, earth side of outside concrete walls which are common with areas to be occupied by equipment, piping, or personnel. Moistureproof coating is not required for walls to be provided with waterproof membrane or for walls which are poured directly against an excavated surface.

B. Surface Preparation. Preparation of concrete and masonry walls shall conform to manufacturer's recommendations.

C. Application. Prime and finish coats shall be applied at the rate of 70 square feet per gallon. The number of finish coats shall be sufficient to produce a dry film thickness of at least 13 mils. Drying time between coats shall be as recommended by the paint manufacturer.

3.3 WATERPROOF MEMBRANE

A. Location. Waterproof membrane shall be applied to exterior surfaces as designated on the drawings.

B. Surface Preparation. Concrete surfaces to receive waterproof membrane shall be clean, dry and shall have at least a Class II form finish.

3.4 MOISTUREPROOF UNDERLAY

A. Install moistureproof underlay in accordance with the manufacturer's written installation instructions.

B. Location. Unless otherwise noted, moistureproof underlay shall be provided under all concrete floors or floating slabs-on-grade deposited on gravel base or sand. Moistureproof underlay shall be provided under all concrete floors or floating slabs-on-grade with pressure relief valves and gravel base.

C. Surface Preparation. Backfilled surfaces to receive moistureproof underlay shall be leveled off and smoothed over to minimize contact with sharp edges. Joints shall be sealed by means of pressure sensitive tape. Where pipes and conduits pass through the plastic membrane, they shall be wrapped tightly with separate sheets of membrane which shall then be sealed with tape to the main membrane. Reinforcing steel or mesh shall be supported by small precast placing chairs designed with flat bases to protect the membrane. CONTRACTOR shall exercise care to maintain the integrity of the membrane at all times.

- END OF SECTION –

SECTION 07 21 00
INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers the work required to provide and install insulation in buildings and structures, complete and in place.

1.2 RELATED WORK

A. Related Work in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 04 22 00 Reinforced Unit Masonry

1.3 REFERENCES

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM C 518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
2. ASTM C 547 Standard Specification for Mineral Fiber Pipe Insulation
3. ASTM C 549 Standard Specification for Perlite Loose Fill Insulation
4. ASTM C 553 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
5. ASTM C 578 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
6. ASTM C 592 Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
7. ASTM C 612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation
8. ASTM C 665 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
9. ASTM C 1029 Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation
10. ASTM D 1622 Standard Test Method for Apparent Density of Rigid Cellular Plastics
11. ASTM D 1621 Standard Test Method for Compressive Properties of Rigid Cellular Plastics
12. ASTM D 2842 Standard Test Method for Water Absorption of Rigid Cellular Plastics
13. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
14. ASTM E 96 Standard Test Methods for Water Vapor Transmission of Materials

C. UNDERWRITERS LABORATORIES (UL)

1. UL1256 Fire Test of Rook Deck Constructions

D. FACTORY MUTUAL (FM)

1. Approval Standard for Class 1 Fire Rating of Insulated Wall or Wall and Roof/Ceiling Panels, Interior Finish Materials or Coatings and Exterior Wall Systems

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit manufacturer’s literature, installation instructions, product test reports and technical data.

C. Submit manufacturer’s certification that the proposed materials comply with this Section.

D. For foam-in-place insulation, submit a copy of the foam insulation contractor’s certification and ICC-ES report and manufacturer’s documentation confirming material conforms to ASTM C 1029.

1.5 DELIVERY AND STORAGE

A. Materials shall not be allowed to become wet, soiled, or covered with ice and snow. Manufacturer's recommendations for handling storage and protection shall be strictly followed. If required, during cold weather, store in heated storage areas following the manufacturer’s guidelines for minimum and maximum temperatures. Material shall not be exposed to sunlight and shall be protected against ignition. Materials shall be concealed as quickly as possible after completion of work.

1.6 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for Insulation. Full compensation for all insulation shall be considered as included in the contract unit or lump sum bid prices for the various items of the contract to which it relates.

PART 2 PRODUCTS

2.1 INSULATION

A. Thermal resistance of insulation shall be not less than the R-values shown on the Contract Drawings. R-values shall be determined at 75 degrees F in accordance with ASTM C 518. Insulation shall be the standard product of a manufacturer and factory marked or identified with manufacturer's name or trademark and R-value. Identification shall be on individual pieces or individual packages.

B. The materials and application of building insulation shall conform to the applicable requirement of the Underwriters Laboratories “Fire Resistance Index”, Factory Mutual requirements, and the manufacturer’s recommendations.

C. Minimum R-Value in all roof insulation shall be R-30.

2.2 FOAMED-IN-PLACE THERMAL INSULATION

A. Foamed-in-place or sprayed polyurethane foam plastic insulation conforming to the requirements of ASTM C 1029 shall be placed in cavities of masonry walls. Foamed-in-place thermal insulation in walls shall be 2-component cellular plastic insulation comprised of a spray-dried polymeric resin and a foaming catalyst concentrate insulation by frothing/pouring in place. It shall have the following characteristics:

Property	Requirement	Standard
Core Density	0.5-1.0 pcf	ASTM D 1622
Termal Resistance at 140°F/90 day Aged R Value, at 75°F mean Temp, min	R4.6/inch	ASTM C 518

B. Foamed-in-place insulation shall be **InsulSmart Interior Foam Insulation by CfiFOAM, Inc., Core-Fill 500 by Tailored Chemical Products**, or approved equal.

2.3 BLANKET INSULATION

A. Blanket insulation shall be glass or other inorganic fibers and resinous binders formed into flexible blankets complying with ASTM C 665, Type III, with foiled back vapor barrier laminated to one face, with 1-inch flanges on long edges, and vapor transmission not more than 0.50 perms. Manufacturers shall be **Owens-Corning, CertainTeed, Johns-Manville**, or approved equal.

2.4 EXTRUDED POLYSTYRENE BOARD (RIGID) INSULATION

A. Rigid insulation shall be polystyrene conforming to ASTM C 578, Type IV with surface burning characteristics per ASTM E84 maximum of 5 for flame-spread and 175 for smoke developed. Minimum thermal resistance per inch of R-5.0 per ASTM C 518 at 75°F mean temperature. Minimum compressive strength of 25 psi per ASTM D 1621.

B. Insulation for roof decks shall be listed per UL 1256 and shall be in compliance with FM Class I roof decks.

C. Insulation thickness in interior walls shall be 4 inches.

D. Manufacturers shall be **Dow Chemical, Owens Corning**, or approved equal.

E. Sill Sealer: Mineral wool, 1 inch thick and compressible to 1/32 inch, width of sill, designed to perform as an air, dirt, and insect seal.

2.5 ALUMINUM SHEETING WITH RIGID INSULATION

A. Vaults with electric power shall be insulated with a combination of rigid insulation (see 2.4) and 24-mil thick (min) aluminum sheeting coated flat white.

B. Accessories:

1. Adhesive: As recommended by manufacturer. Adhesive shall be formulated specifically to bond insulation to steel (hatches and panels) and to concrete surfaces.
2. Tape: Aluminum foil tape with facing to match rigid insulation as recommended by the manufacturer.
3. J-Channel: PVC Closure strip as recommended by manufacturer for terminations.
4. Clip Strip: PVC closure strip for vertical and horizontal seams.
5. Fasteners: Hilti Insulation Fasteners (IZ-type), or approved equal.

C. Aluminum Sheet Manufacturer: **Insul-Mate by RPR Products, Inc.**, or approved equal.

2.6 EXTRUDED POLYSTYRENE BOARD (RIGID) INSULATION (BURIED LOCATIONS)

A. Rigid insulation for buried locations shall be polystyrene conforming to ASTM C 578, Type IV with surface burning characteristics per ASTM E84 maximum of 75 for flame-spread and maximum of 450 for smoke-developed. Minimum thermal resistance per inch of R-5.0 per ASTM C 518 at 75°F mean temperature. Minimum compressive strength of 25 psi per ASTM D 1621.

B. Insulation thickness for exterior foundation walls shall be 1.5 inches minimum.

C. Manufacturers shall be **Dow Chemical, Owens Corning**, or approved equal.

D. Sill Sealer: Mineral wool, 1 inch thick and compressible to 1/32 inch, width of sill, designed to perform as an air, dirt, and insect seal.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify substrate and adjacent materials and insulation board are dry and ready to receive adhesive.

B. Verify mechanical and electrical services within walls have been installed and tested.

3.2 INSTALLATION OF INSULATION

A. Insulation shall be installed after construction has advanced to a point that the installed insulation will not be damaged by remaining work. For thermal insulation the actual installed thickness shall provide the R-values shown. For acoustical insulation the installed thickness shall be as shown. Insulation shall be installed on the weather side of such items as electrical boxes and water lines. Unless otherwise specified, installation shall be in accordance with the manufacturer's recommendation.

3.3 INSTALLATION OF FOAMED-IN-PLACE THERMAL INSULATION

A. The polyurethane foam shall be placed in 4-foot lifts. All insulation shall be done in close coordination with the masonry contractor to allow quality control.

B. The polyurethane foam shall be applied by qualified firms with proper dispensing equipment.

C. Apply in accordance with ASTM C 1029 guidelines and the manufacturer’s instructions.

3.4 INSTALLATION - RIGID INSULATION

A. Foundation Perimeter:

1. Adhere a 6 inches wide strip of polyethylene sheet over joints with double beads of adhesive each side of the joint. Tape seal joints between sheets. Extend sheet full height of joint.
2. Install boards on foundation wall perimeter, horizontally. Place boards in a method to maximize contact bedding. Stagger end joints. Butt edges and ends tight to adjacent board and to protrusions.
3. Extend boards over expansion joints, unbonded to foundation 12 inches either side of joint.

B. Exterior Walls:

1. Apply adhesive in 3 continuous beads per board length. Daub adhesive tight to protrusions.
2. Install boards on wall surface perimeter, vertically. Place membrane surface of insulation against adhesive.
3. Place boards in a method to maximize contact bedding. Stagger side joints. Butt edges and ends tight to adjacent board and to protrusions.
4. Place 24" side polyethylene sheet at perimeter of wall openings from adhesive vapor and air retarder bed to window and door frames. Tape seal in place to ensure continuity of vapor and air retarder.

C. Cavity Walls:

1. Secure impale fasteners to substrate at a frequency of 6 per insulated board.
2. Apply adhesive in 3 continuous beads per board length. Daub adhesive tight to protrusions to ensure continuity of vapor and air retarder.
3. Install boards horizontally between wall reinforcement.

D. Under Concrete Slabs:

1. Place insulation under slabs on grade after base for slab has been compacted.
2. Prevent insulation from being displaced or damaged while placing vapor retarder and placing concrete slab.

3.5 INSTALLATION - BATT INSULATION

A. Install batt insulation and vapor retarder in accordance with manufacturer's instructions.

B. Install batt insulation without gaps or voids

C. Trim insulation neatly to fit spaces. Use batts free of damage.

D. Fit insulation tight in spaces airtight to exterior side of mechanical and electrical services within the plane of insulation.

E. Protect all insulation materials during storage and insulation from moisture, tears or other damage. All damaged material shall be replaced at no additional cost to OWNER.

- END OF SECTION -

SECTION 07 32 00

METAL ROOFING SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall furnish and install metal roofing and soffit panels, system support framing, and appurtenant work, complete and in place. Metal roofing shall be a concealed fastener metal roofing system.

B. The principal items of sheet metal work included in the metal roofing system shall include sheet metal flashing, covers, trim, enclosure batts, collars and sleeves at all roof penetrations, metal soffit panels, and all other sheet metal items necessary for a complete and watertight metal roofing system.

C. The metal roofing applicator shall coordinate his work with sheet metal gutter work and shall report to CONTRACTOR and ENGINEER if any sheet metal work provided by others affects his work negatively.

1.2 RELATED WORK

A. Related work in other sections includes but is not limited to:

1. Section 01 33 00 Submittal Procedures

1.3 REFERENCES

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
2. ASTM A 924 Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
3. ASTM D 226 Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
4. ASTM D 1938 Standard Test Method for Tear-Propagation Resistance (Trouser Tear) of Plastic Film and Thin Sheeting by a Single-Tear Method
5. ASTM E 96 Standard Test Methods for Water Vapor Transmission of Materials
6. ASTM E 330 Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
7. ASTM E 1646 Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference
8. ASTM E 1680 Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems

C. UNDERWRITERS LABORATORY (UL)

1. UL 580 Test for Uplift Resistance of Prepared Roof Assemblies

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit detailed shop drawings showing materials, gages, finishes, layout, corners, trim, flashing, enclosures, edge conditions, jointing, profiles, supports, fasteners, fabrication of special shapes, and method of attachment to adjacent construction to Engineer prior to fabrication. Submit drawings indicating roof size, location and type of penetrations, perimeter and penetration details, roof insulation make-up and sheet layout that have been accepted by an authorized manufacturer's representative.

C. Submit manufacturer's literature indicating materials, finish, construction, and method of installation of prefabricated items and sealant.

D. Provide color samples for color selection by OWNER.

E. Submit the following test reports, certified by an Independent Testing Laboratory or a professional engineer registered in the State of Utah to verify the proposed roofing will meet performance requirements of this Specification:

1. Thermal Cycle Test
2. ASTM E-330 Adapted to Test Formed Metal Panels
3. Clip Fastener Pull-Out Tests and Calculations
4. UL 580 Class 90
5. Concentrated Load Test Data
6. Air Infiltration (E-283) and Water Penetration (E-331) Test Results
7. Coating Performance Testing

F. Submit certification by the manufacturer that the roofing assembly is listed in the UL Building Materials Directory with a Class 1-90 wind uplift rating, including relevant construction number.

1.5 WARRANTIES

A. Manufacturer shall provide to OWNER written warranty that the roof panels will not rupture, fail structurally, or perforate due to corrosion for a period of 20 years from the date of installation.

B. Roofing manufacturer shall provide written 10-year material and labor warranty beginning at the date of final acceptance.

C. CONTRACTOR shall provide to OWNER written warranty that the roof system is installed in accordance with the manufacturer's recommendations and will be free from defective workmanship and remain watertight and weatherproof with normal usage for two (2) years following Project Substantial Completion date.

1.6 QUALITY ASSURANCE

A. A single installer shall perform the work of this Section and shall have completed

projects of similar scope and complexity.

1.7 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for roof systems. Full compensation for roofing systems shall be considered as included in the contract unit or lump sum bid prices for the various items of the Contract to which roof system relates.

PART 2 PRODUCTS

2.1 GENERAL

A. Subject to compliance with the requirements, manufacturers who may offer metal roofing systems and products, which may be incorporated into the work, include **AEP Span, Fabral**, or approved equal.

2.2 ROOF PANELS

A. Minimum Performance Ratings and Properties:

1. Air infiltration: Panel shall have no air infiltration at 20 psf pressure differential and no air exfiltration at 20 psf pressure differential when tested in accordance with ASTM E 1680.
2. Water penetration: Panel shall have no leakage through panel joints when tested in accordance with ASTM E 1646 at static pressure differential of 20.0 psf.
3. Provide UL90 rated roofing system that has been tested in accordance with UL 580 test procedure. Panels shall be capable of spanning 5’-0” on-center purlins with UL90 rating.

B. Profile:

1. Roof panels shall be factory formed ribbed seam pattern with minimum 1” high seams and a nominal panel width of 16 inches.
2. Soffit panels shall be 12-inches wide, 1-1/2” deep, 22- gauge, G90 galvanized finish steel, with concealed fastener, lock-joint design and shall be continuous-vented.

C. Length:

1. Provide panels of sufficient length to minimize end laps.

D. Profile Composition:

1. Base metal shall be a minimum 24-gage structural steel (minimum yield strength 50,000 psi) with G90 hot dipped galvanized coating conforming to ASTM A 653.
2. Sheet metal trim, flashing, and accessories shall be the same material, gauge, finish, and color as the metal roofing.
3. Paint Finish:
   a. All panels shall receive a factory applied Kynar 500/Hylar 5000 finish applied to both sides of the panel over the base protective coating, or approved equal. The exposed side coating shall have a minimum total dry film thickness of 1.0 mil and the underside coating shall have a minimum total dry film thickness of 0.5 mil. Color to be as determined by OWNER.

E. Concealed-Clips:

1. Material: 18-gauge steel with class G60 galvanized coating.
2. Configuration: clips shall be designed so as to attach with two concealed fasteners, and fully attach two ribs of every panel.
3. Spacing: In accordance with the manufacturer’s recommendations.

F. Fasteners:

1. Self-drilling or self-tapping galvanized steel screws and/or stainless steel pop rivets painted to match the panels where visible, per the panel manufacturer's recommendations.

G. Sealants:

1. Sealants shall not contain oil, asbestos, or asphalt. Factory applied sealant shall be applied in the seam and designed for metal to metal concealed joints. Field applied panel end sealant shall be mastic tape sealant. Exposed sealant shall be one-part polyurethane joint sealant. All sealants used shall be as recommended by the metal roofing manufacturer for the job conditions and warranty requirements.

H. Weather resistive barrier:

1. Membrane underlayment shall be composed of a high-strength, spun-bonded polypropylene base sheet, co-extruded on both sides with UV stabilized polyolefin, weight 30-pound. Membrane underlayment shall conform to ASTM D 226, Type II. Permeability shall be 0.54 perms maximum in accordance with ASTM E 96, Procedure A, and tear strength shall be minimum 20 pounds in accordance with ASTM D 1938. Membrane underlayment shall be **Grace Tri-Flex 30 by Grace Construction Products**, or approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify proper placement of all roof openings, pipes, curbs, sleeves, ducts, vents and drains.

3.2 SUBSTRATE PREPARATION

A. Comply with manufacturer’s instructions for preparation of substrate to receive roofing. Clean substrate of dust, debris and other substances detrimental to the roofing work.

3.3 NAILERS

A. Install treated wood nailers at roof perimeters, at base of roof projections, and around specified roof penetrations.

1. Total nailer height shall match total thickness of insulation being used. Install with 1/8” gap between each length and at changes in direction.
2. Firmly fasten nailer to the deck, wall, or existing structurally sound and secured nailer at (16”) o.c. maximum, so as to resist a force of 200 pounds per lineal foot in any direction.

3. Taper nailer where applicable to be flush at point of contact with membrane in either the vertical or horizontal applications.

3.4 GENERAL

A. The metal roofing shall be installed by an applicator and fabricator approved by the roofing system manufacturer who has working experience with the roofing system. Contractor shall provide a letter signed by the roofing manufacturer that the installer is an approved applicator and fabricator of the roofing system.

B. The metal roofing systems shall be installed in accordance with the manufacturer's instructions and recommendations applicable to the job conditions and supporting substrates.

C. The panels and other components of the system shall be securely anchored and placed with concealed fasteners and shall be provided with provisions for thermal/structural movement.

D. Shim and align panel units within installed tolerances of 1/4-inch in 20 feet on level/plumb/slope and location/line as indicated, and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

E. Joint sealers shall be furnished and installed where necessary or where required for weatherproofing of the system.

3.5 INSTALLATION

A. Metal panels shall be installed in accordance with the approved shop drawings and the manufacturer's recommendations.

B. Remove any strippable protective coating on the panels and flashings prior to installation and in any case do not allow the strippable coating to remain on the panels in extreme heat, cold, or in direct sunlight or other UV source.

C. Loosely lay roof insulation with end joints staggered. (Stagger joints between layers.) Joints shall be 1/4" or less in width. Neatly cut and fit insulation around roof penetrations and projections. Install only dry insulation and only as much insulation as can be covered the same day with membrane and completed.

3.6 CLEANING AND PROTECTION

A. Panels and other components of the work which have been damaged or have deteriorated beyond successful repair by means of finish touch-ups or similar minor repair procedures, shall be removed and replaced at no cost to Owner.

B. Temporary protective coverings and strippable films shall be removed from the materials during installation. Upon completion of the work, the roofing systems shall be cleaned as recommended by the roofing manufacturer and shall be maintained in a clean condition until acceptance of the work by Owner.

- END OF SECTION –

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SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 DESCRIPTION

A. The CONTRACTOR shall provide and install sheet metal flashing and trim, and appurtenant work, complete in place, in accordance with the Contract Documents.

B. The scop of Work includes edge, eaves, and other trim, expansion joint covers, copings, prefinished sheet metal flashings, collards, pitch pockets (pans), equipment platforms (sleeper)support at all roof penetrations which are not provided as part of the roofing system, and all other components, mastic, sealants, and anchors necessary to make the structure weathertight.

1.2 RELATED DOCUMENTS

A. Related work in other Sections includes but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 06 10 00 Rough Carpentry
3. Section 07 32 00 Metal Roofing Systems
4. Section 07 92 00 Joint Sealants

1.3 REFERENCES

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
2. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
3. ASTM A792 Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
4. ASTM C920 Standard Specification for Elastomeric Joint Sealants.
5. ASTM C1311 Standard Specification for Solvent Release Sealants.
6. ASTM D1187 Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
7. ASTM D4586 Standard Specification for Asphalt Roof Cement, Asbestos-Free.

C. Sheet Metal and Air Conditioning Contractors Association, SMACNA - Architectural Sheet Metal Manual

1.4 PERFORMANCE REQUIREMENTS

A. Materials, anchorage, fastenings and workmanship shall qualify for U.L. Class 115 MPH (3 second gust) wind uplift rating.

B. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.

C. Thermal Movements: Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and night time-sky heat loss.

1. Temperature Change (Range): 120° F, ambient; 180° F, material surfaces.

D. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

1.5 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings: Show layouts of sheet metal flashing and trim, including plans and elevations. Show materials, gauges, finishes, layout, joints, sizes, profiles and fasteners. Distinguish between shop- and field-assembled work. Include the following:

1. Identify material, thickness, weight, and finish for each item and location in Project.
2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
3. Details for fastening, joining, supporting, and anchoring sheet metal flashing and trim, including fasteners, clips, cleats, and attachments to adjoining work.
4. Details of expansion-joint covers, including showing direction of expansion and contraction.

C. Submit manufacturer’s specifications, literature, and published installation and maintenance instructions for all sheet metal products.

D. Provide samples of color where required.

1.6 QUALITY ASSURANCE

A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.

B. Unload, store, and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack materials on platforms or pallets, covered with suitable weathertight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1.8 COORDINATION

A. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leak-proof, secure, and noncorrosive installation.

PART 2 MATERIALS

2.1 SHEET METAL

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality.

1. Thickness 0.0239-inch (24 U.S. Standard gauge), unless shown otherwise.
2. Finish-factory applied to match color of metal frames, or trim.

B. Manufacturers shall be **Cheney Flashing Company, Fry Reglet Corporation, Heckmann Building Products, Inc.,** or approved equal.

2.2 DOWNSPOUTS, GUTTER AND TRIM

A. Downspouts, gutters and trim shall be same metal and thickness as roof panels. Fabricate gutters in minimum 96-inch long sections. Furnish flat-stock gutter brackets and flat-stock gutter spacers and straps fabricated from the same material as gutters. Fabricate expansion joints, expansion joints covers, gutter bead reinforcing bars, and gutter accessories from same material as gutters. Shop fabricate interior and exterior corners.

B. Color shall match roof panels.

2.3 FASCIA AND RAKE TRIM

A. Fascia and rake trim shall be same metal and thickness as roof panels.

B. Color shall match roof panels.

2.4 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.

B. Fasteners: Self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.

1. Exposed Fasteners: Heads matching color of sheet metal by means of plastic caps or factory-applied coating. Steel, galvanized per ASTM A153/A153M or stainless steel.

2. Fasteners for Flashing and Trim: Steel, galvanized per ASTM A153/A153M or stainless steel. Blind fasteners or self-drilling screws, gasketed, with hex washer head.
3. Blind Fasteners: High-strength stainless-steel rivets.

C. Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, non-staining tape.

D. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, heavy bodied for hooked-type expansion joints with limited movement.

F. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.5 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.

B. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.

C. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

1. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flatlock seams. Tin edges to be seamed, form seams, and solder.

D. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.

E. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with elastomeric sealant concealed within joints.

F. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.

G. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

1. Thickness: As recommended by SMACNA's "Architectural Sheet Metal Manual for application but not less than thickness of metal being secured.

H. Reinforcement and Supports; Provide same material as flashing, unless other material is shown. Steel, where shown or required, shall be galvanized or stainless.

I. Rigid Joints and Seams: make mechanically strong. Solder galvanized and stainless steel metal joints. Do not us solder to transmit stress.

J. Provide watertight closures at exposed ends of counterflashing.

2.6 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Counterflashing: Fabricate from the following material:

1. Galvanized Steel: 0.022 inch thick.

B. Roof-Penetration Flashing: Fabricate from the following material:

1. Galvanized Steel: 0.028 inch thick.

2.7 DOWNSPOUTS AND GUTTERS FABRICATION

A. Form downspouts and gutters in maximum lengths as practicable to sizes and shapes indicated on the Drawings.

1. Lock longitudinal joints of downspouts.
2. Telescope end joints 1-1/2 inches.
3. Provide elbows at bottom where downspouts discharge onto splash blocks.
4. Anchor downspouts with straps of same material as downspouts.
5. Install gutters at locations indicated on drawings.

2.8 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following material:

1. Galvanized Steel: 0.028 inch thick.

2.9 FLEXIBLE BASE PIPE SEALS

A. Flexible base pipe seals shall be prefabricated on-piece aluminum flanged base with stepped, graduated EPDM profile which creates a compression seal between the piping and the flashing. Aluminum base shall be flexible to conform to profile of roof panels.

B. Manufacturers and Products:

1. Pate Co.; Dektite.
2. Portals Plus, Inc.; Deck-Mate.

C. Coat aluminum surfaces in contact with dissimilar metals in accordance with 3.2.B of this Section.

D. Isolation tape shall be butyl or polyisobutylene, internally reinforced.

E. Fasteners shall be stainless steel of type required.

2.10 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.

1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Torch cutting of sheet metal flashing and trim is not permitted.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.

1. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene underlayment.
2. Bed flanges in thick coat of asphalt roofing cement where required for waterproof performance.
3. Use only stainless steel fasteners to connect isolated dissimilar metals.

C. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.

D. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and [elastomeric] [butyl] sealant.

E. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

F. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 30 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.

G. Seal joints with elastomeric sealant as required for watertight construction.

1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70° F, set joint members for 50 percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40° F.
2. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 - "Joint Sealants."

H. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pretin edges of sheets to be soldered to a width of 1-1/2 inches except where pretinned surface would show in finished Work.

1. Pretinning is not required for lead-coated copper.
2. Where surfaces to be soldered are lead coated, do not tin edges, but wire brush lead coating before soldering.
3. Lead-Coated Copper Soldering: Wire brush edges of sheets before soldering.
4. Do not use open-flame torches for soldering. Heat surfaces to receive solder and flow solder into joints. Fill joints completely. Completely remove flux and spatter from exposed surfaces.

3.3 ROOF FLASHING INSTALLATION

A. General: Install sheet metal roof flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight.

B. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.

C. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with elastomeric sealant.

1. Secure in a waterproof manner by means of anchor and washer at 36-inch centers, or other method approved by ENGINEER.

D. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Install flashing as follows:

1. Use appropriate flexible base pipe seal where pipe, conduit or cable, etc. penetrate roofing system.
2. Make work watertight and free of expansion and contraction noise. Seal and clamp flashing to pipes penetrating roof.

3.4 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION -

SECTION 07 92 00
JOINT SEALANTS

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Polyurethane Sealants

B. Tape Mastic Sealants

C. Non-skinning Sealants

D. Silicone Sealants

E. Acrylic Sealants

F. Acoustic Sealants

1.2 SECTION EXCLUDES:

A. Concrete joint sealants which are per Section 03 25 00.

1.3 RELATED DOCUMENTS

A. Related Work in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures

1.4 REFERENCES

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN ARCHITECTURAL MANUFACTURER'S ASSOCIATION (AAMA)

1. AAMA 800-10 Voluntary Specifications and Test Methods for Sealants

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 653 Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
2. ASTM A 792 Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy Coated by the Hot-Dip Process.
3. ASTM C 639 Standard Test Method for Rheological (Flow) Properties of Elastomeric Sealants
4. ASTM C 661 Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer
5. ASTM C 681 Standard Test Method for Volatility of Oil- and Resin-Based, Knife Grade, Channel Glazing Compounds
6. ASTM C 711 Standard Test Method for Low-Temperature Flexibility and Tenacity of One-Part, Elastomeric, Solvent-Release Type Sealants

7. ASTM C 794 Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants
8. ASTM C 834 Standard Specification for Latex Sealants
9. ASTM C 908 Standard Test Method for Yield Strength of Preformed Tape Sealants
10. ASTM C 919 Standard Practice for Use of Sealants in Acoustical Applications
11. ASTM C 920 Standard Specification for Elastomeric Joint Sealants
12. ASTM D 56 Standard Test Method for Flash Point by Tag Closed Cup Tester
13. ASTM D 217 Standard Test Methods for Cone Penetration of Lubricating Grease
14. ASTM D 412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
15. ASTM D 792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
16. ASTM D 925 Standard Test Methods for Rubber Property—Staining of Surfaces (Contact, Migration, and Diffusion)
17. ASTM D 2452 Standard Test Method for Extrudability of Oil- and Resin-Base Caulking Compounds
18. ASTM D 2453 Standard Test Method for Shrinkage and Tenacity of Oil- and Resin Base Caulking Compounds
19. ASTM D 1475 Standard Test Method For Density of Liquid Coatings, Inks, and Related Products
20. ASTM D 2202 Standard Test Method for Slump of Sealants
21. ASTM D 2203 Standard Test Method for Staining from Sealants
22. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
23. ASTM E 90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
24. ASTM E 814 Standard Test Method for Fire Tests of Penetration Firestop Systems
25. ASTM E 1966 Standard Test Method for Fire-Resistive Joint Systems
26. ASTM G 154 Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

D. INTERIM FEDERAL SPECIFICATIONS (FS)

1. FS TT-S-00230C Sealing Compound: Elastomeric Type, Single Component
2. FS TT-C-1796A Caulking Compounds, Metal Seam and Wood Seam
3. FS TT-S-001543A Sealing Compounds: Silicone Rubber Base (For Caulking, Sealing, and Glazing in Buildings and Other Structures

E. SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

1. Rule 1168 Adhesive and Sealant Applications

F. UNDERWRITER'S LABORATORIES (UL)

1. UL 580 Tests for Uplift Resistance of Roof Assemblies

1.5 SUBMITTALS

A. Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Material Safety Data Sheets (MSDS): Provide in accordance with 29 CFR 1910.1200,

C. Hazard Communication

D. Product Test Reports: Reports of tests required by this section performed by a qualified testing agency, indicating that the sealants comply with the requirements.

E. VOC Content: Provide documentation of the Volatile Organic Content (VOC) in accordance with SCAQMD Rule 1168

1.6 WARRANTY

A. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within 5 years of installation.

PART 2 PRODUCTS

2.1 GENERAL MATERIAL REQUIREMENTS

A. Substrate Requirements: When testing is required on a substrate, the material used shall be either ASTM A653 G-90 or ASTM A792 AZ50 and tests shall be conducted with each of the following coatings:

1. Bare (No coating)
2. Acrylic (Galvalume Plus)
3. Polyester
4. Siliconized Polyester
5. Polyvinylidene Fluoride Resin (PVDF)

2.2 POLYURETHANE SEALANT

A. General: Provide Sealants that meet the following specifications:

1. ASTM C 920, Type S, Grade NS, Class 25, Use: NT, A, M, G and O paintable sealant
2. AAMA 808.3
3. FS TT-S-00230C, Type II, Class A

B. Color: The sealant color shall be selected by OWNER.

C. Physical Properties: The sealant shall have the following additional physical properties:

1. Peel Adhesion: All panels shall have at least a 90% cohesive failure of at least 15 lb/in when tested in accordance with ASTM C 794.
2. Tensile Strength: Sealant shall have a tensile maximum of 300 psi and an elongation of 500-600% when tested in accordance with ASTM D 412.
3. Sag: There shall be no sag when tested in accordance with ASTM C 639.
4. Hardness: Shore “A” hardness on all three samples shall not exceed 40 when tested in accordance with ASTM C 661
5. Service Temperature Range: -40 degrees F to 200 degrees F.

6. Water Resistance: There shall be no presence of voids, cracks, separation or breakdown of the compound when tested in accordance with AAMA 800-10, Section 2.11.1.
7. Flash Point: No less than 145 degrees F when tested in accordance with ASTM D 56.
8. Shelf Life: The compound shall have a shelf life of 9 months or more when stored at or below 80 degrees.
9. Skin Time: The compound shall have a skin time of 2-4 hours
10. Cure Time: The compound shall have a cure time of 24-48 hours
11. VOC Content: The Volatile Organic Compound (VOC) content shall be less than 250 g/L when calculated SCAQMD Rule 1168.

2.3 TAPE MASTIC SEALANT

A. General: Provide Sealants that meet the following specifications:

1. AAMA 804.3
2. AAMA 807.3
3. FS TT-C-1796A, Type II, Class B
4. Approved by Underwriters Laboratories for use in roof deck constructions classified under UL-518 Class 90

B. Color: The sealant color shall be selected by OWNER.

C. Physical Properties: The sealant shall have the following additional physical properties:

1. Specific Gravity: 1.4 or higher when tested in accordance with ASTM D 792
2. Tensile Adhesive Strength: 20 psi or higher when tested in accordance with ASTM C 908
3. Elongation: 1000% or higher when tested in accordance with ASTM C 908
4. Cone Penetration: The sealant shall meet the following conditions when tested in accordance with ASTM D 217 with a 300g cone in 5 seconds:
   a. 8.5 – 100 mm at 77 degrees F
   b. 125-135 mm at 120 degrees F
   c. 45-55 mm at Zero degrees F
5. VOC Content: The Volatile Organic Compound (VOC) content shall be less than 250 g/L when calculated SCAQMD Rule 1168.

2.4 NON-SKINNING SEALANT

A. General: Provide sealants that meet the following specifications:

1. AAMA 809,2
2. FS TT-C-1796A, Type 1, Class A

B. Color: The sealant color shall be selected by OWNER.

C. Physical Properties: The sealant shall have the following additional physical properties:

1. Extrudability: The sealant shall deposit in 30 to 50 seconds through a 0.104” orifice at 50 psi pressure in accordance with ASTM D 2452.

2. Total Solids: At least 85% by weight when determined in accordance with ASTM C 681.
3. Volume Shrinkage: Less than 15% when determined in accordance with ASTM D 2453.
4. Weight per U.S. Gallon: 10.75 lbs. +/- 0.25 lbs. when determined in accordance with ASTM D 1475.
5. Vehicle Bleed out: There shall be no visible exudation of vehicle from sealant after 21 days at 158 degrees F on the test panel.
6. Flexibility: There shall be no loss of adhesion at -60 degrees F when tested in accordance with ASTM C 711.
7. Sag: 0.20 in max, full button when tested in accordance with ASTM D 2202.
8. Staining: Sealant will not stain a painted test panel when tested in accordance with ASTM D 925, Method A.
9. UV Resistance: There shall be no cracking, bleeding, or loss of elasticity after 1,000 hours of QUV exposure in accordance with ASTM G 154.
10. Wet Flammability: No less than 110 degree F flash point when determined in accordance with ASTM D 56.
11. Coverage: Each gallon of sealant shall provide the following minimum coverage:
    a. 500 lineal feet with 1/8-inch bead
    b. 690 lineal feet with 3/16-inch bead
    c. 390 lineal feet with 1/4-inch bead.
12. Shelf Life: 18 months minimum in unopened container when stored at or below 90 degrees F.
13. Drying time: Non-skinning, remains permanently soft and tacky.
14. Engageability: Sealant will easily engage and transfer to male joint at 10 degrees F.
15. Service Temperature Range: -60 degrees F to 200 degrees F.
16. Application Temperature Range: 10 degrees F to 120 degrees F.
17. Non-Reactive: Will not darken, etch, or leave salt deposits on the test panel after two years.
18. VOC Content: The Volatile Organic Compound (VOC) content shall be less than 250 g/L when calculated SCAQMD Rule 1168.

2.5 SILICONE SEALANT

A. General: Provide sealants that meet the following specifications:

1. ASTM C 920, Type S, Grade NS, Class 25
2. AAMA 802.3, Type I and II
3. AAMA 805.2 Group C
4. AAMA 808.3
5. FS TT-S-001543A, Class A
6. FS TT-S-00230C, Class A

B. Color: Clear

C. Physical Properties: The sealant shall have the following additional physical properties:

1. Mechanical Properties: The sealant shall have the following mechanical properties as determined by ASTM D 412:
    a. Tensile Strength: 150 psi minimum (Method A)
    b. Modulus at 100% Elongation: 35 psi minimum
    c. Elongation: 400% minimum

d. Recovery: 100%

2. Hardness: Maximum Shore A hardness of 15 when determined in accordance with ASTM C 661.
3. Tack-free Time: 1/4-inch diameter bead at 77 degrees F, 50% relative humidity, 10-15 minutes.
4. Cure Time: 1/4-inch diameter bead at 77 degrees F, 50% relative humidity, 10-12 hours.
5. Service Temperature: -60 degrees F to 300 degrees F.
6. Shelf Life: 9 months when stored in unopened original containers at 80 degrees F or less.
7. VOC Content: The Volatile Organic Compound (VOC) content shall be less than 250 g/L when calculated SCAQMD Rule 1168.

2.6 ACRYLIC SEALANT

A. Color:

1. Clear
2. White
3. Gray

B. Physical Properties:

1. Percent Solids:
   a. Colors: 75% minimum determined in accordance with ASTM D 1475
   b. Clear: 70% minimum determined in accordance with ASTM D 1475
2. Peel Adhesion: All panels shall have at least a 90% cohesive failure of at least 5 lb/in when tested in accordance with ASTM C 794.
3. Weight per U.S. Gallon: 8.7 lbs. +/- 0.25 lbs. when determined in accordance with ASTM D 1475.
4. Viscosity: The sealant shall meet the following conditions when tested in accordance with ASTM D 2452 with a 20g cone with a 0.104-inch orifice at 60 psi at 77 degrees F in the indicated time:
   a. Colors: 40-60 seconds
   b. Clear: 35-45 seconds
5. Elongation: 200% minimum when tested in accordance with ASTM D 412.
6. Hardness: Maximum Shore A hardness of 55 when determined in accordance with ASTM C 661.
7. Flash Point: No less than the following when tested in accordance with ASTM D 56
   a. Colors: 52 degrees F
   b. Clear: 40 degrees F
8. Slump: 0.10” maximum when tested in accordance with ASTM D 2202.
9. Vehicle Migration: No vehicle migration from the sealant edge when tested in accordance with ASTM D 2203 as modified by Section 2.8.1 of AAMA 800-10.
10. Paintability: Compatible with Alkyds, enamels and lacquers post-solvent release.
11. Service Temperature Range: Zero degrees F to 180 degrees F.
12. Shelf Life:18 months when stored in original, unopened containers at or below 80 degrees F.

2.7 ACOUSTIC SEALANT

A. Color

1. White
2. Off-White

B. Furnish and install an acrylic, latex-based sound caulk for use as a sealant in fire-rated partitions, smoke barriers and sound-rated assemblies that meets the following requirements:

1. ASTM C 834 specifications for latex sealants
2. Surface-Burning Characteristics: Class A 5/0 (flame spread/smoke developed) or better in accordance with ASTM E 84.
3. Solids: 73% ± 3% (minimum)
4. ASTM E 90 (sound tests)
5. ASTM E 1966 (fire-resistant joint systems)
6. ASTM E 814 (through-penetration firestop systems)

C. Manufacturer, or approved equal:

1. USG Sheetrock Brand, Acoustical Sealant
2. Liquid Nails, AS-825
3. Auralex Acoustics, Stop Gap

PART 3 EXECUTION

3.1 INSTALLATION

A. Install joint sealants in accordance with manufacturer's specifications and requirements.

B. Install acoustical sealant in accordance with ASTM C 919.

- END OF SECTION –

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SECTION 08 10 00
DOORS AND FRAMES

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section covers all the work necessary to furnish and install the new doors, frames, and hardware, complete and operable.

B. All doors and their pressed steel frames shall be steel, insulated, and the type and size as indicated on the Door Schedule on the Contract Drawings.

1.2 RELATED WORK

A. Related work in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 09 90 00 Painting and Finishes

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publications are referred to in the text by basic designation only.

B. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1. ANSI A 115.IG Installation Guide for Doors and Hardware
2. ANSI A 156.6 Standard for Architectural Door Trim
3. ANSI A 156.16 Standard for Auxiliary Hardware
4. ANSI A 250.8 SDI-100 Recommended Specifications for Standard Steel Doors and Frames
5. ANSI A 250.10 Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames
6. ANSI A 250.11 Recommended Erection Instructions for Steel Frames

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 36 Standard Specification for Carbon Structural Steel
2. ASTM A 108 Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished
3. ASTM A 123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
4. ASTM A 229 Standard Specification for Steel Wire, Quenched and Tempered for Mechanical Springs
5. ASTM A 653 Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process
6. ASTM A 1008 Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

7. ASTM A 1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
8. ASTM C 177 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
9. ASTM D 256 Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
10. ASTM D 635 Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
11. ASTM D 790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
12. ASTM D 792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
13. ASTM D 882 Standard Test Method for Tensile Properties of Thin Plastic Sheeting
14. ASTM D 1622 Standard Test Method for Apparent Density of Rigid Cellular Plastics
15. ASTM D 2583 Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
16. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
17. ASTM E 330 Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

D. AMERICAN WELDING SOCIETY (AWS)

1. AWS D1.1 Structural Welding - Steel
2. AWS D1.3 Structural Welding Code – Sheet Steel

1.4 SUBMITTALS

A. Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Manufacturer's catalog data and preprinted installation instructions of doors.

C. A schedule showing the location of each door shall be included with the drawings. Submittal drawings shall include elevations of each door type, details and method of anchorage, details of construction, method of assembling sections, location and installation of hardware, shape and thickness of materials, details of joints and connections.

D. Manufacturer’s certificates that certify products meet or exceed the specified requirements.

E. Warranty: Provide documentation of the manufacturer’s standard written one (1) year warranty.

1.5 DELIVERY AND STORAGE

A. Doors shall be delivered to the job site wrapped in a protective covering with the brands and names clearly marked thereon. Doors shall be stored in a dry location that is adequately ventilated and free from dust or water, and in a manner that permits easy access for inspection and handling. Doors shall be handled carefully to prevent damage to the faces, edges, and ends. Damaged items that cannot be restored to like-new condition shall be replaced.

1.6 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for doors, frames, and hardware. Full compensation for all doors, frames, and hardware shall be considered as included in the contract unit or lump sum bid prices for the various items of the Contract to which doors relate.

PART 2 PRODUCTS

2.1 STEEL DOORS

A. Steel doors and frames shall be of hollow metal construction and shall be full flush design with no visible seams. Interior and Exterior door face sheets shall be galvannealed, hot-dip galvanized according to the requirements of ASTM A 653 with A60 finish. Manufacturers shall be **Republic Doors and Frames, Steelcraft, Ceco Door Products**, or approved equal. Doors shall conform to ANSI A 250.8 and to the following requirements:

1. Hollow metal door, 1 3/4 inches thick flush type, constructed of two sheets of not less than stretcher leveled, 16-gauge steel sheets formed and welded for flush pan assembly, with internal 20-gauge vertical reinforcing channels spaced not over 8 inches on centers the full height of the door. There shall be no visible joints on the face of the doors. Reinforcing channels shall be uniformly spot welded to face plates at top and bottom of all doors. Filler channels shall be provided at the top and bottom of doors to provide a flush closure. The top of exterior doors shall be provided with flush, water- and weather-tight top enclosures.
2. All interior void spaces shall be completely filled with EPS foam or polyurethane.
3. Concealed sheet or bar steel reinforcement shall be provided for mortise type hardware. Reinforcing shall not be less than the following: 9-gauge for butts, 12-gauge for locksets and 14-gauge for surface applied hardware. Reinforcing shall be drilled and tapped to template requirements. Concealed reinforcing shall be provided for closures. Door bottom weather stripping shall be included to match thresholds.
4. Door frames shall be pressed steel constructed of not less than 16-gauge steel and shall be of the shape indicated on the plans and as required to fit the various wall constructions. Frames shall be of welded unit construction assembled and welded in the shop. Welding shall be to a hairline joint with all exposed beads ground smooth.
    a. Restroom Door Frame (Door 103): Frame shall wrap around both sides of the metal stud wall and gypsum. Supplier shall adjust frame width if needed based on manufacturers backbend length.
    b. Interior Electrical Room (Door 111) and Office (Door 104): Frame shall wrap around the metal stud wall and gypsum wall on the interior room side. The frame can wrap around the CMU wall, but this not required.
5. Concealed reinforcing of the frames for the mortise hardware shall be not less than

the following: 3/16 inch for butts, 12- gauge for lock strike, 14-gauge for surface applied items and 18-gauge for plaster guards over mortised hardware reinforcement. Frames shall be mortised drilled and tapped to template requirements. Lock reinforcing units shall be supplied by finishing hardware supplier. Frames shall be anchored as shown in the drawings.

6. Hinges shall be heavy duty ball bearing hinges with non-removable pins.
7. Pull plates shall be chrome plated or stainless steel and mounted on interior and exterior sides of all doors.
8. All double doors are to be supplied with a “Z” astragal of 14-gage steel for 1-3/4-inch doors and 16-gage for 1-3/8-inch doors.
9. Hardware including locksets and hinges shall be stainless steel.
10. Door Swing: All doors shall be installed with 160 to 180 degree swing except Door 103 and Door 111.

2.2 DOOR HARDWARE

A. Trim material shall be stainless steel, unless noted otherwise.

B. Pull Plates: 8” CTC pull, 4” x 16” plate, stainless steel, No. 110 x 70C by **Rockwood Mfg. Co**., or approved equal, conforming to ANSI A 156.6.

C. Hinges: satin stainless steel, 5 knuckles minimum, non-rising pin for interior doors and non-removable pin for exterior doors, number of hinges per door manufacturer’s recommendation (minimum of 3 hinges per door). Where necessary to keep door leaf clear of walls, casings, jambs or reveals in door opening, wide throw hinges of an approved type shall be furnished. Finish shall be stainless steel satin (32D or 630). Manufacturer shall be **Mckinney T4A3386, Hager, Stanley Works FBB199 (32D),** or approved equal.

D. Cylinder Lock Set: Best Access Systems, Lockset 47H-7-AB-15-J-630-SH-S6-VT for exterior doors and 45H-7-N-15-M-630 for interior doors. Locks must be compatible with Owners existing keys. Contractor shall provide lock sets and keys that will match Owner’s requirements. Lock set shall be ANSI A156.13, Series 1000, Grade 1 Operational, Strength, and Security.

E. Exit Panic Devices: Exit panic devices shall be the rim style with mortice lock meeting the requirements of ANSI/BHMA A156.3 Grade 1, UL listed (3 hours) for “A” label door applications, and ANSI A117.1 Section 404.2.6 accessibility Code (ADA Compliant). Exit devices shall have a stainless-steel latch bolt, strike with stainless steel body with plated steel roller standard fire-rated stainless-steel strike, zinc die-cast head cap & end cap, escutcheon with keyed deadbolt with 7-pin Best Access cylinder, stile width 3 7⁄8" minimum, hex key dogging, and sex bolts. Manufacturer and style shall be **Stanley Sierra** or approved equal.

F. Lever Extension Flush Bolt, Upper, **Rockwood No. 555**, or approved equal, cadmium plated finish (inactive leaf only), conforming to ANSI A 156.16.

G. Lever Extension Flush Bolt, Lower, **Rockwood No. 555**, or approved equal, cadmium plated finish (inactive leaf only), conforming to ANSI A 156.16.

H. Threshold: **#277AS by Pemko Corporation**, or approved equal, raised interior, extruded aluminum threshold with neoprene seal.

I. Drip Cap: Provide drip cap on all exterior doors. Drip cap shall be clear anodized aluminum, **Pemko 346C**, or approved equal.

J. Door Closers: Door closers shall be full rack and pinion, cast iron, with adjustable regulators for closing and latching speed, back check and spring power. Closers shall be mounted for 180 degrees of swing whenever possible. All closers shall be LCN Model 4040XP with 4041-3071 DEL cylinder with extra duty hold open arm. Mounting plates shall be supplied as necessary. All door closers attached to mineral core or particle filled doors shall be installed with hex bolts. Cover shall be metal 4040XP-72MC with 689 Aluminum finish.

K. Lock Strikes: Strikes shall have extended curved lips where required to protect trim from being marred by latch bolt. Strike lips shall not protrude more than 1/8-inch beyond door frame trim. Wrought box strikes shall be furnished on all locks, latches and deadlocks.

L. Door Stop: Solid cast brass, DuraFlex bumper, **Rockwood #445**, or approved equal (Inactive leaf only)

M. Non-Mortise Door Edge with Astragal: 0.06” thick stainless steel, **Rockwood HD306B-AST**, or approved equal (double doors only)

N. Kick Plates: Unless otherwise indicated, kick plates shall be provided and shall be satin stainless 18-8, 18 gage, **Rockwood No. K1050F**, or approved equal.

O. Weatherstripping and Seals: silicone gasketing, **Pemko S88D**, or approved equal.

P. Door Bottom Sweep: stainless steel with neoprene seal, **Pemko 3151SSN**, or approved equal.

2.1 ACOUSTIC SOUND DOORS AND FRAMES

A. **General:** Sound retardant doors and frames shall be complete factory-built, and laboratory tested assemblies, complete with perimeter compression seals and automatic, door-bottom seals at sill. Assemblies shall be complete with metal frame, door(s), sealing system, and Cam-lift hinges.

B. **Performance:** Sound retardant metal swinging door system shall be **Overly Model No. 5292185**, or approved equal, with a STC rating of 52 when tested as and operable system in accordance with ASTM E 90 and ASTM E 413.

C. **Materials:** Sound doors and frames shall be constructed from formed sheet steel or structural shapes and bars. Sheet steel shall be commercial quality, level, cold rolled steel conforming to ASTM A 366 or hot rolled, pickled, and oiled steel conforming to ASTM A 1011. Steel shapes shall comply with ASTM A 36 and steel bars with ASTM A 108, Grade 1018. Exterior and Interior units shall be fabricated from Galvannealed material conforming to ASTM A 653 (A60) with a coating weight of not less than 0.60 ounces per square foot.

D. **Door Design:** Sound doors shall be a 1-3/4” nominal minimum thickness construction with sizes as indicated on the Contract Drawings. No visible seams shall be permitted on door faces. Face gauges, internal sound retardant core and perimeter door edge construction to be manufacturer’s standard for the specified model. No lead or asbestos

shall be permitted in door construction to achieve STC performance.

E. **Frame Design:** Sound door shall be 14-gauge minimum welded units with integral trim and shipped with temporary spreader. Knock-down frames are not acceptable.

F. **Cam Lift Hinges:** When required to achieve STC, manufacturer to furnish laboratory test data certifying hinges have been cycled a minimum of 1,000,000 while supporting a minimum door weight of 350 pounds.

G. **Hardware Reinforcements:** Factory mortise, reinforce drill and tap and door and frames for all mortise hardware as required by hardware manufacturer's template. Provide necessary reinforcement plates as required for surface mounted hardware; all drilling and tapping to be done in field by installer. Provide dust cover boxes on all frame mortises.

H. **Perimeter Seals:** Perimeter seals shall be made of sturdy vinyl with a magnetic tape insert. The hinge side shall be constructed to avoid pinching or other distortion of the seal from opening and closing the door.

I. **Automatic Door Bottoms:** Automatic door bottoms shall close the entire gap between the door and the floor. The seal shall be 50 to 60 durometer neoprene, and the actuating mechanism shall compress or retract the seal properly when the outer face of the door is within 2-inchs of the strike jamb.

J. **Anchors:** Provide suitable anchors to properly install frames in walls. Frames in masonry walls shall have adjustable strap or wire anchors and headers and jambs must be fully grouted in the field.

K. **Painting and Cleaning:** After fabrication of frames, all tool marks and surface imperfections shall be removed, and exposed faces of all welded joints dressed smooth. Chemically treat all surfaces to insure maximum paint adhesion and coat with a rust-inhibitive primer.

2.2 ACCESS DOORS AND FRAMES MISCELLANEOUS

A. Fabricate doors and frames as shown on the drawings and in accordance with best shop practices. Frames shall be rigid, neat in appearance and free from defects. Field measurements shall be taken as required for coordination with adjoining work.

B. Form exposed surfaces free from warp, wave, and buckle, with all corners square, unless otherwise shown. Set each member in proper alignment and relationship to other members with all surfaces straight and in a true plane.

C. Reinforce members and joints with plates, tubes or angles for rigidity and strength.

D. Doors and frames shall be mortised and reinforced for hardware in accordance with the hardware manufacturer's instructions and templates. The reinforcing shall be designed to receive hinges, locks, strikes, closures, etc.

E. Mortar guard boxes shall be provided for hardware cutouts in frames.

F. Furnish at least three (3) metal anchors or polymer spacers in each jamb of frames up to 84" high and one (1) additional anchor for each 24" in height above 84", in shapes, sizes and spacing shown or required for anchorage into adjoining wall construction. Fabricate

joint anchor of stainless steel.

G. Terminate bottom of frames at the indicated finished floor level.

H. Provide clearance for doors of 1/8" at jambs and heads; 1/4" clearance above threshold.

I. Where glazing is required, flush integral stops on one side and screw-on stops on the opposite side shall be provided.

2.3 FINISH

A. Surfaces shall be provided with a shop-primed galvanized finish. Prior to receiving primer, all surfaces shall be cleaned thoroughly and phosphate-treated to assure maximum paint adherence. Primer shall be a metallic oxide or synthetic resin primer of the manufacturer's standard type and shall be applied by dipping or spraying in accordance with ANSI A 250.10.

B. Field painting of doors and frames shall be in accordance with Section 09 90 00 – Painting and Finishes. Finish coat shall be compatible with the shop applied primer coating.

PART 3 EXECUTION

3.1 INSTALLATION

A. Doors shall be installed in accordance with approved detail drawings and manufacturer's instructions and in accordance with ANSI A 115IG. Anchors and inserts for guides, brackets, hardware, and other accessories shall be accurately located. Upon completion, doors shall be weather tight and shall be free from warp, twist, or distortion. Doors shall be lubricated, properly adjusted, and demonstrated to operate freely.

B. Access Door Frame Installation

1. Place frames prior to construction of enclosing walls and ceilings. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders leaving surfaces smooth and undamaged. Frame must not be drilled for brace supports as finish may be damaged. Install frames in accordance with ANSI A 250.11.
2. Locate three (3) wall anchors per jamb at hinge and strike levels. Frames may be grouted full of mortar at jambs and anchors shall be built into the joints as walls are laid up. A continuous bead of silicone sealant is to be applied between the head and jamb at the miter joint.

C. Adjust doors for free swing without binding. Adjust hinge sets, locksets, and other hardware. Lubricate using a suitable lubricant compatible with the door and frame coatings.

D. Install work of this Section in strict accordance with approved shop drawings and manufacturer’s recommended installation instructions. Where installations require field welding, all work must be performed by certified welders in accordance with AWS D1.1/D1.3.

E. Upon installation, secure the services of a qualified representative of the manufacturer to visit the jobsite and inspect the complete installation of the door and frame assemblies,

test all components thru a minimum of ten (10) cycles of operation and direct installer in correcting any non-conforming items found.

F. Remove temporary coverings. Repair or replace damaged installed products. Clean installed products in accordance with the manufacturer's instructions before acceptance by OWNER.

G. Clearances at edge of doors:

1. Between door and frame at head and jambs: 1/8 inch.
2. At meeting edges pairs of doors and at mullions: 1/8 inch.
3. At transom panels, without transom bars: 1/8 inch.
4. At sills without thresholds: 5/8-inch maximum above finish floor.
5. At sills with thresholds: 1/8-inch above threshold.

3.2 HARDWARE SCHEDULE

A. The hardware schedule is arranged for convenience of locating hardware and does not preclude in any way the requirements that all necessary hardware shall be furnished and properly installed. Hardware not specifically called out shall be similar to that required for similar uses.

B. Hardware equal in quality and utility will be accepted provided it conforms in operation, quality, weight, size, workmanship, and finish to the products hereinafter described. All component parts of locksets shall be the product of one manufacturer.

Hardware Set 100 (Single Exterior Doors: 101, 103, 105, 111, 112, 113) Each to Receive:				
Quantity	Item	Model No.	Finish	Manufacturer
3 each*	Hinge	T4A3386-NRP 4.5"x4.5"	32D	McKinney
1 each	Exit Devices	QED311-QET330-M	689	Stanley
1 each	Closer	4040XP	689	LCN
1 each	Kickplate	K1050F	630	Rockwood
1 each	Wall Stop	409	32D	Rockwood
3 each	Silencer	608	Gray	Rockwood
1 each	Threshold	277AS	Alum	Pemko
1 each	Drip Cap	346C	Alum	Pemko
1 set	Perimeter Seal	S88D	Alum	Pemko
*Five Knuckle, Stainless Steel, Non-removal Pin Hinges (size and quantity by door manufacturer)				

Hardware Set 600 (Double Exterior Door: 102)				
Each to Receive:				
Quantity	Item	Model No.	Finish	Manufacturer
3 each***	Hinge	MKCL-180***	32D	McKinney
1 each*	Lockset	47H-7-AB-15-M-630-S6-VT	630	Best Access Systems
1 each	Closer	4040XP	689	LCN
1 each	Kickplate	K1050F	630	Rockwood
1 each	Astragal	HD306B-AST	630	Rockwood
1 each**	Flush Bolt, upper	555	626	Rockwood
1 each**	Flush Bolt, lower	555	626	Rockwood
1 each	Threshold	277AS	Alum	Pemko
1 each	Drip Cap	346C	Alum	Pemko
1 set	Perimeter Seal	S88D	Alum	Pemko
* Deadbolt required on Active Leaf only ** Inactive Leaf Only *** Cam lift hinges, stainless steel (size and quantity by door manufacturer)				

- END OF SECTION –

SECTION 08 33 23
OVERHEAD COILING DOORS

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers all the work necessary to furnish and install new overhead coiling doors, frames, motors, and hardware, complete and operable.

1.2 RELATED WORK

A. Related work in other sections includes but is not limit to:

1. Section 01 33 00 Submittal Procedures
2. Section 05 50 00 Miscellaneous Metals
3. Section 09 91 00 Painting and Finishes

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publications are referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

2. ASTM D 3363 Standard Test Method for Film Hardness by Pencil Test

3. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials

4. ASTM E 90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

1. ASHRAE 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings

D. American Society OF CIVIL ENGINEERS (ASCE)

1. ASCE-7 Minimum Design Loads for Buildings and Other Structures

E. UNDERWRITERS laboratories (UL)

1. UL 325 Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Manufacturer's catalog product data and preprinted installation instructions of doors.

C. A schedule showing the location of each door shall be included with the shop drawings. Submittal drawings shall include elevations of each door type, details and method of anchorage, details of construction, wiring diagrams in motors are required, locations of louvers and glass if required, method of assembling sections, location and installation of hardware, shape and thickness of materials, details of joints and connections.

D. Submit calculations stamped by a registered engineer showing connections are designed to meet code requirements and loads.

E. Provide manufacturer and installer qualifications as noted below.

F. Manufacturer’s certificates that certify products meet or exceed the specified requirements.

G. Submit operation and maintenance manual.

1.5 DELIVERY AND STORAGE

A. Doors shall be delivered to the job site wrapped in a protective covering with the brands and names clearly marked thereon. Doors shall be stored in a dry location that is adequately ventilated and free from dust or water, and in a manner that permits easy access for inspection and handling. Doors shall be handled carefully to prevent damage to the faces, edges, and ends. Damaged items that cannot be restored to like-new condition shall be replaced.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A minimum of five (5) years experience in producing doors of the type specified.

B. Installer Qualifications: Installer must be approved or certified by the manufacturer.

1.7 WARRANTY

A. Standard Warranty: Two years from data of shipment against defects in material and workmanship.

1.8 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for overhead coiling doors. Full compensation for all doors shall be considered as included in the contract unit or lump sum bid prices for the various items of the contract to which doors relate.

PART 2 PRODUCTS

2.1 OVERHEAR COILING DOORS

A. **General:** Overhead coiling doors (roll-up doors) shall be of the metal curtain slat design, motor operated, and shall be weather and dust-resistant. Wiring diagrams shall be submitted for motor operated doors. Doors shall be provided complete with slats, guides, hoods, reduction gears, galvanized hand chain, operating mechanism, motors, controls, wiring, brackets, gears, head, bottom and side weather stripping, hardware, and other items necessary for complete installation and operation.

B. **Wind Loading:** The doors shall be designed to withstand a wind load of 1115 MPH, Exposure B. Door shall also be designed to withstand 20 psf inward and 26 psf outward. Within 10 feet of corner inward pressure to be 33 psf and outward pressure to be 26 psf

C. Air infiltration shall comply with ASHRAE 90.1 requirements of less than 1.0 CFM/SF.

D. Cycle Life: Design doors of standard construction for normal use of up to 20 cycles per day maximum and an overall maximum of 50,000 operating cycles for the life of the door.

E. Provide manufacturer's seismic calculations confirming ASCE 7-05.

F. Manufacturer, or approved equal:

1. Cookson Model TMWI
2. Cornell Model ESD30
3. Overhead Door Stormtite Series

2.2 MATERIALS

A. **Curtain:** Shall have an air infiltration rate of less than 0.4 CFM/SF, validated by an independent testing agency.

1. Fabrication:

a. Slat Material: No. 6F or 3/4 inch minimum by 2-1/2 inch minimum, (Listed Exterior/Interior):

1) Galvanized Steel/Galvanized Steel: Manufacturer recommended gauge based on performance requirements. Minimum 24/24 gauge, Grade 40, ASTM A 653 galvanized steel zinc coating

b. Insulation: foamed-in-place, closed cell urethane. Insulation shall be CFC Free with an Ozone Depletion Potential (ODP) rating of zero.

c. Flame Spread Index of 5 and a Smoke Developed Index of 10 as tested per ASTM E 84

d. R-value: 7.7 minimum (U-value of 0.125) per ASHRAE.

e. STC Rating: Up to 30 for the curtain and up to 22 for the entire assembly, as tested per ASTM E 90 and based on testing a complete, operable assembly.

2. Exterior and Interior Slat Finish:

a. ColorCote® (or equivalent) Coating System:

b. ASTM A 653 galvanized base coating treated with dual process rinsing agents in preparation for chemical bonding, gray baked-on base coat and gray baked-on polyester finish coat.

c. Phosphate treatment followed by baked-on polyester powder coat, with color as selected by OWNER from manufacturer's standard color range; minimum 2.5 mils cured film thickness; ASTM D 3363 pencil hardness: H or better.

B. **Endlocks:** Fabricate interlocking sections with high strength nylon or galvanized cast iron endlocks on alternate slats each secured with two 1/4 inch rivets. Provide windlocks as required to meet specified wind load.

1. **Nylon:** Required up to 21’-5” width (DBG - Distance Between Guides)

2. Galvanized cast iron: Required if above 21’-5” width (DBG - Distance Between Guides)

C. **Insulated Bottom Bar:** Reinforced extruded aluminum interior face with full depth insulation and exterior skin slat to match curtain material and gauge. Minimum 4” tall x 1-1/16” thickness.

1. Finish:

a. Exterior: Match slats
b. Interior: Powder coat to match slats

2. Air Infiltration Certification Label: Must be affixed to bottom bar

D. Guides:

1. Fabrication:

a. Thermal break required: Minimum 3/16 inch stainless steel angles. Provide windlock bars of same material when windlocks are required to meet specified wind load. Top of inner and outer guide angles to be flared outwards to form bellmouth for smooth entry of curtain into guides. Provide removable guide stoppers to prevent over travel of curtain and bottom bar.

2. Finish:

a. Stainless Steel: Type 304 #4 Finish

E. Counterbalance Shaft Assembly:

1. Barrel: Steel pipe capable of supporting curtain load with maximum deflection of 0.03 inches per foot of width.

2. Spring Balance: Oil-tempered, heat-treated steel helical torsion spring assembly designed for proper balance of door to ensure that maximum effort to operate will not exceed 25 lbs. Provide wheel for applying and adjusting spring torque.

F. Brackets: Fabricate from minimum 3/16 inch steel plate with permanently lubricated ball or roller bearings at rotating support points to support counterbalance shaft assembly and form end closures.

1. Finish: Hot-dip galvanized per ASTM A 123, Grade 85 zinc coating. Hot-dip galvanize after fabrication.

G. Hood: Minimum 24 gauge galvanized steel with reinforced top and bottom edges. Provide minimum 1/4 inch steel intermediate support brackets as required to prevent excessive sag.

1. Finish:

a. ColorCote® (or equivalent) Coating System:

1) ASTM A 653 galvanized base coating treated with dual process rinsing agents in preparation for chemical bonding, gray baked-on base coat and gray baked-on polyester finish coat.

2) Phosphate treatment followed by baked-on polyester powder coat, with color as selected by OWNER from manufacturer's standard color range; minimum 2.5 mils cured film thickness; ASTM D 3363 pencil hardness: H or better.

H. Weather Stripping:

1. Bottom Bar:

a. Manually Operated Doors: Replaceable, bulb-style, compressible EDPM gasket extending into guides.

b. Motor Operated Doors: Sensing/weather edge with neoprene astragal extending full width of door bottom bar

2. Guides: Replaceable vinyl strip on guides sealing against both sides of curtain.

3. Lintel Seal: Nylon brush seal fitted at door header to impede air flow.

4. Hood: Neoprene/rayon baffle to impede air flow above coil.

2.3 OPERATION

A. **Manual Chain Hoist:** Provide chain hoist operator with endless steel chain, chain pocket wheel and guard, geared reduction unit, and chain keeper secured to guide. Fabricate gear box to completely enclose operating mechanism and be oil-tight.

B. **Motor Operator:** The operator must not extend above or below the door coil when mounted front-of-coil. Rated for a maximum of 20 cycles per hour (not to be used for consecutive hours) UL listed, Totally Enclosed Non-Ventilated gear head operator(s) rated 1/2 hp min, or larger, as recommended by door manufacture for size and type of door, 480 Volts, Three Phase, 60 Hz. Provide complete with electric motor and factory pre-wired motor control terminals, maintenance free solenoid actuated brake, emergency manual chain hoist, and control station. Motor shall be high starting torque, industrial type, protected against overload with an auto-reset thermal sensing device. Primary speed reduction shall be heavy-duty, lubricated gears with mechanical braking to hold the door in any position. Operator shall be equipped with an emergency manual chain hoist assembly that safely cuts operator power when engaged.

   A disconnect chain shall not be required to engage or release the manual chain hoist. Operator drive and door driven sprockets shall be provided with #50 roller chain. Provide an integral Motor Mounted Interlock system to prevent damage to door and operator when mechanical door locking devices are provided. Operator shall be capable of driving the door at a speed of 8 to 9 inches per second.

   Fully adjustable, driven linear screw type cam limit switch mechanism shall synchronize the operator with the door. The electrical contractor shall mount the control station and supply the appropriate disconnect switch, all conduit and wiring per the overhead door wiring instructions. The motor-operated doors, motors, controls, safety devices, and wiring shall conform to requirements of governing codes and authorities. Motor operator shall be **Cookson Model SG, Cornell Model MG, Overhead Door Model RHX,** or approved equal.

C. Control Station: “Open/Close” key switch with “Stop” push button in a NEMA 3R enclosure.

D. Control Operation:

   1. Momentary Contact to Close, Fail-safe UL 325 Compliant entrapment protection for motor operation; 2-wire, E.L.R. electric sensing/weather edge extending full width of door bottom bar. Contact before door fully closes shall cause door to immediately stop downward travel and reverse direction to the fully opened position.

   2. Sensing/Weather Edge: Automatic reversing control by an automatic sensing switch within neoprene or rubber astragal extending full width of door bottom bar.

      a. Electric sensing edge device. Provide a wireless sensing edge connection to motor operator eliminating the need for a physical traveling electric cord connection between bottom bar sensing edge device and motor operator.

2.4 ACCESSORIES

A. Locking: For non-motor operated doors, provide a master keyable cylinder operable from both sides of bottom bar, options for all types of operation. Cylinder shall be BEST 7-pin.

B. Vision Panels: 10 x 1-1/2 x 3/4 inch thick oval acrylic panes set with double-sided foam glazing tape and fully contained within slat assembly. Refer to drawings for number and placement. Smaller vision panels are not acceptable.

C. Operator and Bracket Mechanism Cover: If the operator components are lower than 8 feet above finish floor level, provide Minimum 0.040 inch aluminum sheet metal cover to enclose exposed moving operating components at coil area of unit.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates upon which work will be installed and verify conditions are in accordance with approved shop drawings

B. Coordinate with responsible entity to perform corrective work on unsatisfactory substrates.

C. Commencement of work by installer is acceptance of substrate.

3.2 INSTALLATION

A. General: Install overhead coiling door and operating equipment with necessary hardware, anchors, inserts, hangers, and supports in accordance with the manufacturer's installation instructions.

B. Doors and frames shall be accurately cut, fitted, and installed level, square, plumb, and in alignment. Fasteners shall be of sufficient length and shall be sized for loads imposed.

C. Installation of motor operators shall be in accordance with the manufacturer's installation instructions and as required by Division 26.

3.3 ADJUSTING

A. Following completion of installation, including related work by others, lubricate, test, and adjust the doors for ease of operation, free from warp, twist, or distortion.

3.4 CLEANING

A. Clean surfaces soiled by work as recommended by the manufacturer.

B. Remove surplus materials and debris from the site.

3.5 DEMONSTRATION

A. Demonstrate proper operation to OWNER's Representative.

B. Instruct OWNER’s Representative in maintenance procedures.

- END OF SECTION -

SECTION 08 62 00

SKYLIGHTS

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers all the Work necessary to furnish and install skylights, complete and in place.

1.2 RELATED WORK

A. Related work in other Sections includes but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 09 90 00 Painting and Finishes

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publications are referred to in the text by basic designation only.

B. AMERICAN ARCHITECTURAL MANUFACTURER'S ASSOCIATION (AAMA)

1. AAMA 1606 Voluntary Uniform Load Structural Standard for Plastic Domed Skylights

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 123 Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
2. ASTM B 221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
3. ASTM D 256 Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
4. ASTM D 4802 Standard Specification for Poly (Methyl Methacrylate) Acrylic Plastic Sheet

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide unit skylights capable of withstanding loads indicated without failure. Failure includes the following:

1. Thermal stresses transferred to the building structure.
2. Framing members transferring stresses, including those caused by thermal and structural movement, to glazing.
3. Noise or vibration created by thermal and structural movement and wind.
4. Weakening of fasteners, attachments, and other components.

B. Structural Loads: Provide unit skylights that meet the requirements of AAMA 1606-82, which requires acrylic thickness adequate to withstand a positive and negative test pressure of 60 PSF.

1.5 SUBMITTALS

A. Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Product Data Sheet: For each type of skylight specified, include details of construction and installation, relative to applicable roofing materials, materials, gauges, sizes, finishes, and fasteners.

C. Samples for Selection: Manufacturer's color charts showing a full range of colors available for each type of skylight glazing and Aluminum Finish.

1.6 DELIVERY AND STORAGE

A. Skylights shall be delivered to the jobsite wrapped in a protective covering with the brands and names clearly marked thereon.

1.7 WARRANTY

A. Manufacturer shall provide to the Owner written guarantee against defects in material or workmanship for a period of five (5) years.

1.8 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for skylights. Full compensation for all skylights shall be considered as included in the contract unit or lump sum bid prices for the various items of the Contract to which they relate.

PART 2 PRODUCTS

2.1 SKYLIGHTS

A. Skylights shall be as noted on the drawings and be manufactured by **Wasco Products, Inc., Aladdin Industries,** or approved equal. Skylights shall be factory assembled with square double-dome type designed to meet applicable OSHA and building code requirements. Skylights shall be watertight with curb frame insulation and meet the requirements specified herein. All hardware shall be stainless steel throughout. Skylights shall be provided with a permanent label showing the manufacturer's name and address and the model number.

1. Curb Frame: High performance PVC with minimum effective thickness of 0.60 inch. Provide integral condensation gutter with corners fully welded for waterproof quality.
2. Retainer Frame: Extruded aluminum alloy 6063-T5 (min) conforming to ASTM B 221 with minimum effective thickness of 0.60 inch.
3. Integral Curbs (Where indicated): Fabricated from double skin of 1100-H14 sheet aluminum, insulated with 1-inch fiberglass insulation. Provide thermal break at top and bottom. Provide minimum 0.025 inch minimum thickness inner and outer skin. Outer skin to be 0.032 inch when length exceeds 48 inches.

4. Plastic Sheets: Monolithic, formable, transparent (colorless – Clear) with good weather and impact resistant.
    a. Acrylic: Conforming to ASTM D 4802, thermoformable, acrylic (methacrylate), Category C-2 or CC-2 Type UVA (formulated with ultraviolet absorber), with Finish 1 (smooth or polished), unless otherwise indicated. Average impact strength of 5.0 ft-lb/in when tested per ASTM D 256 (Charpy unnotched).
    b. Impact Modified Acrylic: Conforming to ASTM D 4802, thermoformable, acrylic (methacrylate) impact modified sheets manufactured by the extrusion process, category C-2 or CC-2, type UVA (formulated with ultraviolet absorber) with Finish 1 (smooth or polished). Average impact strength of 0.75 ft-lb/inch (40 J/m of notch) when tested according to ASTM D 256, Test Method A (Izod).
5. Thermal Break: Fabricate skylight units with thermal barrier separating interior metal framing from materials exposed to outside temperature.
6. Shape and Size: As indicated by model number.
7. Fasteners: Same material as metals being fastened or non-magnetic stainless steel as recommended by the manufacturer.

2.2 SKYLIGHT SCREENS

A. All skylights that do not meet OSHA and building code requirements for opening protection shall be provide with skylight screens. Screens shall be designed to meet OSHA regulation 29 CFR 910.23(e)(8) and shall meet the code requirements for opening protection. The entire assembly and anchoring system shall be designed and tested to withstand a minimum impact load of 300 foot pounds.

B. Screens shall be hot-dip galvanized, 3-inch by 4-inch welded wire mesh with a minimum diameter of 0.195-inch. Galvanizing shall conform to ASTM A 123.

C. Screens shall be manufactured by **Wasco Products, Inc., Aladdin Industries, Plasteco, Inc.**, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Skylights shall be installed in accordance with approved detail drawings and manufacturer's instructions. Anchors and inserts for guides, brackets, hardware, and other accessories shall be accurately located. Upon completion, skylights shall be weather tight and shall be free from warp, twist, or distortion.

B. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape as recommended by the manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint. Where aluminum will contact pressure-treated wood, separate dissimilar materials by methods recommended by the manufacturer.

C. Coordinate with installation of the roof deck and other substrates to receive skylights. Coordinate vapor barriers, roof insulation, roofing material, and flashing as required to assure that each element of the work performs properly and that combined elements was waterproof and watertight. Anchor units securely to supporting structure substrates to adequately withstand lateral and thermal stresses as well as inward and outward loading pressures.

D. Where counter flashing is required as a component of the skylight, install to provide adequate waterproof overlap with roofing or roof flashing. Seal with a thick bead of mastic sealant, except where overlap is indicated to be left open for ventilation.

- END OF SECTION -

SECTION 09 20 00
GYPSUM BOARD

PART 1 GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall provide gypsum board and appurtenances, complete and in place, as shown on the Contract Drawings and in accordance with the specifications.

1.2 RELATED WORK

A. Related Work in other sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 01 60 00 Product Requirements
3. Section 09 90 00 Painting and Finishes

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. American Society for Testing and Materials (ASTM)

1. ASTM C 473 Standard Test Methods for Physical Testing of Gypsum Panel Products
2. ASTM C 475 Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board
3. ASTM C 754 Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
4. ASTM C 840 Standard Specification for Application and Finishing of Gypsum Board
5. ASTM C 919 Standard Practice for Use of Sealants in Acoustical Applications
6. ASTM C 920 Standard Specification for Elastomeric Joint Sealants
7. ASTM C 1002 Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
8. ASTM C 1177 Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
9. ASTM C 1178 Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel
10. ASTM C 1280 Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing
11. ASTM C 1325 Standard Specification for Non-Asbestos Fiber-Mat Reinforced Cementitious Backer Units
12. ASTM C 1396 Standard Specification for Gypsum Board
13. ASTM C 1629 Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels
14. ASTM C 1658 Standard Specification for Glass Mat Gypsum Panels
15. ASTM D 3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber

16. ASTM E 72 Standard Test Methods of Conducting Strength Tests of Panels for Building Construction
17. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
18. ASTM E 90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
19. ASTM E 96 Standard Test Methods for Water Vapor Transmission of Materials
20. ASTM E 119 Standard Test Methods for Fire Tests of Building Construction and Materials
21. ASTM E 136 Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C
22. ASTM E 814 Standard Test Method for Fire Tests of Penetration Firestop Systems
23. ASTM G 21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

C. American National Standards Institute (ANSI)

1. ANSI A 108.11 Specifications for Interior Installations of Cementitious Backer Units
2. ANSI A 118.9 Test Methods and Specifications for Cementitious Backer Units

D. Gypsum Association (GA)

1. GA-214 Recommended Levels of Finish – Gypsum Board, Glass Mat & Fiber-Reinforced Gypsum Panels
2. GA-216 Application Finishing Gypsum Panel Products
3. GA-234 Control Joints for Fire-Resistance Rated Systems
4. GA-253 Application of Gypsum Sheathing
5. GA-600 Fire Resistance Design Manual

E. Wall and Ceiling Bureau (WCB)

1. TB-52010 Control Joints for Gypsum Board

1.4 SUBMITTALS

A. CONTRACTOR shall submit documents per the requirements of Section 01 33 00 Submittal Procedures.

B. Submit manufacturer’s literature, product data sheets, and installation instructions for plaster and gypsum products and appurtenances to be used in the Work.

1.5 DELIVERY AND STORAGE

A. Delivery, storage, and handling of gypsum products shall be in accordance with Section 01 60 00 – Product Requirements, the manufacturer’s printed instructions, and as indicated below.

B. Manufactured materials shall be delivered in original unbroken packages, containers, or bundles, bearing the manufacturer’s label.

C. Verify products undamaged before acceptance at the Project Site. Do not use products with visible signs of mold and damage.

D. Storage

1. Store the materials in an area that is protected from the elements as recommended by the manufacturer.
2. Storage shall be in a manner that will prevent damage to the material and its finish.
3. Materials shall be stored above ground in a dry and ventilated space,
4. Boards that will be directly applied to masonry walls shall be stored at 70 degrees F for 24 hours prior to installation.

1.6 PROJECT CONDITIONS

A. Do not install gypsum board when the ambient temperature is below 40 degrees F.

1.7 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for plaster and gypsum board. Full compensation for plaster and gypsum board shall be considered as included in the contract unit or lump sum bid prices for the various items of the contract to which it relates.

PART 2 PRODUCTS

2.1 MANUFACTURERS OR APPROVED EQUAL:

A. National Gypsum Company

B. United States Gypsum Company (USG Corporation)

C. Georgia Pacific Corporation

D. Certainteed (a Saint-Gobain Company)

2.2 ACOUSTICALLY ENHANCED GYPSUM BOARD

A. Performance Criteria – Wall Assembly STC: (wood stud construction) 52 (metal stud construction 55.

B. Attach gypsum board to furring channels hung from **KNC "Wave Hanger"** Acoustic System per manufacturer instructions.

C. Panel Physical Characteristics

1. Core
   a. Inner Layer: Viscoelastic damping polymer
   b. Outer layers: Enhanced, high density mold-resistant gypsum core
2. Overall thickness: 5/8 inch, Type X
3. Long Edges: Tapered
4. Mold Resistance:
   a. 10 when tested in accordance with ASTM D 3273
   b. 0 when tested in accordance with ASTM G 21

5. Surface Abrasion Resistance: Classification Level 3 in accordance with ASTM C 1629
6. Indentation Resistance: Classification Level 1 in accordance with ASTM C 1629
7. Soft Body Impact Resistance: Classification Level 2 in accordance with ASTM C 1629
8. Hard Body Impact Resistance: Level 1 in accordance with ASTM C 1629
9. Environmental Requirements: Provide products that comply with testing and product requirements for low emitting materials

2.3 ACCESSORY PRODUCTS

A. Acoustical Sealant

1. Conform to ASTM C 919
2. VOC content less than 15 g/L
3. Manufacturer, or approved equal:
   a. Grabber Acoustical Sealant GSCS
   b. USG Acoustical Sealant
   c. STI SpecSeal Smoke N Sound Caulk
   d. BOSS 824 Acoustical Sound Sealant

B. Firestopping

1. Conform to ASTM E 90
2. Manufacturer, or approved equal:
   a. STI SpecSeal SSP Putty Pads
   b. USG Firecode Smoke-Sound Sealant
   c. 3M Fire Barrier Moldable Putty Pads MPP+
   d. BOSS 818 Fire Rated Putty Pads

C. Metal trim, corner beads, edge, casing beads, and accessories shall be manufactured from galvanized sheet steel unless noted otherwise.

2.4 FASTENERS

A. General: Fastener screws shall be of the self-drilling, self-tapping, bugle head type for use with power tools, with a length as recommended by the Gypsum Association referenced standards and in accordance with the local Building Code.

1. Types:
   a. Type “S” for board-to-sheet metal application
   b. Type “W” for board-to-wood application
   c. Type “G” for board-to-board application
   d. Type “S” or “S-12”, for tile backing board-to-metal studs application

2.5 TAPE

A. General: Joint reinforcing tape shall conform to ASTM C 475 and ASTM C 840.

B. Tape:

1. Paper Tape: 2- 1/16 inches wide, **ProForm Joint Tape – Heavy**, **USG Heavy Joint Tape**, **CertainTeed Marco Spark-Perf 94# Heavy Weight,** or approved equal.
2. Fiberglass Mesh Tape: Nominal 2-inch wide self-adhering tape, **ProForm Fiberglass Mesh Tape**, **FibaTape Drywall Joint Tape,** or approved equal.

2.6 JOINT COMPOUND

A. General: Joint compound shall conform to ASTM C 475.

B. Drying Type Compound:

1. Ready Mix vinyl base compound, **ProForm All Purpose Ready Mix Joint Compound, USG All Purpose Joint Compound - Select**, **CertainTeed All Purpose**, or approved equal.
2. Ready Mix vinyl base compound formulated for enhanced mold and mildew resistance, **ProForm XP Ready Mix Joint Compound**, **CertainTeed Mold Resistant Lite All-Purpose,** or approved equal, conforms to ASTM D 3273
3. Ready Mix vinyl base topping compound for finish coating, **ProForm Topping Compound, CertainTeed Topping, USG Topping Joint Compound,** or approved equal
4. Ready Mix vinyl base compound for embedding joint tape, cornerbeads or other accessories, **ProForm Taping Joint Compound**, **CertainTeed Heavy Taping Joint Compound, USG Ready-Mixed Taping Joint Compound,** or approved equal
5. Field Mix vinyl base compound, **ProForm Triple-T Compound**, or approved equal

C. Setting Compound:

1. Field mixed hardening compound, **ProForm Quick Set Setting Compound**, **USG Durabond Setting-Type Compound**, or approved equal
2. Field mixed hardening compound for fire resistance rated construction and penetrations, **ProForm Fire Shield 90**, **USG Firecode Compound,** or approved equal, conforms to ASTM E 136 and ASTM E 814.
3. Field mixed hardening compound for mold and moisture resistance, **CertainTeed M2Tech 90 Setting Compound**, or approved equal.

D. Joint Sealant

1. Joint sealants shall conform to ASTM C 920
2. Joint sealants shall have VOC content less than 2 g/L

2.7 ACCESS PANELS

A. Provide access panels where indicated or where required for access to valves and equipment

B. Standard access panels: flush installation type, grey powder coated steel, double-acting concealed spring hinges, screw type lock, **Milcor Type DW, KARP Model KDW**, or approved equal.

C. Acoustical access panel: recessed panel, with screw type lock, **Milcor Type AP**, or approved equal.

D. Fire rated access panel: UL listed, self-closing, self-latching, **Milcor Type UFR**, or approved equal.

PART 3 EXECUTION

3.1 GENERAL

A. Provide gypsum board over framing and furring members.

B. Gypsum board installation and fire-rated gypsum board construction shall conform to applicable codes, reference standards, manufacturer's printed recommendations, the Gypsum Association's recommendations, and the following requirements:

1. Gypsum board shall be applied first to the ceiling and then to the walls.
2. Fastening
   a. Gypsum board shall be screwed to metal framing and furring.
   b. The fastener spacing shall be in accordance with the referenced standards.
   c. Do not attach gypsum board to metal roof decking.
3. The gypsum wall board surface finish shall be as indicated below.
4. The installation of the steel framing shall be in accordance with ASTM C 754 and code requirements.

3.2 EXAMINATION

A. Verify installation conditions are satisfactory to receive work of this Section before beginning.

B. Verify framing systems, including backing, insulation, vapor barriers, and other systems ready for work of this Section.

C. Do not begin work until building envelope is fully enclosed and temperature, ventilation, and humidity are controlled.

D. Do not begin work under conditions that gypsum board installation may be exposed to contact with water.

3.3 PREPARATION

A. Protect surrounding areas and surfaces to preclude damage.

B. Avoid soiling, spatter, and damage to work of other trades. Use cover cloths, or other means of protection. Remove, clean, and repair soiled or damaged work.

3.4 INSTALLATION

A. Conform to ASTM C 840, GA-216, and manufacturer's instructions.

B. Corner Trim: Reinforce external corners with specified corner beads.

C. Edge Trim: Install square edged metal trim bead at exposed edges and boundaries of areas where abutting dissimilar materials.

D. Reveal Trim:

1. Install with screws at 12 inch on center in 10 foot lengths, except where shorter lengths are sufficient for dimension of wall plane.
2. Make butt joints tight and in alignment.
3. Miter corners.
4. Promptly remove excess joint compound.

E. Control Joints: Conform to WCB TB-52010 and GA-234, except as otherwise indicated. Verify that required double framing is in place before installing control joints.

1. Door and Other Openings: Install control joints at each side of wall opening and at both sides of wall, except alcoves and similar wall configurations.
2. Continuous Wall Planes: Install control joints floor to ceiling at each 30 lineal foot of wall.
3. Ceilings: Install across ceiling at each 50 lineal foot distance and each 2,500 square foot of ceiling area.
4. Joints with Other Materials: Install where gypsum board meets masonry, concrete, and other materials, except where joints are concealed under horizontal chair rails or other trim.

F. Other Trim: Install as indicated or required for complete and finished installation.

G. Panel Joints:

1. Layout: Design to reduce joints to minimum.
2. Install board in maximum lengths to minimize horizontal and vertical joints.
3. Start installation of panels at exterior wall to position butt joints as far away from exterior wall as possible.
4. Place edges in contact and fit neatly, without forcing into place.
5. Stagger joints on opposite sides of partitions and on same side of wall surface at adjacent joints.
6. Maintain 1/2 inch clearance from bottom of wall panel and top of floor. Seal with acoustical sealant.
7. In order to prevent wicking of moisture, do not let gypsum board rest on floor after installation.

H. Single Layer Systems: Install in accordance with ASTM C840. Where modified, amended, or required by fire resistive or sound isolation system, conform to the requirements of the manufacturer's tests, as approved.

I. Double Layer Systems: Install in accordance with ASTM C840, including System VIII for double layer gypsum wallboard installations applied with screws. Conform to required fire resistance standards.

J. Joint Sealant and Acoustical Sealant: Install to completely fill void between wallboard edges and adjacent surface.

K. Firestopping and Smoke Sealants: Install in accordance with manufacturer’s recommendations.

L. Plumbing, HVAC, and Electrical: Coordinate work with other Divisions. Provide for installations and penetrations of ductwork, equipment, receptacles, and other work.

3.5 TOLERANCES

A. Shim panels as necessary to conform to tolerances.

B. Between Board Faces: 1/16 inch offset.

3.6 ADJUSTING

A. Remove and replace the following gypsum board installations:

1. Board in contact with water for over 18 hour time period
2. Gypsum core exhibiting dampness or water intrusion
3. Facing paper exhibiting delamination
4. Facing of core exhibiting mold growth or turning black
5. Board sagging or warped
6. Board directly exposed to water determined to be contaminated

3.7 CLEANING

A. Clean beads, screeds, metal base, metal trim, mechanical and electrical items, and other work.

B. Wipe clean, leaving work ready for finish specified under other Sections.

C. As work is completed in each space, clean all rubbish, utensils, and surplus materials from the space. Leave floors broom-clean.

3.8 SURFACE FINISH

A. Gypsum board joints shall be taped, and joints, end trim, corner beads, fasteners, and other depressions shall be treated with joint and finishing compounds, applied in accordance with the manufacturer's printed recommendations for Level 4 Finish (3-coat work) according to ASTM C 840 and the table below.

B. The gypsum board shall be sanded smooth, dusted, and provided with a smooth finish coat.

3.9 PAINTING

A. The surface shall be painted in accordance with Section 09 90 00 Painting and Finishes.

LEVEL OF FINISH	
Finish Level	Description
Level 0	No taping, finishing or corner beads are required.
Level 1	All joints and interior angles shall have tape embedded in joint compound. Surface shall be free of excess joint compound. Tool marks and ridges shall be acceptable.
Level 2 (1-coat work)	All joints and interior angles shall have tape embedded in joint compound and shall be immediately wiped with a joint knife or trowel leaving a thin coating of joint compound over all joints and interior angles. Fastener heads and accessories shall be covered with a coat of joint compound. Surface shall be free of excess joint compound.

	Tool marks and ridges are acceptable. Joint compound applied over the body of the tape at the time of tape embedment shall be considered a separate coat of joint compound and shall satisfy the conditions of this level.
Level 3 (2-coat work)	All joints and interior angles shall have tape embedded in joint compound and shall be immediately wiped with a joint knife or trowel leaving a thin coating of joint compound over all joints and interior angles. One additional coat of joint compound shall be applied over all joints and interior angles. Fastener heads and accessories shall be covered with two separate coats of joint compound. All joint compounds shall be smooth and free of tool marks and ridges. The prepared surface shall be covered with a drywall primer prior to the application of the final decoration.
Level 4 (3-coat work)	All joints and interior angles shall have tape embedded in joint compound and shall be immediately wiped with a joint knife or trowel leaving a thin coating of joint compound over all joints and interior angles. Two separate coats of joint compound shall be applied over all flat joints. One separate coat of joint compound shall be applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compound. All joint compounds shall be smooth and free of tool marks and ridges. The prepared surface shall be covered with a drywall primer prior to the application of the final decoration.
Level 5 (3-coat work)	All joints and interior angles shall have tape embedded in joint compound and shall be immediately wiped with a joint knife or trowel leaving a thin coating of joint compound over all joints and interior angles. Two separate coats of joint compound shall be applied over all flat joints. One separate coat of joint compound shall be applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compound. A thin skim coat of joint compound shall be trowel-applied to the entire surface. Excess compound is immediately sheared off, leaving a film of skim coating compound completely covering the paper. As an alternate to a skim coat, a material manufactured especially for this purpose shall be applied. The surface shall be smooth and free of toll marks and ridges.

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SECTION 09 90 00
PAINTING AND FINISHES

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers furnishing, surface preparation, and applying paints and coatings, complete and in place, to all specified surfaces including exposed valves, piping or fittings.

B. Definitions

1. The term “paint”, “coatings”, or “finishes” as used herein, shall include surface treatments, emulsions, enamels, paints, epoxy resins, and other protective coatings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat.
2. The term “DFT” means minimum dry film thickness, without any negative tolerance.
3. The term “mil” means thousandths of an inch.
4. The term “SSPC” means The Society for Protective Coatings.

C. The following surfaces shall not be coated:

1. Concrete, unless required by items on the concrete coating schedule below or the Drawings.
2. Stainless steel
3. Machined surfaces
4. Grease fittings
5. Glass
6. Equipment nameplates
7. Platform gratings, stair treads, door thresholds, and other walk surfaces, unless specifically indicated to be coated.

D. The protective coatings applicator (Applicator) shall possess a valid state license as required for the performance of the painting and coating work called for in this specification and shall provide 5 references which show the Applicator has previous successful experience with the indicated of comparable coating systems. Include the name, address, and the telephone number for the owner of each installation for which the Applicator provided the protective coating.

1.2 RELATED WORK

A. Related Work in other Sections includes, but is not limit to:

1. Section 01 33 00 Submittal Procedures
2. Section 33 05 05 Ductile Iron Pipe
3. Section 33 11 10 Miscellaneous Appurtenances
4. Section 33 92 10 Steel Pipe, Specials, and Fittings

1.3 REFERENCES AND STANDARDS

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract:

1.	OSHA	Occupation Safety and Health Act: State of Utah and Federal
2.	ICRI	International Concrete Repair Institute Guideline No. 310.2 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays

B. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1.	ANSI A 13.1	Standard for Scheme for the Identification of Piping Systems
2.	ANSI Z 535	Standard for Safety Colors

C. AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

1.	ASTM C 309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
2.	ASTM D 520	Standard Specification for Zinc Dust Pigment
3.	ASTM D 521	Standard Test Methods for Chemical Analysis of Zinc Dust (Metallic Zinc Powder)
4.	ASTM D 6943	Standard Practice for Immersion Testing of Industrial Protective Coatings Linings
5.	ASTM D 1653	Standard Test Methods for Water Vapor Transmission of Organic Coating Films
6.	ASTM D 2370	Standard Test Method for Tensile Properties of Organic Coatings
7.	ASTM D 2794	Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
8.	ASTM D 4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
9.	ASTM D 4414	Standard Practice for Measurement of Wet Film Thickness by Notch Gages
10.	ASTM D 4417	Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
11.	ASTM D 7234	Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers
12.	ASTM D 7682	Standard Test Method for Replication and Measurement of Concrete Surface Profiles Using Replica Putty
13.	ASTM E 96	Standard Test Methods for Water Vapor Transmission of Materials
14.	ASTM F 1869	Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
15.	ASTM F 2170	Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes

D. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1.	AWWA C 210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
2.	AWWA C 222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings

E. AMERICAN CONCRETE INSTITUTE (ACI)

1. ACI 301 Specifications for Structural Concrete

F. NACE International (NACE)

1. NACE RP0287 Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape
2. NACE SP0188 Standard Practice for Discontinuity (Holiday) Testing of Protective Linings
3. NACE SP0892 Standard Practice for Coatings and Linings over Concrete for Chemical Immersion and Containment Service
4. NACE No. 1/SSPC-SP 5 White Metal Blast Cleaning
5. NACE No. 2/SSPC-SP10 Near White Metal Blast Cleaning
6. NACE No. 3/SSPC-SP6 Commercial Blast Cleaning
7. NACE No. 6/SSPC-SP13 Surface Preparation of Concrete

G. SSPC: The Society for Protective Coatings (SSPC)

1. SSPC PA1 - Shop, Field, and Maintenance Painting of Steel
2. SSPC-PA2 – Paint Application Specification No. 2: Measurement of Dry Coating Thickness with Magnetic Gages.
3. SSPC-PA11 - Protecting Edges, Crevices, and Irregular Steel Surfaces by Stripe Coating
4. SSPC-SP 6/NACE No. 3 - Commercial Blast Cleaning.
5. SSPC-SP10/NACE 2 - Near White Metal Blast Cleaning
6. SSPC-SP16 – Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals
7. SSPC-VIS 1 - Guide to Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. CONTRACTOR shall supply shop drawings for approval on all paint materials at least 30 days prior to installation. Submittals shall include the following data sheets:

1. For each paint system used herein, furnish a Paint System Data Sheet (PSDS), Technical Data Sheets, and paint colors available (where applicable) for each product used in the paint system, except for products applied by equipment manufacturers.

C. Where ANSI/NSF 61 approval is required, submit ANSI/NSF 61 certification letter for each coating in the system indicating the product application limits on size of tank or piping, dry film thickness, number of coats, specific product tests, colors certified, and approved additives.

D. Quality Control Submittals:

1. Furnish a list of references for the Applicator substantiating the requirements as specified.

2. Manufacturer's certification stating factory applied coating systems meets or exceeds requirements specified herein.
3. If the manufacturer of finish coating differs from that of shop primer, provide both manufacturers' written confirmation that materials are compatible.

1.5 PAINT DELIVERY, STORAGE, AND HANDLING

A. Deliver paint to the project site in unopened containers that plainly show, at the time of use, the designated name, date of manufacture, color, and name of manufacturer.

B. Store paints in a suitable protected area that is heated or cooled as required to maintain temperatures within the range recommended by the manufacturer.

1.6 QUALITY ASSURANCE

A. All inspection for quality assurance shall ultimately be the responsibility of CONTRACTOR. OWNER retains the right to observe, accept, or reject the work based on the results of CONTRACTOR's inspection or observations by ENGINEER, at OWNER's discretion, in accordance with the specifications.

B. Repair and recoat all runs, overspray, roughness, or any other signs of improper application in accordance with paint manufacturer's instructions and as reviewed by ENGINEER.

C. Observations by OWNER or ENGINEER, or the waiver of inspection of any particular portion of the work, shall not be construed to relieve CONTRACTOR of his responsibility to perform the work in accordance with these specifications.

1.7 MANUFACTURER'S SERVICES

A. Furnish paint manufacturer's representative to visit jobsite at intervals during surface preparation and painting as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions and these specifications, and as may be necessary to resolve field problems attributable to, or associated with, manufacturer's products furnished under this Contract.

1.8 SPECIAL CORRECTION OF DEFECTS REQUIREMENTS

A. An inspection may be conducted during the eleventh month following completion of coating work. CONTRACTOR and a representative of the coating material manufacturer shall attend this inspection. Defective work shall be repaired in accordance with these specifications and to the satisfaction of OWNER. OWNER may, by written notice to CONTRACTOR, reschedule the inspection to another date within the one-year correction period or may cancel the inspection altogether. CONTRACTOR is not relieved of its responsibilities to correct defects whether or not the inspection is conducted.

PART 2 PRODUCTS

2.1 GENERAL

A. CONTRACTOR shall use suitable coating materials as recommended by the manufacturer. Materials shall comply with Volatile Organic Compound (VOC) limits applicable at the Site.

B. Where manufacturers and product numbers are listed, it is to show the type and quality of coatings that are required. If a named product does not comply with VOC limits in effect at the time of Bid opening, that product will not be accepted, and CONTRACTOR shall propose a substitution product of equal quality that does comply. Proposed substitute materials will be considered as indicated below. Coating materials shall be materials that have a record of satisfactory performance in industrial plants, manufacturing facilities, and water and wastewater treatment plants.

C. In any coating system 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. If necessary, a barrier coat shall be applied between existing prime coat and subsequent field coats to ensure compatibility.

D. Colors and shades of colors of coatings shall be as indicated or selected by ENGINEER. Each coat shall be of a slightly different shade to facilitate observation of surface coverage of each coat. Finish colors shall be as selected from the manufacturer's standard color samples by OWNER.

E. Substitute or “Or-Equal” Products

1. Basis of Design: The Coating Systems listed below in paragraph 2.3 are based on products from Tnemec Company Incorporated, except where indicated below.
2. Product Substitution: To establish equality under Section 01 60 00 – Product Requirements, the specified coating systems are the minimum standard of quality for this project. Equivalent materials of other manufacturers may be substituted only by approval of ENGINEER. Requests for material substitutions shall be in accordance with requirements of the project specification.
3. Product Requirements: CONTRACTOR shall furnish satisfactory documentation from the manufacturer of the proposed substitute or "or equal" product that the material meets the indicated requirements and is equivalent or better in the following properties: Quality, Durability, Resistance to abrasion and physical damage, Life expectancy, Ability to recoat in the future, Solids content by volume, Dry film thickness per coat, Compatibility with other coatings, Suitability to chemical attack, Temperature limitations during application and in service, Type and quality of recommended undercoats or topcoats, Ease of repairing damaged areas, and stability of colors.
4. Manufacturers of “or equal” products shall provide direct performance comparison with the materials specified, in addition to complying with all other requirements of these Specifications. “Or equal” products shall employ the same generic type materials and system components as the specified coating systems.
5. Requests for product substitution shall be made and approved at least 10 days prior to bid date.
6. CONTRACTOR shall bear any additional costs, if a proposed substitution requires changes or additional work.

2.2 COLORS

A. Provide colors as selected by OWNER or ENGINEER.

B. Colors shall be formulated with colorants free of lead, lead compounds, or other materials which might be affected by the presence of hydrogen sulfide or other gas likely to be present at the project.

C. Proprietary identification of colors is for identification only. Any authorized manufacturer may supply color matches.

D. Equipment colors;

1. Equipment shall mean the machinery or vessel itself plus the structural supports and fasteners.
2. Paint non-submerged portions of equipment in the same color as the process piping it serves, except as indicated 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: OSHA Yellow

3. Fiberglass reinforced plastic (FRP) equipment with an integral colored gel coat does not require painting, provided the color is as specified.

E. Piping color coding shall be in accordance with ANSI A13.1, Division of Drinking Water R-309-525, and International Plumbing Code.

1. Color code non-submerged metal piping except electrical conduit. Paint fittings and valves the same color as the pipe unless otherwise specified.
2. Pipe supports: If pipe supports are not galvanized or stainless steel, supports shall be painted ANSI No. 70 light gray as specified in ANSI Z535.
3. Fiberglass reinforced plastic (FRP) pipe and polyvinyl chloride (PVC) pipe located outside of buildings and enclosed structures will not require painting, unless noted otherwise on the Drawings.

2.3 COATING SYSTEMS

A. System No. 1 Steel – Immersion Potable Water NSF 61 Certification

1. Materials

Type	Epoxy conforming to AWWA C 210 and D 102 (for steel tanks).
VOC content, max, g/L	250
Volume Solids, min, %	67
Demonstrated Suitable for	Long term immersion in water, resistant to corrosion, good color retention
Certification	NSF 61 if in contact with potable water

2. Surface preparation and Coating System

Surface Preparation	**Products**	**Total System** (mils)
SSPC-SP10 Near-White Blast Cleaning with	Primer: Tnemec 140 Pota-Pox Plus Intermediate: Tnemec 140 Pota-Pox Plus Finish: Tnemec 140 Pota-Pox Plus	Primer: 3-5 DFT Intermediate: 4-6 DFT Finish: 4-6 DFT

minimum angular profile of 1.5 mils	Primer: Sherwin Williams Tank Clad HS Intermediate: Sherwin Williams Tank Clad HS Finish: Sherwin Williams Tank Clad HS	
	Primer: Carboline Carboguard 891 VOC Intermediate: Carboline Carboguard 891 VOC Finish: Carboline Carboguard 891 VOC (For AWWA C210 only)	

3. Application
   a. For use on the interior and exterior of steel surge tanks, pipes, valves, pumps, equipment in potable water service including concrete embedded surfaces of metallic items under submerged conditions, such as wall pipes, pipes, pipe sleeves, casings, access manholes, gate guides and thimbles, and structural steel, except reinforcing steel.

B. System No. 2 Steel – Immersion Non-Potable Water (NOT USED)

C. System No. 3 Steel – Interior Exposed

1. Materials

Type	Polyamide Epoxy
VOC content, max, g/L	250
Volume Solids, min, %	67
Demonstrated Suitable for	Ferrous, galvanized, surfaces in industrial exposure, resistant to mild corrosion and chemical fumes, has good color and gloss retention
Certification	None

2. Surface preparation and Coating System

Surface Preparation	**Products**	**Total System** (mils)
Ferrous Metal: SSPC-SP6 Commercial Blast Cleaning with a minimum angular anchor profile of 1.5 mils Galvanized and Non-Ferrous: SSPC-SP16 with a minimum angular anchor profile of 1.5 mils	Primer: Tnemec Series 69 Hi-Build Epoxoline II Finish: Tnemec Series 69 Hi-Build Epoxoline II	Primer: 3-5 DFT Finish: 4-6 DFT
	Primer: Sherwin Williams Macropoxy 646 Fast Cure Epoxy Finish: Sherwin Williams Macropoxy 646 Fast Cure Epoxy	
	Primer: Carboline Carboguard 60 Finish: Carboline Carboguard 60	

3. Application
   a. All exposed metal surfaces located inside of structures.
4. Special Requirements
   a. The surface preparation and primer shall be shop applied to all surfaces prior to installation. Finish coats need only be applied to the surfaces exposed after completion of construction.

D. System No. 4 Steel – Exterior Exposed (NOT USED)

E. System No. 5 Buried Steel Pipe (NOT USED)

F. System No. 6 Steel – Doors and Frames

1. Materials

Type	Modified Polyamidoamine Epoxy with Aliphatic Acrylic Polyurethane (topcoat)
VOC content, max, g/L	250
Demonstrated Suitable for	Interior and Exterior Industrial, Architectural, and Commercial applications

2. Surface preparation and Coating System

Surface Preparation	**Products**	**Total System** (mils)
SSPC-SP2/SP3 Hand and Power Tool Cleaning; feather rough edges; remove loose rust, dirt, and other contaminants with sandpaper	Primer: Tnemec Series 135 Chem-Build Finish: Tnemec Series 1095 Endura-Shield	Primer: 3-5 DFT Finish: 3-5 DFT
	Primer: Sherwin Williams Macropoxy 646 Fast Cure Epoxy Finish: Sherwin Williams HS Polyurethane 250	
	Primer: Carboline Carboguard 60 Finish: Carboline Carbothane 133LV(Satin) or 134VOC(Gloss)	

3. Application
   a. Factory primed steel doors and frames
   b. Exterior and Interior steel in corrosive and non-immersion environments.
   c. Maintenance of existing marginally prepared rusty steel and tightly adhering old coatings.

G. System No. 7 Galvanized Steel and Cast/Ductile Iron – Exterior Exposed

1. Materials

Type	Polyamide Epoxy with Aliphatic Acrylic Polyurethane (topcoat)
VOC content, max, g/L	250

Demonstrated Suitable for	Ferrous, galvanized, nonferrous, cast/ductile iron surfaces in industrial exposure, highly resistant to abrasion, wet conditions, corrosive fumes, and exterior weathering

2. Surface preparation and Coating System

Surface Preparation	**Products**	**Total System** (mils)
Galvanized Steel and Non-Ferrous: SSPC-SP16 brush-off blast cleaning of coated and uncoated galvanized steel and non-ferrous metals to achieve a uniform anchor profile of 1.0-2.0 mils. Ductile and Cast Iron: Prepare all surfaces as per NAPF 500-03 - Uniformly abrasive blast the entire exterior surface using abrasive to an NAPF 500-03-04 with a minimum angular anchor profile of 1.5 mils.	Primer: Tnemec Series 69 Hi-Build Epoxoline II Finish: Tnemec Series 1095 Endura-Shield	Primer: 3-5 DFT Finish: 2.5-4 DFT
	Primer: Sherwin Williams Macropoxy 646 Fast Cure Epoxy Finish: Sherwin Williams HS Polyurethane 250	
	Primer: Carboline Carboguard 890 Finish: Carboline Carbothane 133LV(Satin) or 134VOC(Gloss)	

3. Application
   a. Exposed galvanized and cast/ductile iron surfaces located outside of structures requiring painting and the following specific surfaces unless noted otherwise:
      1) All exposed galvanized pipe
      2) All exposed cast/ductile iron pipe

H. System No. 8 Galvanized Steel and Cast/Ductile Iron – Interior Exposed

1. Materials

Type	Polyamide Epoxy
VOC content, max, g/L	250
Demonstrated Suitable for	Ferrous, galvanized, nonferrous, cast/ductile iron surfaces in industrial exposure, resistant to mild corrosion and chemical fumes, has good color and gloss retention

2. Surface preparation and Coating System

Surface Preparation	Products	Total System (mils)
Galvanized Steel and Non-Ferrous: SSPC-SP16 brush-off blast cleaning of coated and uncoated galvanized steel and non-ferrous metals to achieve a uniform anchor profile of 1.0-2.0 mils. Ductile and Cast Iron: Prepare all surfaces as per NAPF 500-03 - Uniformly abrasive blast the entire exterior surface using abrasive to an NAPF 500-03-04 with a minimum angular anchor profile of 1.5 mils.	Primer: Tnemec Series 69 Hi-Build Epoxoline II Finish: Tnemec Series 69 Hi-Build Epoxoline II	Primer: 3-5 DFT Finish: 3 – 5 DFT
	Primer: Sherwin Williams Macropoxy 646 Fast Cure Epoxy Finish: Sherwin Williams Macropoxy 646 Fast Cure Epoxy	
	Primer: Carboline Carboguard 60 Finish: Carboline Carboguard 60	

3. Application
   a. Exposed galvanized and cast/ductile iron surfaces located inside of structures requiring painting and the following specific surfaces unless noted otherwise:
      1) All exposed galvanized pipe
      2) All exposed cast/ductile iron pipe
   b. Do not paint galvanized steel mechanical pipe and equipment supports unless noted otherwise.

I. System No. 9 Concrete Floors – Light Traffic, Low Impact (NOT USED)

J. System No. 10 Concrete Floors – Chemical Exposure (NOT USED)

K. System No. 11 – Gypsum Wallboard and Plaster

1. Materials

Type	Waterborne Epoxy/Acrylic Polymer
VOC content, max, g/L	175/94
Demonstrated Suitable for	long term protection in both interior/exterior exposures

2. Surface preparation and Coating System

Surface Preparation	Products	Total System (mils)

Sand joint compound smooth and feather edge. Clean and dry.	Primer: Tnemec Elasto-Grip FC Series 151-1051 Intermediate: Tnemec Enduratone Series 1028 Finish: Tnemec Enduratone Series 1028	Primer: 0.7-1.5 DFT Intermediate: 2-3 DFT Finish: 2-3 DFT
	Primer: Carboline Sanitile 120 Intermediate: Carboline Carbocrylic 3359 Finish: Carboline Carbocrylic 3359	

3. Application
   a. Interior gypsum wallboard and plaster on walls and ceilings.

L. System No. 12 – Concrete Walls and Concrete Masonry Units, Interior – Not Exposed to Chemicals (NOT USED)

M. System No. 13 – Concrete Walls and Concrete Masonry Units, Interior – Exposed to Chemicals (NOT USED)

N. System No. 14 Concrete – Concrete Exposed to Severe Wastewater (NOT USED)

O. System No. 15 Wood, Interior Exposed

1. Materials

Type	Acrylic
VOC content, max, g/L	50
Demonstrated Suitable for	Wood trim and plywood sheathing in pump stations and similar municipal water and wastewater facilities.

2. Surface preparation and Coating System

Surface Preparation	**Products**	**Total System** (mils)
Surface Preparation: Sand rough areas, Clean and Dry	Primer: Sherwin Williams Multi-purpose Interior-Exterior Latex Primer-Sealer Intermediate: Sherwin Williams Pro-Industrial Acrylic Coating Finish: Sherwin Williams Pro-Industrial Acrylic Coating	Primer: 0.7-1.5 DFT Intermediate: 2-3 DFT Finish: 2-3 DFT
	Primer: Tnemec Series 51-1051 Elasto-Grip Intermediate: Tnemec Series 1026 EnduraTone Finish: Tnemec Series 1026 EnduraTone	
	Primer: Carboline Sanitile 120	

	Intermediate: Carboline Carbocrylic 3359 Finish: Carboline Carboguard 3359	

3. Application
   a. Trim and plywood sheathing

2.4 SPECIAL COATING SYSTEMS – INCLUDING FOR BURIED PIPING

A. System 200 - PVC Tape: Prior to wrapping the pipe with PVC tape, the pipe and fittings first shall be primed using a primer recommended by the PVC tape manufacturer. After being primed, the pipe shall be wrapped with a 20-mil adhesive PVC tape, half-lapped, to a total thickness of 40 mils. PVC Tape wrap buried pipe where indicated on the Drawings.

B. System 201 – Water Retardant, Concrete and Masonry

1. Materials and Coating System

Type	Silane-modified siloxane
Demonstrated suitable for	Repelling water from vertical concrete and masonry surfaces
VOC Content, g/L, max	250
Products, or approved equal	TAMMS Barracade M.E./9 Rainguard Blok-Lok Tnemec Dur A Pell 20 Series 636

2. Preparation
   a. Surface cracks, holes, or other imperfections in concrete surfaces only that exceed 1/64 of an inch shall be filled with pointing mortar. Masonry joints found to be unsound, hollow, or otherwise defective shall be raked out to a depth of 1/2 inch and pointed with mortar.
   b. Remove loose particles and foreign matter. Remove oil or foreign substance with a cleaning agent which will not affect the coating.
   c. Scrub and rinse surfaces with water, and let dry.
   d. Protect adjacent surfaces not scheduled to receive coating and landscaping, property and vehicles from over spray and drift.
   e. Concrete shall cure a minimum of 28 days before application.
   f. Apply coating per manufacturer's recommendations and instructions.

3. Application
   a. Exterior concrete walls of pump station

C. System 202 – **Polyethylene Encasement is required for all buried Ductile Iron Pipe**: Application of polyethylene encasement shall be in accordance with ANSI/AWWA C105 using Method C. Provide polyethylene encasement where indicated on the drawings or per Section 30 05 05 – Ductile Iron Pipe.

D. System 203 – **Wax Tape Coating is required coating for all buried valves, buried dismantling joints, buried flanges, buried DIP mechanical joints, and buried tapping saddles**.

1. Wax Tape Coating
   a. Apply coating in accordance with AWWA C217, except as modified herein.
   b. Provide filler material to fill and smooth irregular surfaces, such that no tenting or voids remain under the applied wax tape.
   c. Protect coating from damage and provide special sand backfill protect wax coating from damage.
   d. Coating System
      1) Surface Preparation: SP3 Power Tool or SP11 Power Tool to Bare Metal.
      2) Primer: Petroleum or petrolatum wax.
      3) Filler Material: Filled petroleum or petrolatum wax.
      4) Inner Tape: Petroleum or petrolatum wax impregnated fabric, 6-inch width maximum, 40-mils thick.
      5) Outer Wrap: PVC or tape suitable for application to inner tape.
   e. Wax tape coating system shall be as manufactured by, or approved equal:
      1) **Petrolatum Tapes by Denso North American**
      2) **Wax-Tape by Trenton**

E. System 204 – Ductile or Cast-Iron, Valves and Gates - Immersion in Water and Wastewater

1. Materials

Type	High Solids Epoxy
VOC content, max, g/L	285
Demonstrated Suitable for	Ductile or Cast-Iron immersion in water or wastewater
Certification	NSF 61 if used for immersion in potable water

2. Surface preparation and Coating System

Surface Preparation	**Products**	**Total System** (mils)
Prepare all surfaces by uniformly abrasive blasting the entire exterior surface to ensure cleanliness and to create a minimum angular anchor profile of 2.0 mils.	Primer: Tnemec Hi-Build Epoxoline II Series N69(1) Intermediate: Tnemec Hi-Build Epoxoline II Series N69(1) Finish: Tnemec Hi-Build Epoxoline II Series N69(1)	Primer: 3 - 5 DFT Intermediate: 4 - 6 DFT Finish: 4 - 6 DFT
	Primer: Ameron Amerlock 400 Intermediate: Ameron Amerlock 400 Finish: Ameron Amerlock 400	
	Primer: International Interseal 670 HS Intermediate: International Interseal 670 HS Finish: International Interseal 670 HS	
	Primer/wastewater: Carboline Phenoline 1205 Finish/wastewater: Carboline Phenoline 1205	

	Prime (NSF61): Carboline Carboguard 635VOC Intermediate (NSF 61): Carboline Carboguard 635VOC Finish (NSF 61): Carboline Carboguard 635VOC	
	(1) For NSF 61 certified potable water applications use Tnemec Pota-Pox Plus Series N140.	

3. Application
   a. Exterior coating on pump bowls

2.5 CONCRETE FINISHES

A. Exterior Above Grade Concrete: Concrete surfaces exposed to view outside the building and including 6 inches below finished grade on the building or structure should be finished with a “Class B” finish. Products for the “Class B” finish are identified or specified in Section 03 30 00 - Cast-In-Place Concrete.

B. Interior Exposed Above Floor Concrete: Interior above grade concrete shall be finished with a “Class B” finish. Products for the “Class B” finish are identified or specified in Section 03 30 00 - Cast-In-Place Concrete.

C. Interior Concrete Floors: Interior concrete floors shall be finished with a “Trowel” finish. Products for the “Trowel” finish are identified or specified in Section 03 30 00 - Cast-In-Place Concrete.

D. Exterior Concrete Flat Surfaces: Exterior concrete flat surfaces shall be finished with a “Broom” finish. Products for the “Broom” finish are identified or specified in Section 03 30 00 - Cast-In-Place Concrete.

PART 3 EXECUTION

3.1 GENERAL

A. The intention of this specification is for all new, interior and exterior, masonry, concrete, and metal, whether atmospheric or submerged exposure surfaces to be painted whether specifically mentioned or not, except as modified herein. Concealed structural steel surfaces shall receive a prime coat only unless modified herein.

B. Surface preparation and coating application shall be in accordance with these specifications and the coating manufacturer’s written product data sheets and written recommendations of the manufacturer’s technical representative. Where conflict occurs between the manufacturer’s recommendations and these specifications, the more stringent of the two shall apply unless approved by ENGINEER.

C. For immersion coatings, obtain full cure for completed system before immersing or allowing exposure to water of condensation for more than 12 hours.

3.2 REGULATORY REQUIREMENTS

A. Meet federal, state, and local requirements limiting the emission of volatile organic compounds and worker exposures.

B. Protect workers and comply with applicable federal, state, and local air pollution and environmental regulations for surface preparation, blast cleaning, disposition of spent aggregate and debris, coating application, and dust prevention including but not limited to the following Acts, Regulations, Standards, and Guidelines:

1. Clean Air Act
2. National Ambient Air Quality Standard
3. Resource Conservation and Recovery Act (RCRA)
4. SSPC Guide 6

C. Comply with applicable federal, state, and local regulations for confined space entry.

D. Provide and operate equipment that meets explosion proof requirements.

3.3 ENVIRONMENTAL CONDITIONS

A. Do not apply paint in extreme heat, temperatures below 40 degrees F, nor in dust, smoke-laden atmosphere, damp or humid weather. The Applicator shall adhere to the manufacturer's recommendations regarding environmental conditions. The Applicator shall monitor humidity, air temperature, and surface temperature with properly calibrated instruments.

B. Do not perform abrasive blast cleaning whenever relative humidity exceeds 85 percent, nor whenever surface temperature is less than 5 degrees F above dew point of ambient air. Strictly adhere to manufacturer's recommendations.

C. Surface preparation power tools and blast equipment shall contain dust collection devices that will prevent discharge of dust particles into the atmosphere around electrical or mechanical equipment unless otherwise permitted by ENGINEER.

D. Where weather conditions or project requirement dictate, the Applicator shall provide and operate dehumidification equipment to maintain environmental conditions suitable for abrasive blasting and coating application as specified.

3.4 WORKMANSHIP

A. Skilled craftsmen and experienced supervision shall be used on coating work.

B. Coating shall be done in a workmanlike manner so as to produce an even film of uniform thickness. Edges, corners, crevices, and joints shall receive special attention to insure thorough surface preparation. The finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks, and variations in color, texture, and finish. The hiding shall be so complete that the addition of another coat would not increase the hiding. Special attention shall be given so that edges, corners, crevices, welds, and similar areas receive a film thickness equivalent to adjacent areas, and installations shall be protected by the use of drop cloths or other precautionary measures.

C. Damage to other surfaces resulting from the work shall be cleaned, repaired, and refinished to original condition.

3.5 STORAGE, MIXING, AND THINNING OF MATERIALS

A. Unless otherwise indicated, the coating manufacturer's printed recommendations and instructions for thinning, mixing, handling, applying, and protecting its coating materials, for preparation of surfaces for coating, and for other procedures relative to coating shall be strictly observed.

B. Coating materials shall be used within the manufacturer's recommended shelf life.

C. Coating materials shall be stored under the conditions recommended by the Product Data Sheets, and shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings from different manufacturers shall not be mixed together.

3.6 SURFACE PREPARATION

A. All surfaces which receive paint or other coatings shall be prepared in accordance with the recommendations of the manufacturer of the material being used. The Applicator shall examine surfaces to be coated and shall correct surface defects before application of any coating material. Marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any field coating application.

B. Perform sandblasting for piping and any other items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed. Materials, equipment, and procedures shall meet requirements of the Society for Protective Coatings (formerly the Steel Structures Painting Council).

3.7 PROTECTION OF MATERIALS NOT TO BE PAINTED

A. Surfaces that are not to receive coatings shall be protected during surface preparation, cleaning, and coating operations.

B. Remove, mask or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.

C. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

D. Protect working parts or mechanical and electrical equipment and motors from damage.

E. Care shall be exercised not to damage adjacent work during blasting operations. Spraying shall be conducted under carefully controlled conditions. CONTRACTOR shall be fully responsible for and shall promptly repair any and all damage to adjacent work or adjoining property occurring from blasting or coating operations.

3.8 SURFACE PREPARATION STANDARDS

A. The following referenced surface preparation specifications of the the Society for Protective Coatings shall form a part of this specification:

1. Solvent Cleaning (SSPC SP1): Removal of oil, grease, soil, salts, and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.
2. Hand Tool Cleaning (SSPC SP2): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.
3. Power Tool Cleaning (SSPC SP3): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.
4. White Metal Blast Cleaning (SSPC SP5): Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.
5. Commercial Blast Cleaning (SSPC SP6): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each square inch of surface area.
6. Brush-Off Blast Cleaning (SSPC SP7): Removal of all visible oil, grease, soil, dust, loose mill scale, loose rust, and loose paint.
7. Near-White Blast Cleaning (SSPC SP10): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each square inch of surface area.
8. Surface Preparation of Concrete (SSPC-SP13): Removal of protrusions, laitance and efflorescence, existing coatings, form-release agents, and surface contamination by detergent or steam cleaning, abrasive blasting, water jetting, or impact or power tool methods as appropriate for the condition of the surface and the requirements of the coating system.
9. Surface Preparation (SSPC-SP16): Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals

3.9 FERROUS METAL SURFACE PREPARATION (UNGALVANIZED)

A. The minimum abrasive blasting surface preparation shall be as indicated in the coating system schedules included at the end of this Section. Where there is a conflict between these requirements and the coating manufacturer's printed recommendations for the intended service, the higher degree of cleaning shall apply.

B. Oil, grease, welding fluxes, and other surface contaminants shall be removed by solvent cleaning per SSPC SP1 - Solvent Cleaning prior to blast cleaning.

C. Round or chamfer all sharp edges and grind smooth burrs and surface defects and weld splatter prior to blast cleaning.

D. Surfaces shall be cleaned of dust and residual particles of the cleaning operation by dry air blast cleaning, vacuuming, or another approved method prior to painting.

E. Enclosed areas and other areas where dust settling is a problem shall be vacuum cleaned and wiped with a tack cloth.

F. Damaged or defective coating shall be removed by the blast cleaning to meet the clean surface requirements before recoating.

G. If the required abrasive blast cleaning will damage adjacent work, the area to be cleaned is less than 100 square feet, and the coated surface will not be submerged in service, then SSPC SP2 or SSPC SP3 may be used as per manufacturers recommendations.

H. Shop-applied coatings of unknown composition shall be completely removed before the indicated coatings are applied. Valves, castings, ductile or cast iron pipe, and fabricated pipe or equipment shall be examined for the presence of shop-applied temporary coatings. Temporary coatings shall be completely removed by solvent cleaning per SSPC SP1 before the abrasive blast cleaning has been started.

I. Shop primed equipment shall be solvent-cleaned in the field before finish coats are applied.

J. Exposed ductile iron pipe shall be given a shop coat of rust-inhibitive primer conforming to these specifications. Abrasive blasting of the asphaltic coating on ductile iron pipe will not be allowed.

3.10 FERROUS METAL SURFACE PREPARATION (GALVANIZED)

A. Galvanized ferrous metal shall be alkaline cleaned per SSPC SP1 to remove oil, grease, and other contaminants detrimental to adhesion of the protective coating system, followed by blast cleaning per SSPC SP16.

B. Pretreatment coatings of surfaces shall be in accordance with the printed recommendations of the coating manufacturer.

3.11 CONCRETE BLOCK MASONRY SURFACE PREPARATION

A. Surface preparation shall not begin until at least 30 Days after the masonry has been placed.

B. Oil, grease, and form release and curing compounds shall be removed by detergent cleaning per SSPC SP1 before abrasive blast cleaning.

C. Concrete block masonry surfaces to be coated shall be abrasive blast cleaned to remove existing coatings, laitance, deteriorated concrete, and to roughen the surface equivalent to the surface recommended by manufacturer.

D. If acid etching is required by the coating application instructions, the treatment shall be made after abrasive blasting. After etching, rinse surfaces with water and test the pH. The pH shall be between neutral and 8.

E. Surfaces shall be clean and as recommended by the coating manufacturer before coating is started.

F. Unless required for proper adhesion, surfaces shall be dry prior to coating. The presence of moisture shall be determined with a moisture detection device such as Delmhorst Model BD-2100, or equal.

3.12 CAST-IN-PLACE CONCRETE SURFACE PREPARATION

A. Concrete surfaces to receive protective coating shall be cast with a Smooth Form Finish in accordance with ACI 301. Surfaces shall not be rubbed, sacked, troweled or otherwise finished in any manner that will obscure or cover the parent concrete surface with materials other than materials as specified in this Section.

B. All surfaces must be clean, dry and free of oil, grease and other contaminants, prior to preparation in accordance with NACE No. 6/SSPC-SP13. Concrete surfaces must be sound and capable of supporting the corrosion protection lining system.

C. Prepare concrete surfaces in accordance with NACE No. 6/SSPC-SP13 Joint Surface Preparation Standards and ICRI Technical Guidelines. Abrasive blast, shot-blast, water jet or mechanically abrade concrete surfaces to remove laitance, curing compounds, hardeners, sealers, existing coatings, and other contaminants and to provide the recommended ICRI-CSP Profile.

D. Level or grind concrete substrates to produce a uniform and smooth surface, including removal of sharp edges, ridges, form fins, and other concrete protrusions.

E. Unless required for proper adhesion, surfaces shall be dry prior to coating. The presence of moisture shall be determined with a moisture detection device such as Delmhorst Model BD-2100, or equal.

3.13 SHOP COATING REQUIREMENTS

A. Unless otherwise indicated, items of equipment or parts of equipment which are not submerged in service shall be shop-primed and then finish-coated in the field after installation with the indicated or selected color. The methods, materials, application equipment, and other details of shop painting shall comply with this Section. If the shop primer requires topcoating within a specific period of time, the equipment shall be finish coated in the shop and then be touched up after installation.

B. Items of equipment or parts and surfaces of equipment which are submerged or inside an enclosed hydraulic structure when in service, with the exception of pumps and valves, shall have surface preparation and coating performed in the field.

C. For certain pieces of equipment, it may be undesirable or impractical to apply finish coatings in the field. Such equipment shall be primed and finish coated in the shop and touched up in the field with the identical material after installation. CONTRACTOR shall require the manufacturer of each such piece of equipment to certify as part of its Shop Drawings that the surface preparation is in accordance with these specifications. The coating material data sheet shall be submitted with the Shop Drawings for the equipment.

D. For certain small pieces of equipment, the manufacturer may have a standard coating system that is suitable for the intended service conditions. In such cases, the final determination of suitability will be made during review of the Shop Drawing submittals. Equipment of this type generally includes only indoor equipment such as instruments, small compressors, and chemical metering pumps.

E. Shop-painted surfaces shall be protected during shipment and handling by suitable provisions including padding, blocking, and the use of canvas or nylon slings. Primed surfaces shall not be exposed to the weather for more than 2 months before being topcoated, or less time if recommended by the coating manufacturer.

F. CONTRACTOR shall make certain that the shop primers and field topcoats are compatible and meet the requirements of this Section. Copies of applicable coating manufacturer's data sheets shall be submitted with equipment Shop Drawings.

G. Damage to shop-applied coatings shall be repaired in accordance with this Section and the coating manufacturer's printed instructions.

3.14 APPLICATION

A. General

1. Schedule inspection with ENGINEER in advance for cleaned surfaces and all coats prior to each succeeding coat.
2. Apply coatings in accordance with the paint manufacturer’s recommendations and these specifications, whichever is more stringent. Allow sufficient time between coats to assure thorough drying of previously applied paint.
3. Blast cleaned ferrous metal surfaces shall be painted before any rusting or other deterioration of the surface occurs. Blast cleaning shall be limited to only those surfaces that can be coated in the same day.
4. Special attention shall be given to materials that will be joined so closely that proper surface preparation and application are not possible. Such contact surfaces shall be coated prior to assembly or installation.
5. Finish coats, including touch-up and damage repair coats shall be applied in a manner that will present a uniform texture and color matched appearance.
6. Non-buried steel piping shall be abrasive blast cleaned and primed before installation.
7. Finish coats shall be applied after concrete, masonry, and equipment installation is complete, and the working areas are clean and dust free.

3.15 CURING OF COATINGS

A. CONTRACTOR shall maintain curing conditions in accordance with the conditions recommended by the coating material manufacturer or by this Section, whichever is the most stringent, prior to placing the completed coating system into service.

B. In the case of enclosed areas, forced air ventilation, using heated air, if necessary, may be required until the coatings have fully cured.

3.16 SHOP AND FIELD OBSERVATION AND TESTING

A. CONTRACTOR shall give ENGINEER a minimum of 3 Days advance notice of the start of any field surface preparation or coating application, and a minimum of 7 Days advance notice of the start of any surface preparation activity in the shop.

B. Observation by ENGINEER, or the waiver of inspection of any particular portion of the work, shall not relieve CONTRACTOR of its responsibility to perform the work in accordance with these Specifications.

C. CONTRACTOR shall furnish inspection devices in good working condition for the detection of holidays and measurement of dry film thicknesses of coatings. Dry-film thickness gauges shall be made available for ENGINEER's use while coating is being done, until final acceptance of such coatings. CONTRACTOR shall furnish the services of a trained operator of the holiday detection devices until the final acceptance of such coatings. Holiday detection devices shall be operated only in the presence of ENGINEER.

D. CONTRACTOR shall test for continuity (holiday test) all coated surfaces inside reservoirs, other surfaces that will be submerged in water or other liquids, surfaces that are enclosed

in a vapor space in such structures, and surfaces coated with any of the submerged and severe service coating systems. Areas that contain discontinuities shall be marked and repaired or recoated in accordance with the coating manufacturers' printed instructions and then be retested.

1. Coatings with thickness exceeding 20-mils total DFT: Pulse-type holiday detector such as Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20, or equal shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the required coating thickness.
2. Coatings with thickness of 20-mils or less total DFT: Tinker & Rasor Model M1 nondestructive type holiday detector, K-D Bird Dog, or equal shall be used. The unit shall operate at less than 75 volts. For thicknesses between 10- and 20-mils, a nonsudsing type wetting agent, such as Kodak Photo-Flo or equal, shall be added to the water prior to wetting the detector sponge.

E. On ferrous and non-ferrous the dry film coating thickness shall be measured in accordance with the SSPC PA 2 using a magnetic type dry film thickness gauge such as Mikrotest Model FM, Elcometer Model 111/1EZ, or equal. Each coat shall be tested for the correct thickness. No measurements shall be made until at least 8 hours after application of the coating. On non-ferrous metals and other substrates, the coating thicknesses shall be measured at the time of application using a wet film gauge.

F. Evaluation of blast cleaned surface preparation will be based upon comparison of the blasted surfaces with the standard samples available from SSPC and NACE, such as using NACE standards TM-01-70 and TM-01-75.

G. Visually inspect concrete, nonferrous metal, plastic, drywall, and wood surfaces to ensure proper and complete coverage has been attained.

3.17 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at the end of each day.

B. Upon completion of the work, remove staging, scaffolding, and containers from the site or destroy in a legal manner.

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

D. Damages due to overspray on buildings, vehicles, trees, or other surfaces not specified to be painted would be the responsibility of CONTRACTOR.

3.18 MANUFACTURER' SERVICES

A. Furnish paint manufacturer's representative to visit jobsite at intervals during surface preparation and painting as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions and these specifications, and as may be necessary to resolve field problems attributable to, or associated with, manufacturer's products furnished under this Contract.

- END OF SECTION –

SECTION 09 98 10
STEEL PIPELINE COATINGS AND LININGS

PART 1 GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall apply external coating and internal lining on steel pipe (field coating of joints not allowed) and field repair of coating damage, complete and in place, in accordance with the specifications.

B. Buried steel pipe shall be dielectrically-coated with a tape wrap.

C. Exposed steel pipe will be coated in accordance with Section 09 90 00 – Painting and Finishes, unless noted otherwise.

1.2 RELATED WORK

A. Related Work in other sections includes, but is not limit to:

1. Section 01 33 00 Submittal Procedures
2. Section 09 90 00 Painting and Finishes
3. Section 33 92 10 Steel Pipe, Specials, and Fittings (AWWA C200, modified)
4. Section 33 12 00 Miscellaneous Appurtenances

1.3 REFERENCES AND STANDARDS

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract:

B. OSHA - Occupation Safety and Health Act: State of Utah and Federal

C. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C205 Cement-Mortar Protective Lining and Coating for Steel Water Pipe-4-inch and Larger- Shop Applied.
2. AWWA C209 Cold-Applied Tape Coating Systems for the Exterior of Special Sections, Connection, and Fittings for Steel Water Pipelines
3. AWWA C210 Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
4. AWWA C214 Tape Coating Systems for the Exterior of Steel Water Pipelines
5. AWWA C217 Cold-Applied Petrolatum Tape and Petroleum Wax Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines

D. NATIONAL ASSOCIATION OF CORROSION ENGINEERS INTERNATIONAL (NACE)

1. NACE RP 274 High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation

E. SOCIETY FOR PROTECTIVE COATINGS (SSPC)

1. SSPC-SP-1 Solvent Cleaning Surface Preparation
2. SSPC-SP-2 Hand Tool Cleaning Surface Preparation
3. SSPC-SP-3 Power Tool Cleaning Surface Preparation
4. SSPC-SP-5 White Metal Abrasive Blast Surface Preparation
5. SSPC-SP-6 Commercial Abrasive Blast Surface Preparation
6. SSPC-SP-10 Near White Metal Abrasive Blast Surface Preparation
7. SSPC-SP-11 Power Tool to Bare Metal

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit catalog cuts and other manufacturer's performance information for products proposed that demonstrate compliance with the Specifications herein described. Provide a copy of approved coating system submittals to the coating applicator. Provide Paint System Data Sheets (PSDS) and/or Material Safety Data Sheets (MSDS) for coating and lining materials.

C. Quality Control Submittals

1. Applicator's experience with list of references substantiating compliance.

D. If the manufacturer of field-applied coating differs from that of the shop-applied primer, furnish written confirmation from both manufacturers that the 2 coating materials are compatible

1.5 QUALITY ASSURANCE

A. All inspection for quality assurance shall ultimately be the responsibility of CONTRACTOR. OWNER retains the right to observe, accept, or reject the work based on the results of CONTRACTOR's inspection or observations by ENGINEER, at OWNER's discretion, in accordance with the specifications.

B. Coating applicator shall have a minimum of 2 years experience applying the specified coating system and the application supervisor (Certified Applicator) for the coating application personnel shall have a minimum of 5 years practical experience in application of the indicated products.

C. Coating and/or lining manufacturer technical representative shall be present for a minimum of 3 days to furnish technical assistance and instruction at the start of coating and/or lining operations within the shop and at the Site. During these visits, the technical representative shall observe surface preparation and coating application and conduct tests of the coating to insure conformance with application instructions, recommended methods, and conditions.

D. Coating and/or lining manufacturer shall furnish 8 hours per month of field or shop coating technical support if requested by ENGINEER.

E. Technical representative shall provide a written report to ENGINEER for each visit. Report shall include copies of test data collected, description of observations, and recommended corrective actions. Report shall be submitted within 10 working days after the visit. When deemed necessary by ENGINEER, work will not be permitted to proceed

until the recommended corrective actions have been implemented. After corrective recommendations have been implemented; the manufacturer representative shall return and certify that the application complies with the manufacturer's coating application recommendations.

F. Additional visits by the manufacturer's representative shall be made at sufficient intervals during surface preparation and coating or lining as may be required for product application quality assurance and to determine compliance with manufacturer's instructions, and as may be necessary, to resolve problems attributable to or associated with, manufacturer's products furnished for this project.

G. Repair and recoat all runs, overspray, roughness, or any other signs of improper application in accordance with paint manufacturer's instructions and as reviewed by ENGINEER.

H. CONTRACTOR shall notify OWNER and minimum of 14 days prior to the commencement of any work. CONTRACTOR shall provide the OWNER and/or ENGINEER with full access to facilities and application documentation. Observation by OWNER and/or ENGINEER, or the waiver of inspection of any particular portion of the work, shall not be construed to relieve CONTRACTOR of his responsibility to perform the work in accordance with these specifications.

1.6 DEFINITIONS

A. Manufacturer's Representative: Employee of coating manufacturer who is factory trained and knowledgeable in technical aspects of manufacturer's products and systems. Sales representatives are not acceptable as a technical representative unless written authorization from the coating manufacturer is furnished stating the sales representative has full authority to act on behalf of the coating manufacturer.

1.7 ABBREVIATIONS

A. ANSI American National Standards Institute

B. AWWA American Water Works Association

C. MDFT Minimum Dry Film Thickness

D. Mil Thousandths of an Inch

E. OSHA Occupation Safety and Health Act

F. SSPC Society for Protective Coatings

1.8 SPECIAL WARRANTY REQUIREMENT

A. CONTRACTOR and coating applicator shall warrant the work under this Section against defective workmanship and materials for a period of two (2) years commencing on the date of final acceptance of the pipeline.

B. This warrantee shall be in addition to the prime CONTRACTOR's warrantee that covers repair of all defective work, including linings and coatings.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not apply paint in extreme heat, temperatures below 40 degrees F, nor in dust, smoke-laden atmosphere, damp or humid weather.

B. Do not perform abrasive blast cleaning whenever relative humidity exceeds 85 percent, nor whenever surface temperature is less than 5 degrees F above dew point of ambient air. Strictly adhere to manufacturer's recommendations.

PART 2 PRODUCTS

2.1 GENERAL

A. Exterior and interior pipe and fitting surfaces shall be prepared and coated in accordance with referenced standards, written directions of the coating or lining manufacturers, and this Section, whichever is more stringent.

B. Pipeline coating or lining materials shall be the products of a single manufacturer. Product substitutions during the project will not be considered or permitted.

C. Coating applicator shall provide a monitoring system approved by the coating manufacturer that constantly records pipe and coating conditions during coating application. Recorded monitoring parameters shall include pipe temperature, line speed, surface preparation, holiday test and other parameters applicable to the type of coating.

D. Coatings and linings will be stored, handled and applied per the manufacturer's written directions.

2.2 EXTERIOR SHOP-APPLIED COATINGS

A. General

1. Buried dielectrically coated steel pipe shall be coated in accordance with AWWA C214 and buried steel pipe specials and fittings or pipes with outlets shall be coated in accordance with C209, except where noted otherwise.

2. Buried dielectrically coated pipe and fittings passing through a structure wall or floor shall be coated for a minimum of 2-inches beyond the interior wall or floor surface.

3. Pipe that is atmospherically exposed shall be shop primed as specified herein and in accordance with Section 09 90 00 – Painting and Finishes.

B. Polyethylene Tape Wrap

1. Steel pipe shall be coated with the following 80-mil (nominal) tape-coating system applied in accordance with AWWA C214 and this Section.

2. **Polyken YGIII** Tape Coating System:

a. Primer: **Polyken 1019, 1027, 1029**, or as recommended by the coating manufacturer.

b. Weld Stripe Tape: **Polyken 931** without backing, 25-mils nominal, 4-inches wide minimum.
c. Inner Wrap: **Polyken 989 YGIII**, 20-mils nominal, corrosion protection layer.
d. Middle Wrap: **Polyken 955 YGIII**, 30-mils nominal, mechanical protection layer.
e. Outer Wrap: **Polyken 956 YGIII**, 30-mils nominal, mechanical protection layer.

3. Weld Preparation: Provide weld stripe tape or grind welds at pipe fabricator's option.

4. Steel Surface Preparation: SSPC-SP5, White Metal blast, 2.5-mils blast profile, minimum.

5. Tape Coating Requirements

a. Tape layers shall have adhesive for the full width of the tape. Adhesive shall have the ability to stick to itself and to the proceeding tape layer or pipe.
b. Each layer shall be a different color or shade with the outer layer white.
c. Outer wrap shall have sufficient ultraviolet (UV) inhibitors to resist above grade exposure for a minimum of 12 months or the proposed storage and construction time, whichever is greater.
d. Tape width shall be 12-inches maximum. Wider tape will be conditionally allowed if the coating applicator can demonstrate that proper tensioning can be maintained and mechanical wrinkling prevented throughout the coating application. If at any time during the pipe fabrication, tape quality becomes inconsistent with a wider tape, OWNER may require the remainder of the pipe to be coated using the maximum indicated tape width.

C. Exterior Coating for Exposed Coating or Overcoat

1. All atmospherically exposed or vault piping shall be shop primed with the coating system as specified in Section 09 90 00 – Painting and Finishes.
2. Manufacturer of shop-applied primer shall be coordinated with field application to provide a completed system by a single manufacturer as specified in Section 09 90 00 – Painting and Finishes. OWNER approval of a coating system with two or more coating manufacturer's will required written approval from all coating manufacturer's as to compatibility and acceptance under warranty.

2.3 INTERIOR SHOP-APPLIED LININGS

A. Cement Mortar Lining

1. Clean and cement mortar line steel pipe and fittings in accordance with AWWA C205.
2. Cement shall conform to ASTM C150, Type II.
3. Shop applied cement mortar lining shall be uniform in thickness over the full length of the pipe joint.
4. Aggregate shall be silica sand or other aggregate that is not subject to leaching. Conform to ASTM C33.
5. Water for cement mortar: Clean and free from organic matter, strong alkalis, vegetable matter, and other impurities.

2.4 EXTERIOR FIELD JOINT COATING

A. Welded field joints (and associated coating) are not allowed on this project.

B. Buried field joints (flanged or grooved end couplings) shall be wax tape coated.

1. Wax Tape Coating
   a. Wax tape coatings shall be limited to field application on joints, fittings, or irregular shapes or complex configurations that are not suited for the use of heat shrink or hand-applied tape wrap coating systems.
   b. Apply coating in accordance with AWWA C217, except as modified herein.
   c. Provide filler material to fill and smooth irregular surfaces, such that no tenting or voids remain under the applied wax tape.
   d. Protect coating from damage and provide special sand backfill to protect wax coating from damage.
   e. Coating System
      1) Surface Preparation: SP3 Power Tool or SP11 Power Tool to Bare Metal.
      2) Primer: Petroleum or petrolatum wax.
      3) Filler Material: Filled petroleum or petrolatum wax.
      4) Inner Tape: Petroleum or petrolatum wax impregnated fabric, 6-inch width maximum, 40-mils thick.
      5) Outer Wrap: PVC or tape suitable for application to inner tape.
   f. Wax tape coating system shall be as manufactured by, or approved equal:
      1) **Petrolatum Tapes by Denso North American**
      2) **Wax-Tape by Trenton**

2.5 INTERIOR FIELD JOINT LINING

A. Welded field joints (and associated lining) are not allowed on this project.

2.6 FIELD REPAIR OF COATINGS AND LININGS

A. General

1. Field repair materials for coatings and linings shall be compatible with shop-applied coating or lining systems and be approved by coating or lining manufacturer.
2. Minor repairs on tape wrapped pipe shall be with heat applied patches.

B. Buried Pipe - Coating Repair Materials

1. Heat Shrink Sleeves (major repair)
   a. Filler Mastic: Provide mastic filler to fill tape void as required.
   b. Full Wrap Coating: Cross-linked polyolefin wrap with a mastic sealant, 85-mil thickness minimum, suitable for pipeline operating temperature, sleeve material recovery as recommended by the manufacturer. Sleeve length shall provide a minimum of 3-inches overlap onto intact pipe coating.
   c. Manufacturers: **AquaSleeve by Canusa-CPS, Covalence by Berry CPG**, or approved equal.
2. Heat-Applied Patches (minor repair)
   a. Heat applied adhesive, polyolefin-backed, mastic coated tape, 12-inches maximum size.
   b. Patch shall provide a minimum of 2-inches overlap onto intact pipe coating.

c. Manufacturers: **CRP patch by Canusa, PERP patch Berry CPG**, or approved equal.

C. Exposed Pipe Coating System

1. Touch-up repair all damage to primer and/or intermediate coats with the specified coating system prior to final coating of the pipeline in accordance with Section 09 90 00 – Painting and Finishes.

PART 3 EXECUTION

3.1 ENVIRONMENTAL LIMITATIONS

A. General

1. Products shall comply with federal, state, and local requirements limiting the emission of volatile organic compounds and worker exposure.
2. Comply with applicable federal, state, and local, air pollution and environmental control regulations for surface preparation, blast cleaning, disposition of spent aggregate and debris, and coating application.
3. Do not perform abrasive blast cleaning whenever the relative humidity exceeds 85 percent or whenever surface temperature is less than 5 degrees above the dew point of the ambient air.
4. Do not apply coatings when:
   a. Surface and ambient temperatures exceed the maximum or minimum temperatures recommended by the coating manufacturer or these specifications.
   b. In dust or smoke-laden atmosphere, blowing dust or debris, damp or humid weather, or under conditions that could cause icing on the metal surface.
   c. When it is expected that surface temperatures would drop below 5 degrees above dew point within 4 hours after application of coating.
   d. Whenever relative humidity exceeds 85 percent for polyurethane coating application.
5. Where weather conditions or project requirements dictate, CONTRACTOR shall provide and operate heaters and/or dehumidification equipment to allow pipe surfaces to be abrasive blasted and coated as indicated and in accordance with the manufacturer's coating application recommendations.
6. Work activities may be restricted until adequate temperature and humidity controls are in place and functioning within the environmental limits given.
7. Coating applicator shall provide a monitoring system approved by the coating manufacturer that constantly records pipe and coating conditions during coating application. Recorded monitoring parameters shall include pipe temperature, line speed, surface preparation, holiday test, and other parameters applicable to the type of coating.

B. Temperature Control

1. In cold weather or if moisture collects on the pipe, if the temperature of the pipe is less than 45 deg F, preheat the pipe to a temperature of 50 deg F or 5 degrees above dew point, whichever is greater.
2. When temperatures are above or below the coating manufacturer's recommended application temperatures, CONTRACTOR shall provide temperature controls as

necessary to permit the work to proceed within the manufacturer's temperature limitations.

3. Provide tenting, insulating blankets, baffles, or bulkheads as required to zone and control heating or cooling effectiveness.
4. Heating shall be with indirect propane fired heaters that do not increase humidity levels within the working area. Heaters shall be sized for the area to be heated.

C. Dehumidification

1. CONTRACTOR shall provide dehumidification equipment when necessary for shop or field environmental control during surface preparation and/or coating application. Dehumidification equipment shall be properly sized to maintain dew point temperature 5 degrees or more below surface temperature of metal surfaces to be cleaned and coated.
2. Cleaned metal surfaces shall be prevented from flash rusting throughout the project duration; condensation or icing shall be prevented throughout surface preparation and coating application.
3. Equipment size and power requirements shall be designed by personnel trained in the operation and setup of dehumidification equipment based on project requirements and anticipated weather conditions.
4. Dehumidification equipment shall operate 24 hours per day and continuously throughout surface preparation and coating application.
5. CONTRACTOR shall use personnel properly trained in the operation and maintenance of the dehumidification equipment or provided adequate training by the dehumidification equipment supplier.
6. Daily maintenance requirements of the equipment shall be documented in writing and posted near the equipment for review if required by ENGINEER.
7. Re-blasting of flash rusted metal surfaces or removal of damaged coatings because of equipment malfunction, shutdown, or other events that result in the loss of environmental control, will be at the sole expense of CONTRACTOR.

3.2 OBSERVATION OF WORK

A. CONTRACTOR shall give ENGINEER a minimum of 14 days advance notice of the start of any pipe fab work and 14 days notice in advance of any shop coating work to allow scheduling for shop or field observation. Notify ENGINEER a minimum 3 days in advance of actual start of surface preparation and coating application Work.

1. Provisions shall be made to allow ENGINEER full access to facilities and appropriate documentation regarding coating application.
2. Observation by ENGINEER or the waiver of observation of any particular portion of the coating work shall not be construed to relieve CONTRACTOR of responsibility to perform the coating in accordance with these Specifications.
3. Materials shall be subject to observation for suitability as ENGINEER may determine, prior to or during incorporation into the work.

3.3 SURFACE PREPARATION

A. General

1. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of coating manufacturer whose product is to be applied.
2. Visible oil, grease, dirt, and contamination shall be removed in accordance with SSPC-SP1, solvent cleaning.
3. Surface imperfections such as metal slivers, burrs, weld splatter, gouges, or delaminations in the metal shall be removed by filing or grinding prior to abrasive surface preparation.
4. Protect prepared pipe from humidity, moisture, and rain. Flash rust, imperfections, or contamination on cleaned pipe surface shall be removed by reblasting.
5. Priming and coating of pipe shall be completed the same day as surface preparation.

B. Weld Surface Preparation

1. Application
   a. Spray applied coating systems do not require weld grinding.
   b. Grind welds on tape wrap coated pipe or apply weld stripe tape over the weld, at the pipe fabricator's option, unless otherwise indicated.
2. Weld Grinding: Under the weld grinding option, welds taller than 3/32-inch above pipe surface shall be ground to a tolerance of +3/32-inch to zero-inches above the pipe surface as measured on the highest side of the weld.
3. Weld Stripe Tape
   a. Weld stripe tape shall be applied to primed metal.
   b. Tape shall either have no polyethylene backing or be double sided adhesive tape to permit adhesion of the inner corrosion protection layer to the weld stripe tape.
   c. Apply tape with a pressure roller to fully conform the tape to the weld surface.
   d. Adhesion of the weld stripe tape shall be the same as for the coating system.

C. Steel Surface Preparation

1. Surface preparation of steel pipe shall be in accordance with SSPC surface preparation standards utilizing the degree of cleanliness appropriate to the coating system to be applied.
2. Grit and/or shot abrasive mixture and gradation shall be as required to achieve the degree of cleanliness and coating adhesion required.
3. Pipe cleaned by abrasive blasting with recyclable steel grit and/or shot or other abrasive shall be cleaned of debris and spent abrasive in an air wash separator.
4. Preparation of the steel pipe for the Polyurethane coating system shall have a sharp angular surface profile of the minimum depth indicated.
5. Work shall be performed in a manner that does not permit the cleaned metal surface to rust back or flash rust.
6. Rust back or flash rust shall be fully removed with the steel surface cleanliness equal to the required metal surface cleanliness prior to rust back or flash rusting. Determination of the equivalent surface cleanliness shall be at ENGINEER'S sole discretion.

3.4 SHOP-APPLIED COATING SYSTEMS

A. Exposed Piping Coatings – See Section 09 90 00.

B. Buried Pipe - Tape Wrap Coating:

1. Applicator shall use a monitoring system approved by the tape manufacturer that constantly records pipe and tape conditions during coating application. Recorded monitoring parameters shall include, but not be limited to; pipe temperature, line speed, primer and tape roll body temperature, and tape tension.
    a. Pipe surface temperature shall be between 45 and 120 degrees and 5 degrees above dew point, whichever is greater.
    b. Tape roll temperature shall be in accordance with the manufacturer's recommendations, but shall not be less than 55 degrees for the inner wrap and 65 degrees for the outer wraps.
2. Apply a uniform coat of primer as recommended by the manufacturer without skips, runs, or sags. Allow to properly dry prior to applying the tape as required by the tape manufacturer and as necessary to achieve maximum tape adhesion. Rug type application will not be allowed.
3. If welds are not ground flush, apply a weld stripe tape to longitudinal or spiral pipe welds prior to application of the inner wrap.
4. Tape layers shall be applied continuously with the use of hydro-tension tape stands. Tension shall be maintained between the manufacturer's minimum and maximum tension recommendations or as required to achieve approximately 2.0 percent reduction in tape width.
    a. Inner tape wrap shall adhere tightly to the pipe surface. Coating shall be 100 percent adhering to the metal surface and shall not have any visible damage, wrinkles, voids, disbondment, contamination, or holidays.
5. Tape coating adhesion testing shall be performed on the pipe per this Section.
6. Holidays testing shall be conducted on the inner layer tape prior to proceeding with subsequent tape layers. Holidays shall be primed and patched using coating repair procedures herein.
7. Perform coating and lining repairs per this Section.

3.5 PIPE LINING APPLICATION

A. For Buried Pipe: Shop-Applied Cement Mortar Lining

1. Place mortar lining used in steel piping and steel plate specials in pipe to thickness below.

Pipe Diameter, Inches	Lining Thickness, Inches	Tolerances, Inches
4 through 10	3/8	-1/16, +1/8
11 through 24	5/16	-1/16, +1/8
24 through 36	3/8	-1/16, +1/8
Greater than 36	1/2	-1/16, +3/16

2. Centrifugally line straight sections of pipe. Lining of special pieces or fittings shall be by mechanical, pneumatic, or hand placement. Provide cement mortar lining of uniform thickness. Finish to a smooth dense surface.
    a. Steel plate specials larger than 16-inches in diameter shall have lining reinforced with 2-inch by 4-inch No. 13-gauge welded steel wire mesh.

b. Brace and support pipe during lining application to minimize pipe distortion or vibration. Bracing and supports shall not damage the pipe, coating, or lining.
c. Tightly close ends of pipe and fittings with plastic sheet caps within 30 minutes of lining application. Plastic end caps shall be of sufficient thickness and strength to resist shipping, handling, and storage stresses.
d. Damage to the cement mortar lining, including disbondment, cracking, or blistering, caused by improper curing, shipping, handling, or installation shall be repaired in accordance with AWWA specifications.
e. Other requirements of mortar lining materials and processes are in AWWA C205.

B. Field Mortar Lining of Steel Pipe Joints (not used)

3.6 FIELD COATING JOINTS

A. Except for Wax Tape coatings of flanged and grooved joints, field coating of joints is not allowed on this project.

3.7 REPAIR OF COATING AND LININGS

A. General

1. Areas where holidays are detected or coating is visually damaged, such as blisters, tears, rips, bubbles, wrinkles, cuts, or other defects shall be repaired. Areas where no holidays are detected, but are visually damaged shall also be repaired.
2. Maximum defects allowable shall be as indicated for the coating system.

B. Tape Wrap Coating Repairs

1. General
   a. No more than 5 repairs per joint of pipe will be permitted with tape wrap coating, excluding adhesion test damage. The coating on any pipe with more than 5 coating repairs or with more than 2 areas of coating damage greater than 5 square feet will be rejected.
   b. Pipes exceeding the maximum number or size of coating defects shall be stripped, reblasted, and recoated at the CONTRACTOR's expense.
   c. Pipe arriving in the field with defects or repairs exceeding the maximum number or size of coating defects will be returned to the shop for recoating at CONTRACTOR's expense.
   d. The number of layers and total thickness of the tape repair coating shall be the same as the shop-applied coating; unless heat applied coating materials are used.
   e. Wipe the area to be repaired with solvent for a minimum distance of 4-inches outside the damaged area.
2. Defect Size
   a. Minor repairs - repairs that are less than 6-inches in the greatest dimension, measured after cutout of damaged tape layers. Damage to the inner tape layer will be considered minor only if repairs are made using heat-applied patch materials.
   b. Major repairs - repairs that exceed 6-inches in the greatest dimension or where damage to the inner tape layer has occurred.
3. Minor Repairs
   a. Complete minor repairs using a heat-applied coating patch material.

b. Cut patch material to overlap onto the undamaged coating a minimum of 2-inches on all sides with one-inch radius on each corner of the patch.
c. Carefully remove damaged layers by cutting the coating with a sharp knife without cutting or damaging the inner wrap.
d. Cut middle and outer layers in stepped fashion to expose one-inch or more of the underlying tape layer for the circumference of the repair.

4. Major Repairs
   a. Coating repairs shall be with heat shrink sleeves as indicated for joints.
   b. Carefully remove damaged layers by cutting the coating with a sharp knife without cutting or damaging the inner wrap.
   c. Holiday test the inner wrap and if a holiday is detected cut outer layers back to fully exposed the holidays and retest for holidays.
   d. Cut middle and outer layers in stepped fashion to expose one-inch or more of the underlying tape layer for the circumference of the repair.
   e. Width of sleeve shall be the width of the damaged area plus 4-inch overlap. Multiple sleeves may be used for larger repairs, but must be overlapped a minimum of 2-inches.

3.8 INSPECTION AND TESTING

A. Inspection

1. Applicator shall inspect and test the coating system in accordance with referenced standards and these specifications, whichever is more stringent.
2. The frequency of the testing shall be determined by the applicator, but shall not be less than the requirements of this Specification.
3. CONTRACTOR will conduct random independent inspections and tests for the final acceptance or rejection of pipe coating or lining.

B. Adhesion Testing, General

1. Adhesion testing shall be conducted at the shop prior to shipment. Pipe shipped without adhesion testing will be field-tested. Pipe rejected in the field will be returned to the shop for repair at the sole expense of CONTRACTOR.
2. A minimum of 2 pipes will be tested for adhesion from each lot of pipe coated up to 4,000 square feet of pipe. An additional adhesion test will be conducted on every increment up to 3,000 square feet of pipe coated in excess of the first 4,000 square feet of pipe. (i.e., if one workday of production is 8,000 square feet of pipe, 4 adhesion tests will be conducted on the pipe lot.
3. A pipe lot is defined as the quantity of pipe that is coated by a single crew within a work shift, but not to exceed 12 hours.
4. The pipe coating applicator shall repair coating damage from adhesion testing.
5. Adhesion tests will be performed not less than 24 hours after coating application. Tests conducted prior to 24 hours will be acceptable only if the test meets or exceeds the adhesion criterion and the test was requested by the pipe fabricator.
6. Pipe will be randomly selected for adhesion testing.
7. If any pipe tested fails the adhesion test, all pipes within the lot will be rejected. Each pipe within the rejected pipe lot will then be individually tested for adhesion and accepted or rejected on a pipe-by-pipe basis.
8. Rejected pipe shall have the coating fully removed from the pipe and the pipe abrasive blasted and recoated.

C. Adhesion Testing, Tape Wrap

1. Inner tape coating shall have an adhesion of 20 pounds per inch width on steel pipe or 15 pounds per inch width on ductile iron pipe, minimum, when tape is pulled in a continuous manner at an angle of 180 degrees to the pipe surface.
2. Adhesion tests shall be conducted at temperatures above 60 degrees F and less than 80 degrees F.
3. Pulling tension shall be continuous, without stopping, and monitored throughout the length of the pull, which shall be not less than 12-inches in length.
4. The pull tension shall be recorded for each inch of pull. The 2 highest and 2 lowest readings shall be discarded and the remaining values averaged. Pull speed shall be not less than 5 seconds per inch nor greater than 10 seconds per inch. If elongation of the tape backing occurs, pull speeds may be exceed 10 seconds per inch provided the minimum adhesion rating can still be achieved.
5. Failure shall be by cohesive failure of the adhesive only. Delamination failure, defined as separation of the adhesive from the backing material, will result in rejection of the tape lot. Intermittent skip failures will be counted as zero pounds of adhesion and included in the calculations for average coating adhesion. Adhesive failure, defined as separation of the adhesive from the metal substrate, will be rejected.
6. Pipe that fails the test by delamination will be retested on 2 other pipes within the same lot of coated pipe. Failure of any 2 pipes within the lot will result in rejection of all pipes coated with the rejected tape lot.

D. Holiday Testing

1. Holiday test the inner layer of tape wrap coatings after application and prior to the subsequent tape layer in accordance with AWWA C214 and NACE Standard RP 0274.
2. Holiday tests on polyurethane coatings shall be conducted on the completed coating after cure or 24-hours, whichever is less, using a high voltage spark test in accordance with NACE Standard RP 0274 and these specifications.
3. Coating thickness used for holiday testing shall be the minimum coating thickness.
4. Dry Film Thickness Testing

    a. Coatings shall be tested for dry film thickness using a properly calibrated magnetic pull off or eddy current equipment.
    b. Coating thickness measurements shall be conducted as necessary and without limitation. Testing conformance to the requirements of SSPC PA-2 is specifically excluded from this specification.

3.9 HANDLING, TRANSPORTATION, AND STORAGE

A. Pipe shall be handled in such a manner as to protect the pipe and coating from damage.

B. Coated pipe shall not be shipped or installed until coating has developed full adhesion and cure.

C. During coating application, storage, loading, and transportation, every precaution shall be taken to protect and prevent damage to pipe, lining, and coating. Forklift equipment shall have load-bearing surfaces padded with suitable material. Lift pipe with web slings a minimum of 12-inches wide and of a type that will not damage the coating. Metal

chains, cables, tongs, forklifts or other equipment likely to damage the coating will not be permitted. Dragging or skidding of pipe on grade or in the trench will not be permitted.

D. Provide transportation vehicles with padded bolsters between each layer of pipe and heavy padding under load ties. Bolsters shall be curved to fit the outside of the pipe and 12-inches wide, minimum. Pipe contact locations shall be heavily padded with carpet and strips of the outer tape wrap material (adhesive side against the carpet) during shipment to the Site and from the storage yard to the point of installation.

E. Pipe shall not be stored on rocks, gravel, or other hard materials that might damage the coating. Provide padded 12-inch wide skids and chucks, sand bags, select loamy or sand berms, or suspended from cutback ends, where possible, to minimize coating damage. Pipe shall not be laid on asphalt without suitable padding at contact points.

F. Pipe shall be inspected by CONTRACTOR at the Site for damage. Any damage to the pipe, lining, or coating shall be repaired if a satisfactory repair can be made; otherwise, the damaged section shall be replaced at the sole expense of CONTRACTOR.

G. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Workers shall not be permitted to walk on the coating except when absolutely necessary. When required, shoes with rubber or composition soles and heels or other suitable footwear that will not damage coating shall be used.

H. Long-term Exposure: Pipe shall either be provided with UV inhibitor for length of above grade exposure or covered to prevent UV degradation of outer wrap. Amount of UV stabilizers required shall depend on the project location, laying schedule, anticipated length of exposure, and type of outer wrap. Coating manufacturer shall be consulted for recommended UV inhibitors requirements or pipe shall be stored under a protective cover. Protective covering can be colored plastic sheeting, canvas, or other UV blocking material. Clear plastic sheets are not acceptable. Areas of coating that display UV degradation shall be removed and repaired at sole cost of CONTRACTOR.

I. End Caps: Pipe ends of mortar lined pipe and fittings shall be tightly closed with a plastic wrap to aid in curing and to minimize drying out of and contamination of the lining. Plastic end cap shall consist of a minimum of one 10-mil sheet of polyethylene or other suitable material. End caps shall be substantial enough to resist shipment, handling, and storage loads and to remain firmly attached in place. The plastic end cap shall remain intact and in place until pipe installation. Damaged or missing plastic end caps shall be repaired or replaced.

- END OF SECTION –

SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.1 DESCRIPTION

A. The CONTRACTOR shall provide fire protection equipment and appurtenant work, complete and in place, according to the Contract Documents.

B. If more than one fire extinguisher or other fire protection equipment is required, provide products from a single manufacturer.

1.2 RELATED WORK

A. Related work in other Sections includes but is not limited to:

1. Section 01 33 00 Submittal Procedures

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publications are referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM E 814 Standard Test Method for Fire Tests of Penetration Firestop Systems

C. NATIONAL FIRE PROTECTION ASSOCIATION PUBLICATIONS (NFPA)

1. NFPA No. 10 Standard for Portable Fire Extinguishers

D. INTERNATIONAL FIRE CODE (IFC)

1.4 SUBMITTALS

A. Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures

B. Submit manufacturer’s literature, installation instructions, and fire protection equipment details.

1.5 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for fire protection equipment. Full compensation for the equipment shall be considered as included in the contract unit or lump sum bid prices for the various items of the Contract to which it relates.

PART 2 PRODUCTS

2.1 GENERAL

A. Mount one fire extinguisher in wellhouse Chlorine Room and another fire extinguisher in Fluoride Room.

B. Fire protection equipment shall comply with the IFC, NFPA Pamphlet No. 10, and the manufacturer's recommendations.

2.2 MATERIALS

A. Fire Extinguisher Designated FE-1: FE-1 fire extinguishers shall be 10 pound minimum capacity, A.B.C. dry-chemical type, with minimum UL rating of 4A:80BC.

B. Mounting brackets shall be specially designed for fire extinguisher.

C. Other materials not specifically shown on the drawings or listed in the specifications but required for a complete and proper installation shall be as selected by the CONTRACTOR, subject to approval by the ENGINEER.

D. Fire protection equipment shall be manufactured by **Larsen's Manufacturing, Amerex Corporation, Potter-Roemer**, or approved equal.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. Fire protection equipment shall be delivered to the site in unbroken packages or containers bearing the manufacturer's label with product description and rating.

B. Products shall be carefully stored in an area that is protected from deleterious elements as recommended by the manufacturer. Storage shall be in a manner that will prevent damage to the material and finish of the equipment.

3.2 INSTALLATION

A. All equipment shall be mounted and installed as per NFPA Pamphlet No. 10 and the manufacturer recommendations unless otherwise directed by the Fire Marshall. Coordinate final location and mounting heights with the fire Marshall prior to installation.

B. Fire extinguishers shall be provided with and installed on brackets or brackets within cabinets. The CONTRACTOR shall provide blocking and other reinforcing in walls to support the fire extinguishers.

- END OF SECTION –

SECTION 22 10 10
PLUMBING PIPING AND SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. The CONTRACTOR shall furnish and install plumbing piping and specialties, complete and operable, as indicated on the Drawings and in accordance with the Contract Documents.

B. Plumbing piping and specialties includes piping, pipe hangers, sleeves, supports, brackets, valves, drains, cleanouts, hose bibs, yard hydrants, and related items.

1.2 RELATED WORK

A. Related work specified in other Sections includes but is not limited to:

1.	Section 01 33 00	Submittal Procedures
2.	Section 05 45 00	Mechanical Metal Supports
3.	Section 09 90 00	Painting and Finishes
4.	Section 31 23 15	Excavation and Backfill for Buried Pipelines
5.	Section 33 05 03	Copper Pipe
6.	Section 33 05 26	Utility Identification
7.	Section 33 12 00	Mechanical Appurtenances
8.	Section 33 13 00	Pipeline Testing and Disinfection
9.	Section 40 05 13.19	Stainless Steel Process Piping

1.3 MEASUREMENT AND PAYMENT

A. Plumbing piping shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

1.4 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publication is referred to in the text by basic designation only.

B. AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

1.	B31.1	Power Piping

C. AMERICAN STANDARDS FOR TESTING AND MATERIALS (ASTM)

1.	ASTM A 74	Standard Specification for Cast Iron Soil Pipe and Fittings
2.	ASTM B 43	Standards for Seamless Red Brass Pipe

D. CAST IRON SOIL PIPE INSTITUTE (CISPI)

1.	CISPI 301	Standard Specification for Hub-less Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

E. INTERNATIONAL MECHANICAL CODE (IMC)

F. INTERNATIONAL PLUMBING CODE (IPC)

G. FACTORY MUTUAL INSURANCE COMPANY (FM GLOBAL)

1. FM 1680 Approval Standard for Couplings Used in Hubless Cast Iron Systems for Drain, Waste or Vent, Sewer, Rainwater or Storm Drain Systems Above and Below Ground, Industrial/Commercial and Residential

1.5 PIPING SYSTEM LAYOUTS

A. Piping system drawings are diagrammatic and are intended to show approximate location of equipment and piping. Verify dimensions, whether in figures or scaled, in the field. CONTRACTOR is responsible for the installation of complete and workable systems whether completely detailed on the plans or not.

B. Ascertain locations of apparatus, fixtures, equipment, and piping in the field, and layout work accordingly. ENGINEER reserves the right to make minor changes in location of piping and equipment up to the time of installation without additional cost to OWNER.

1.6 SUBMITTALS

A. Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit general arrangement drawings of system components.

C. Submit product catalog cut sheets and other manufacturer information.

1.7 REQUIREMENTS OF REGULATORY AGENCIES

A. Install work per applicable provisions of codes, rules, regulations, statutes, and ordinances of authorities having jurisdiction.

PART 2 PRODUCTS

2.1 GENERAL

A. Plumbing piping and specialties shall be as recommended by the manufacturer for the intended use.

B. Any pipe, plumbing fitting or fixture, solder, or flux used in the installation or repair of any potable water system shall be “lead free” except where necessary for the repair of leaded joints of cast iron pipes.

2.2 PIPING AND FITTINGS

A. Below ground drains and fittings (for building and backwashing drains) shall be PVC Schedule 80 unless noted otherwise.

B. Cast iron sanitary, storm, vent pipe and fittings shall be manufactured in accordance with ASTM A 74.

C. Hub-less cast iron soil pipe and fittings with **Camp-All** type pipe couplings, or approved equal, shall be used for above ground sanitary, storm, and vent piping where approved for use by local authorities.

D. Hub-less cast iron soil pipe and fittings shall meet CISPI Standard 301.

E. Pipe couplings shall have high-torque capacity and shall meet FM Standard 1680.

F. Copper tubing and fittings for potable water shall be in accordance with Section 33 05 03 – Copper Pipe.

G. Brass piping shall match iron pipe size standards and meet ASTM B 43 Standards for Seamless Red Brass Pipe.

H. Stainless Steel Pipe shall be Type 304 Stainless Steel, unless otherwise specified, and shall be in accordance with Section 40 05 13.19 – Stainless Steel Process Pipe.

2.3 PIPE HANGERS AND SUPPORTS

A. Pipe hangers and supports shall meet the requirements of IMC Section 305 Pipe Support, Section 05 45 00 – Mechanical Metal Supports, and the following. If there is a discrepancy in the requirements of these documents the more stringent requirement shall apply.

B. Properly support, suspend, or anchor all piping and fittings to prevent sagging, over stressing, or longitudinal movement of piping, and to prevent thrust or loads on or against other equipment.

C. Support horizontal piping on adjustable split steel ring or clevis hangers. The following schedule shows minimum spacing.

1. Steel, Brass and Copper:
   a. 1-1/4" and smaller — 6'-0" on center
   b. 1-1/2" thru 3" — 8'-0" on center
   c. 4" and larger — 12'-0" on center

2. PVC, CPVC, AND ABS:
   a. 1" and smaller — 4'-0" on center
   b. 1-1/4" thru 2" — 5'-0" on center
   c. 2-1/2" thru 4" — 6'-0" on center
   d. 5" and larger — 8'-0" on center

D. Support insulated piping with pipe saddles and hangers that fit on outside of insulation. Do not compress or damage pipe insulation with hangers or supports.

E. Provide all rigid hangers with a means of vertical adjustment after erection.

F. Use copper or copper plated hangers for supporting uninsulated copper pipe.

G. All vertical and horizontal piping supports shall be fiberglass **EnduroStrut by Enduro Systems, Inc**., or approved equal.

H. Perforated strap hangers or wire supports will not be permitted.

2.4 INSERTS

A. Furnish and set inserts in concrete forms; provide reinforcing rods for pipe sizes over 3 inches or equivalent.

B. Furnish concrete inserts as follows: Black, malleable iron, universal type for threaded connections with lateral adjustment. Inserts shall be galvanized unless noted otherwise on the Drawings.

2.5 INSULATION

A. Hot water piping, valves, fittings, and exposed horizontal sanitary, storm, and vent piping shall be provided with one-inch thick insulation.

B. Covering valves, flanges, fittings, and ends of insulation with pre-molded high- and low-temperature PVC fitting cover, end cap, or similar pre-formed unit. The pre-formed unit covers shall be sized to receive the same thickness insulation as used in adjacent ping.

C. Exposed supply and drain piping for lavatories shall be insulated under the wash basins in order to prevent burns and abrasions to handicapped persons. Removeable insulated covers shall be **Handy-Shield Type by Plumberex Specialty Products**, or approved equal.

2.6 SHIELDS

A. Provide shields to protect insulation in all areas.

B. Provide approved galvanized form shields to isolate pipe in contact with hangers and supports.

C. Furnish low compressive insolation protector shields. Size the shields per the manufacturer's recommendations.

2.7 SLEEVES

A. Where pipes pass through floors, footings, foundations, walls, or ceilings, furnish and install pipe sleeves. Sleeves for concealed piping shall be of Schedule 40 galvanized steel pipe one size larger than the pipe passing through. For exposed piping Schedule 40 black steel pipe installed so as to be completely covered by escutcheons. Extend sleeves through floors 1/2 inch above finish floor.

2.8 ESCUTCHEONS

A. Fit pipe passing through walls, floors, or ceilings with escutcheons with set screws.

B. Use prime painted escutcheons where surface is to receive a paint finish; otherwise, use escutcheons that are nickel or chromium plated.

C. Where piping is insulated, use escutcheon outside the insulation.

2.9 JOINTS

A. For screwed pipe make ends with sharp, clean tapered threads using Teflon tape on the male thread only. Do not use mill cut threads. Ream cut pipe to full inside diameter.

B. Welding may be done by either the arc or acetylene process conforming to the requirements for the ASME B31.1.

C. For solder joints use fittings specifically made for soldering. Clean all burrs and roughen pipe to clean; solder complete around joint.

D. For grooved pipe jointing systems use mechanical pipe couplings and fittings.

E. For no-hub cast iron soil pipe use double screw joint neoprene coupler.

2.10 UNIONS

A. Furnish and install unions for each valve or piece of equipment to permit easy installation and removal of equipment.

2.11 VALVES

A. Water shutoff valves shall be the gate or ball type as designated on the drawings, except on fixture supply piping where globe style valves shall be used.

B. Hose Bibs shall be provided where indicated on the Drawings. The hose nipple shall be a female iron pipe thread inlet with hose thread outlet. Hose bibs shall be 3/4-inch size unless noted otherwise on the Drawings.

C. Gate and ball valves shall be in accordance with Section 33 12 00 – Mechanical Appurtenances.

2.12 TRENCH DRAIN IN CONCRETE FLOOR

A. Floor trench drains in concrete floors shall be 4-inch internal width, invert channel of polymer concrete sloped at 0.5% with slotted stainless steel cover.

B. Trench pieces shall be numbered for proper installation. Provide cleanout catch basin at 90 degree bend into drain pipe.

C. Floor trench drain shall be **ACO KS100 w/ Type 450 SS grate**, or approved equal.

2.13 FLOOR DRAINS IN CONCRETE FLOORS

A. Floor drains in concrete floors shall be constructed of cast iron of the size indicated on the Drawings and provided with sediment buckets.

B. Each floor drain located on an upper floor shall have a clamping collar with 4 pound sheet lead flashing 12 inches minimum all around. Where flashing does not comply with local code use epoxy waterproofing membrane.

C. Floor drains shall be **Z520-Y by Zurn Industries, 32100-AE-81 by Josam Company, Figure 2350 by Jay R Smith Mfg. Co.**, or approved equal.

2.14 FLOOR CLEANOUTS

A. Cleanouts in concrete floors shall be heavy plugs with tapered shoulders against heavy brass plugs.

B. Cleanout shall have a minimum diameter of 3-inches.

C. Floor cleanouts shall be fabricated from cast iron with gas and watertight ABS tapered thread plug.

D. Floor cleanout shall be **Z1400 by Zurn Industries, 55000 Series by Josam Company, 4237 Series by Jay R Smith Mfg. Co.**, or approved equal.

2.15 NON-FREEZE HYDRANTS

A. Hydrants in exposed locations subject to freezing shall be the non-freeze type. Hydrant shall have a brass pipe outer casing, brass operating rod, and brass male hose nozzle. Hydrants shall be **Model Iowa Y1 by Woodford Manufacturing Co.**, or approved equal.

PART 3 EXECUTION

3.1 FIELD JOINTS

A. Unless required otherwise, provide restrained field joints (threaded, glued, or otherwise restrained) that comply with manufacturer recommendations for joints.

3.2 PREPARATION

A. Prior to installation of piping, verify that it will not interfere with clearances required for the erection and finish of structural members, architectural members, electrical, sprinkler, or mechanical items.

B. Hang or support piping materials from roof support system whenever possible.

C. Do not cut any structural members for installation of piping.

3.3 INSERTS

A. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

B. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 3 inches in diameter.

C. Where concrete slabs form finished ceiling, finish inserts flush with slab surface.

D. Where inserts are omitted, drill through concrete slab from below and provide rod with recessed squared steel plate and nut above slab.

3.4 SLEEVES

A. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.

B. Extend sleeves through potentially wet floors 1 inch above finished floor level. Caulk sleeves full depth and provide floor plate.

C. Where piping passes through floor, ceiling, or wall, close-off space between pipe and construction with noncombustible insulation. Provide tight-fitting metal caps on both sides and caulk.

3.5 PIPE HANGERS AND SUPPORTS

A. Support all piping and make adequate provisions for expansion, contraction, slope and anchorage.

B. The use of pipe hooks, chains, or perforated metal for pipe support will not be permitted.

C. Suspend all piping in the building as indicated.

D. Install hangers to provide minimum 1/2-inch clear space between finished covering and adjacent work.

E. Place a hanger within 1 foot of each horizontal elbow.

F. Use hangers which are vertically adjustable 1-1/2 inch minimum after piping is erected.

G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

H. Where practical, support riser piping independently of connected horizontal piping.

3.6 PIPING INSTALLATION

A. Cut piping accurately for fabrication to measurements established at the construction site and work into place without springing or forcing.

B. Remove burrs and cutting slag from pipe by reaming or other approved cleaning methods.

C. Make changes in direction with proper fittings.

D. Arrange piping so as not to interfere with the removal of other equipment, ducts, or devices. Do not block doors, windows, or access openings. Provide unions in the piping at connections to all equipment. Unions must be accessible.

E. Cap or plug open ends of pipes and equipment with PVC caps or expanding neoprene plugs to keep dirt and other foreign materials out of the system. Plugs of rags, wool, cotton, waste, or similar materials are not acceptable.

F. Install all piping systems so they can easily be drained. Provide anti-siphon hose bibbs at low points on water lines.

G. Slope all soil and waste lines within the building at 1/4 inch per foot fall in the direction of flow unless indicated otherwise.

3.7 PRIMING AND COATING

A. Prime coat exposed steel hangers and supports and hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces in accordance with Section 09 90 00 – Painting and Finishes.

3.8 PIPE LABELING

A. Exposed pipe shall be labeled in accordance with Utah State Regulation R309-525-8, Section 33 05 26 – Utility Identification, and the IPC.

1. Labeling shall include direction arrows for flow.

3.9 DISINFECTION AND TESTING

A. The CONTRACTOR shall perform such tests as are required by local ordinances and codes in the presence of the local governing authority inspector to show that piping is tight, leak free, and otherwise satisfactory, and shall perform such tests as the ENGINEER may direct to ensure that fixtures and equipment operate properly.

B. Disinfect potable water piping in accordance with Section 33 13 00 - Pipeline Testing and Disinfection.

C. Test all potable water piping.

D. Repair defects which develop under tests promptly and repeat tests. No caulking or screwed joints, cracks, or holes will be permitted. Replace pipe or fitting or both with new material when repairing leaks in screwed joints.

E. Repair leaks in copper tubing by melting out joint, thoroughly cleaning both tubing and fitting, and resoldering.

- END OF SECTION -

SECTION 23 05 00
GENERAL HVAC REQUIREMENTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

Sections of other Divisions which relate to HVAC work apply to the work of this section. See various Sections on sitework, underfloor work, structural work, finish materials, etc.

Related Sections: Refer to "Electrical Requirements for HVAC Equipment Section in Division 23 for basic electrical requirements for all HVAC equipment. Special and specific electrical requirements are specified within each respective equipment specification section.

Section 26 00 00 – “Electrical General Provisions” applies to the HVAC work.

1.2 SUMMARY: This Section specifies the basic requirements for HVAC installations and includes requirements common to more than one of the Division 23 HVAC sections. It expands and supplements the requirements of Division 1 and the Mechanical Sections 21, 22 and 33.

This Division does not define, nor is it limited by, trade jurisdictions. All work described herein is a part of the General Contract and is required of the Contractor regardless.

1.3 DESCRIPTION OF PROJECT: The HVAC work described in these Division 23 specifications is for a Pump Station project located in Davis County, Utah. Design weather conditions are: 97°F db, 63°F wb and winter 0°F. Altitude readings, unless otherwise noted, are for an elevation of 4300 feet above sea level. Make adjustment to manufacturer's performance data as needed.

Work includes:

- HVAC systems for the New Pump Station and Fluoridation Building.

1.4 CODES AND PERMITS, AUTHORITIES HAVING JURISDICTION:

A. Perform the HVAC work in strict accordance with the applicable provisions of the various codes. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications govern.

B. Hold and save the Owner and Engineer free and harmless from liability of any nature or kind arising from Contractor failure to comply with codes and ordinances.

C. Secure permits necessary for the prosecution of the work under this contract. Contractor to pay all fees.

D. Referenced Standards:

American Welding Society
International Mechanical Code/State Code
International Building Code/State Code
International Plumbing Code with amendments
SMACNA Duct Design Standards
Locally enforced NFPA Codes
NFPA 90A related to general Heating and Ventilation
NFPA 820 related to Ventilation of Water Treatment Plants
Local Power Utility Regulations
ASME Codes for Pressure Vessels and Piping
ANSI B31.1 Piping

E. Review of work in progress will be made throughout the course of the work. Final review by the Engineer will not be made nor Certificate of Substantial Completion issued until certificates of acceptability from the Authorities having jurisdiction are delivered.

1.5 DEFINITION OF PLANS AND SPECIFICATIONS: The HVAC drawings at reduced scale show the general arrangement of equipment, etc., and, after prior coordination, are to be followed as closely as the actual building construction and the work of other trades will permit. The architectural and structural drawings shall be considered as part of the work insofar as these drawings furnish the Contractor with information relating to design and construction of the building. Structural, Architectural, Mechanical and Electrical drawings take precedence over HVAC drawings. Request clarification and participate in resolution in the event of conflict.

Examine the actual construction site prior to bidding and obtain an understanding of the existing conditions under which the work will be performed. No allowances will be made for failure to make such examination.

During construction, set up the rough work, and verify the evolving dimensions governing the HVAC work at the building. Do not claim or expect extra compensation because of differences between actual dimensions and those indicated on the drawings. Examine adjoining work on which HVAC work is dependent for perfect efficiency, and report any work of other trades which must be corrected. No waiver of responsibility for defective work shall be claimed or allowed due to unfavorable construction consequent conditions affecting the HVAC work.

1.6 ROUGH-IN:

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 3 through 44 for rough-in requirements.

1.7 HVAC INSTALLATIONS:

A. Equipment Arrangement: Unless specifically indicated otherwise, the arrangement of equipment indicated is based upon information available at the time of design and is not intended to show exact dimensions particular to a specific manufacturer. Some aspects of the drawings are diagrammatic and some features of the illustrated equipment arrangement may require revision to meet the actual equipment requirements. Structural supports, foundations, and electrical and instrumentation connections indicated may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions and alterations. Substantiating calculations and drawings shall be submitted prior to beginning the installation of equipment.

B. Coordinate HVAC equipment and materials installation with other building components.

C. Verify all dimensions by field measurements.

D. Arrange for openings in building wall to allow for HVAC installations.

E. Coordinate the installation of required supporting devices and sleeves to be set in building wall structural components, as they are constructed.

F. Sequence, coordinate, and integrate installations of HVAC materials and equipment for efficient flow of the Work.

G. Coordinate the cutting and patching of building components to accommodate installation of HVAC equipment and materials.

H. Install HVAC equipment at mounting heights as indicated on the plans. Make adaptations as field conditions require after consulting with the HVAC and Structural Engineers.

I. Install HVAC equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

J. Where HVAC work penetrates other trade work such as masonry walls, etc., penetration shall be neatly cut and sleeved, and the rough wall opening shall be filled and patched.

1.8 EQUIPMENT SUPPORTS AND FOUNDATIONS

A. Equipment Supports: Unless otherwise indicated, equipment supports, anchors, and restrainers shall be adequately designed for static, dynamic, wind, and seismic loads as stated in the 2015 (or latest edition) International Building Code (IBC), Chapter 16 and ASCE 7-05. Submitted design calculations for equipment supports and anchorage shall bear the signature and seal of a Registered Professional Engineer licensed in the State of Utah, unless otherwise indicated. Calculations shall account for forces and distribution of forces on supporting structures resulting from normal operation, normal operation plus seismic loadings, normal operation plus wind loadings, as well as the other load combinations stated the 2006 IBC.

1. Wall-mounted equipment weighing more than 250 pounds shall be provided with fabricated steel supports as shown on the contract document sections. Pedestals shall be of welded steel. If the supported equipment is a panel or cabinet or is enclosed with removable sides, the pedestal shall match the supported equipment in appearance and dimensions.

B. Wind Load: The wind load shall be calculated in accordance with ASCE 7-05, Chapter 6, using the following design parameters:
   1. Wind Speed: 90 mph
   2. Exposure: C
   3. Importance Factor: Iw = 1.15

C. Seismic Loads: The seismic lateral and vertical forces shall be calculated in accordance with the ASCE 7-05, Chapters 11 and 13, using the appropriate design parameters for the respective site location. Provide values for the following categories as part of the Seismic Submittal.
   1. Site Class
   2. Seismic Design Category (SDC)
   3. Seismic Importance Factor:
   4. Short Period Spectral Acceleration
   5. 1 Second Period Spectral Acceleration

D. Hydrodynamic Forces: Hydrodynamic forces calculated in accordance with AWWA D100, API 650 or ACI 350.3-06 shall be based on the appropriate parameters for the respective site location. Provide values for the following categories as part of the Seismic Submittal.
   1. Site Class
   2. Seismic Design Category (SDC)
   3. Seismic Importance Factor:
   4. Short Period Spectral Acceleration
   5. 1 Second Period Spectral Acceleration

E. Anchors: Anchor bolts shall be in accordance with Section 05500 - Miscellaneous Metalwork, and shall be designed to resist the above loads. Anchor bolt calculations shall clearly show that the capacity of the anchor and the capacity of the concrete that the anchor is embedded in are adequate to resist all loads stated in the 2015 (or latest edition) IBC and ASCE 7-05, including lateral wind and lateral and vertical seismic loads. Reduction factors associated with edge distance embed length, and bolt spacing shall all be considered and based on the actual dimensions of the concrete that resists the anchorage forces. Anchor bolt details shall include required bolt diameter, embed, and edge distances. Further, the design of Anchors shall consider the ductility requirements stated in ASCE 7-05, Chapter 13, Section 13.4.2 and Chapter 15, Section 15.7.3. Anchor bolt calculations and details shall be submitted and shall bear the signature and seal of a Registered Professional Engineer licensed in the State of Utah.

F. Equipment Foundations: Where indicated on the Contract Documents the structural steel supporting the Wall Mounted AC Unit serving the Electrical Room shall be mounted on a minimum 6-inch high concrete base. The CONTRACTOR, through the equipment manufacturer, shall verify the size and weight of equipment foundation to insure compatibility with equipment. The dimensions of the concrete base shall be sufficient to provide the edge distances required by the anchor bolt calculations.

1.1 ACCESSIBILITY

A. Install equipment and materials to provide required access for servicing and maintenance. Allow ample space for removal of all parts that require replacement or servicing.

B. Extend all grease fittings to an accessible location.

C. Establish required clearance to all installation features involving operation and maintenance. Respect manufacturer's recommendations for access and clearance.

1.9 CHANGE ORDERS See General Conditions.

1.10 ALTERNATIVE CONSTRUCTION/SUBSTITUTION: These documents outline a way in which the Owner may be delivered a functional and reliable facility. Drawings and specifications describe reasonable engineering practice for the Contractor to follow.

Coordination between trades may result in periodic needs to adjust the installation from that indicated, but in no case shall the intended function be compromised.

The Contractor may perceive some material or work methods which differ from those specified which could save time and effort without compromising quality. These may be presented to the Engineer with a breakdown of possible cost savings for review. Implement changes only with authorization.

Materials substitutions will generally be covered in a review process prior to bidding. After bidding, material or equipment substitutions shall be proposed only on the basis of definitive cost accounting and implemented only with authorization.

1.11 CUTTING AND PATCHING

A. Lay out the project where new work is involved ahead of time, providing sleeves and block outs, and have work specifically formed, poured and framed to accommodate HVAC installations. Cut and patch only as needed. Repair wall where cutting and patching is needed to match existing.

B. Refer to Division 26 Section: ELECTRICAL GENERAL REQUIREMENTS for requirements for cutting and patching for electrical equipment, components, and materials.

C. Do not endanger or damage installed Work through procedures and processes of cutting and patching.

D. Arrange for repairs required to restore other and any work damaged as a result of HVAC installations.

E. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.

F. Perform cutting, fitting, and patching of HVAC equipment and materials required to:

1. Remove and replace defective Work;

2. Remove and replace Work not conforming to requirements of the Contract Documents;

3. Remove samples of installed Work as specified for testing:

G. Upon written instructions from the Engineer, uncover and restore Work to provide for Engineer observation of concealed Work.

H. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

I. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

1.12 SUBMITTALS: Submittal of shop drawings, product data, and samples will be accepted only from the Contractor to the Engineer. Submittal shall meet the requirements of section 01 30 00 – Submittals. Data submitted from subcontractors and material suppliers directly to the Engineer will not be processed. There is opportunity and allowance for discussion prior to submittal. Document each transmittal at each transfer level of the process, and sign and stamp the submittal indicating that it has been reviewed and is in compliance with the criteria of the project, any exceptions being clearly noted. Submittals are to include all supporting calculations for the equipment, supports and anchorage of the equipment.

A. SHOP DRAWINGS: As soon as possible after the contract is awarded, submit to the Engineer, an electronic copy of the descriptive literature covering all equipment and materials to be used in the installation of HVAC systems for this project. Obtain written confirmation of acceptable review by the Owner's Representative before ordering, purchasing, acquiring or installing any such equipment or materials for the project.

Prepare the submittals in an orderly manner after the order of this specification, with identification tabs for each item or group of related items. Clearly indicate performance, quality, utility requirements, dimensions of size, connection points and other information pertinent to effective review.

Equipment must fit into the available space with allowance for operation, maintenance, etc. The Contractor shall take full responsibility for space and utility requirements for equipment installed. Don’t submit anything that won’t fit or won’t work.

Factory-wired equipment shall include shop drawings of all internal wiring to be furnished with unit.

Review by the Engineer will be for general conformance of the submitted equipment of the project specification; in no way does such approval relieve Contractor of his obligation to furnish equipment and materials that comply in detail to the specification, nor does it relieve the Contractor of his obligation to lay out ahead of time to determine actual field dimensions and conditions which may affect his work.

B. Record Drawings: See Division 1. During the course of construction, maintain a set of drawings, specifications, change orders, shop drawings, addenda, etc., for reference and upon which all deviations from the original layout are recorded. Turn these marked up documents over to the Engineer within 90 days of system acceptance so that the original tracings can be revised. If the Contractor fails to mark up the prints, he shall reimburse the Engineer for the time required to do so.

1.13 OPERATION AND MAINTENANCE TRAINING

A. Instruction of Owner's Personnel: At a time prior to Owner making use of a device or system, and in general after testing and balance work for a building or major system is complete, prepare, schedule and conduct a series of training sessions for Owner's operating and supervisory personnel. Instructions shall cover each device and system with emphasis on understanding of the purpose and function, the maintenance requirements and the proper adjustment and operating technique.

B. Instruct building operating staff in operation and maintenance of HVAC systems utilizing Operation and Maintenance Manual when so doing.

C. Contractor to video tape instruction sessions, and give video tape to owner.

D. Minimum instruction periods shall be as follows:

1. HVAC - 8 hours, or more as needed, allocated among the various systems.

2. Temperature Control - 4 hours, or more. Programming help as needed. Coordinate with Division 26 HVAC control.

E. Initial instruction periods shall occur after pre-final inspection when systems are properly working and before final payment is made. Schedule subsequent visits with the Building Operation Personnel throughout the first year.

F. Vendors for each piece of equipment, controls, etc., shall participate along with the Contractor(s).

1.14 GUARANTEE/WARRANTY: The following guarantee is a part of this specification and is binding on the part of the Contractor and his assigns:

"Contractor guarantees that this installation is in accordance with the terms of the Contract and is free from HVAC defects. He agrees to replace or repair, to the satisfaction of the Owner's Representative, any part of this installation which may fail or be determined unacceptable within a period of one (1) year after final acceptance. See also the General Conditions of these specifications. Failed equipment in the repair or replacement shall be guaranteed for one full year from the date of “Substantial Completion."

Compile and assemble the warranties required by Division 23 into a separated set of vinyl covered, insert sheets, tabulated and indexed for each reference, included in the O & M Manual.

Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

HVAC systems and equipment shall not be considered for substantial completion and initiation of warranty until they have performed in service continuously without malfunction for at least thirty (30) working days.

1.15 TESTS AND CERTIFICATIONS: Make all tests required by code or specification in the presence of a representative of the Owner, with tests recorded and certified by the Contractor and Representative. Involve local authorities where required.

1.16 PERMITS, FEES, LICENSES: Refer to General Conditions.

1.18 HVAC RELATED CONTROLS AND INSTRUMENTATION

A. Include Division 26 – Electrical section in the following work.

1. Power supply wiring from power source to power connection on controls and/or unit control panels. Includes starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

2. Interlock wiring between electrically operated equipment units; and between equipment and field installed control devices. Interlock wiring specified as factory installed is work of this section.

3. Control wiring between field installed equipment, controls, indicating devices, and unit control panels.

4. 24 volt and 120 volt service work required by instrumentation/control systems.

B. Participate in "System Commissioning, Testing and Balancing".

PART 2 – PRODUCTS

2.1 QUALITY AND CHARACTER OF MATERIALS AND EQUIPMENT:

A. New and conventional: All equipment and materials shall be new, and shall be the standard products of manufacturers regularly engaged in the production of heating, ventilating and air conditioning equipment, and shall be the manufacturer's latest design. Specific equipment shown in schedules on drawings and specified herein is to be the basis for the Contractor's bid. Provisions for substitute equipment are outlined in the General Conditions.

B. Complete: Furnish and install all major items of equipment herein specified and/or called out in the equipment schedules on the drawings complete with all accessories normally supplied with catalog items listed, and with all other accessories necessary for a complete and satisfactory installation.

2.2 PROTECTION OF MATERIALS AND EQUIPMENT:

A. Close duct openings with caps or plugs to prevent lodgement of dirt or trash during the course of installation. Cover equipment tightly and protect against dirt, water and chemical or HVAC injury. At the completion of the work, clean equipment and materials and polish thoroughly and deliver in a factory dock condition for the Owner's acceptance. Make damage and defects developing before acceptance of the work good at Contractor's expense.

B. Do not make temporary use of project equipment, during construction. DO NOT USE PERMANENT HVAC SYSTEMS FOR TEMPORARY HEAT!!

2.3 QUALIFICATIONS OF WORKMEN:

A. All mechanics shall be capable journeymen, skilled in the work assigned to them. Apprentices may be used with appropriate direction.

B. Do not employ unskilled persons in the work; execute all work in a skillful and workmanlike manner. All persons employed shall be competent, faithful, orderly and satisfactory to the Owner. Should the Owner's Representative deem anyone employed on the work incompetent or unfit for his duties, and so certify, Contractor shall remove that employee from this project and he shall not be again employed upon the project without permission of the Owner's Representative.

2.4 FOREMAN: Designate an experienced and qualified general HVAC foreman for the project work to be consistently available on site during the life of the project for consultation. Do not replace this individual without prior approval from the Owner's Representative.

2.5 USE OF COMMON VENDORS: Regardless of subcontract delegations, coordinate purchasing between trades so that equipment and materials of similar nature come from a single vendor, i.e., all package HVAC units shall be common source. Do not burden the Owner with multiple brands of similar equipment unless so directed.

2.6 WALL PENETRATIONS - SLEEVES:

A. Install metal sleeves through all wall openings for supply air diffuser and return air grille ductwork, caulked and sealed. Reference Duct Penetration Detail on the contract drawings.

2.7 HANGERS AND SUPPORTS (GENERAL):

A. Provide mountings and supports for all HVAC equipment. Primary information is contained in these specifications as noted in, but not limited to, paragraph 1.8 above and on the drawings. Correlate HVAC work with the work of other trades to obtain a consistent manner of installation.

B. Provide supports to correlate with seismic restraint, expansion/contraction, and vibration isolation.

2.8 MANUFACTURER'S DIRECTIONS: Install all equipment in strict accordance with directions and recommendations furnished by the manufacturer. Where such directions are in conflict with the plans and specifications, report such conflicts to the Engineer.

2.9 LUBRICATION: Lubricate equipment at startup. Then, provide all lubricants for the operation of all equipment until acceptance by the Owner. The Contractor is held responsible for all damage to equipment consequent to pre-acceptance operation.

2.10 ELECTRICAL WIRING AND CONTROL:

A. In general, primary motor starters, related motor starter equipment and power wiring indicated on the electrical drawings and control diagrams are to be furnished and installed under the Division 26 Specification. Items of electrical control equipment specifically mentioned to be furnished by the HVAC (Controls) Contractor either in these specifications or on the related drawings, shall be obtained and mounted by this Contractor and shall be connected under and as required by specifications, all in compliance with the National Electric Code, and Division 26. Many control devices and fan motors are to be furnished and terminal block wired to a unit mounted power or control panel. The project requires this single location of connection for fan and pump motors, damper actuators, valve actuators, sensors smoke detectors and the like.

B. Refer to the control equipment and wiring shown on the diagrams. Any changes or additions required by specific equipment furnished shall be the complete responsibility of the contractor.

C. HVAC electrical work must be fully coordinated with Division 26 to insure that all required components of the work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of coordination.

D. Where the detailed electrical work is not shown on the electrical drawings, the HVAC Contractor shall furnish, install and wire or have prewired all specified and necessary controls for package air equipment specified for this project. The objective of this paragraph is to make sure a complete operating system is obtained at no additional cost to the Owner for field wiring required related to the equipment.

2.11 CLEANING OF DUCTS: Duct systems shall have all debris removed and fans shall be run to blow out all dust and foreign matter before grilles and diffusers are installed and connected.

Damp wipe all ductwork on installation, cap open ducts, cover fan inlets, vacuum fan plenums and related installation before starting fans. Run fans only with filters in place.

2.12 JOBSITE CLEANUP:

A. Keep site clean during progress of work.

B. At the conclusion of work, clean all installation thoroughly. Leave equipment in a factory dock condition. Correct any damage and touch up or repaint if necessary. Remove all debris from site.

END OF SECTION

SECTION 23 05 20
HVAC IDENTIFICATION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23 Basic HVAC Materials and Methods section apply to work of this section.

1.2 SUMMARY:

A. Label all heating, air conditioning, automatic temperature control equipment (excluding thermostats), and distribution systems. Also label all electrical switches and starters for all HVAC equipment.

PART 2 – GENERAL MECHANICAL MATERIAL AND METHODS

2.1 EQUIPMENT IDENTIFICATION:

A. Equipment Identification:

1. Identify all HVAC equipment including, but not limited to controllers, etc., a with signs made of laminated plastic with 1/8" or larger engraved letters.

2. Give each piece of equipment its own unique equipment number or symbol.

3. Information on sign shall include name of equipment, identification on plans and schedules, rating, maintenance instructions, and any other important data not included on factory attached name plate.

4. Signs shall be attached to equipment so they can be easily read. Attachment shall be by rust proof screws or rivets. Do not use adhesive.

5. Identification signs for equipment shall be similar to the following:

a. Supply Fan (F-2)

Rating: 49,850 cfm @ 3.5" s.p. (At 1600 ft. elevation)

Maintenance: Check bearings for lubrication every 30 days and lubricate as required with S.A.E. 30 oil.

2.2 PANEL IDENTIFICATION:

A. Provide all panel devices on panel faces with engraved black face Formica with white engraved lettering labels.

B. Provide all internal panel components with engraved black face Formica labels with white engraved lettering. Fasten label beneath each device.

C. Numerically or alphabetically code all panel wiring and tubing.

END OF SECTION

SECTION 23 05 30
HVAC - OPERATION AND MAINTENANCE (O&M) MANUALS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.

B. Division-23, Section 23 05 00 General HVAC Requirements sections apply to work of this section.

1.2 SUMMARY:

A. Furnish four sets of bound operation and maintenance (O&M) manuals within 90 days of system acceptance. Manuals shall contain descriptive drawings and data which identify equipment installed at the project and detail the procedures and parts required to operate, maintain and repair the equipment. Copies of approved submittals shall be included for all equipment.

1.3 OPERATION AND MAINTENANCE MANUAL FOR MECHANICAL HVAC SYSTEMS:

A. General:

1. The "Operating and Maintenance Manual" is a bound compilation of drawings and data that the owner requires for each building or project. Furnish these manuals, complete with drawings and data, to the Owner through the Engineer.

2. The mechanical contractor has overall responsibility to obtain the necessary data from and compile the data as set forth in this specification.

3. The number of binders (or "volumes") required will depend on the amount of information to be catalogued. Total "sets" see paragraph 1.2A.

4. Make all information legible and sufficiently marked to indicate the exact size, model, type, etc., of equipment furnished and installed.

B. Purpose: The Operating and Maintenance Manual is prepared to provide a ready reference to all important pieces of mechanical and electrical equipment installed on the project. It is also to provide the necessary operating and maintenance data for use by service personnel. It is also to provide information required for checking equipment performance or for planning of plant expansion or redesign.

PART 2 – MATERIALS AND METHODS

2.1 PAGE SIZE: All pages shall be standard 8-1/2 x 11 inches size or approximate multiples (preferably 17 x 11 inches) folded to 8-1/2 x 11 inch.

2.2 DRAWINGS: All drawings larger than 8-1/2" x 11" shall be folded and inserted in individual 8-1/2" x 11" manila pockets, which shall have standard three-ring side punching for insertion in the binders. The equipment name, drawing description and number shall be written on the face of each manila pocket.

2.3 BINDERS: Binders shall be piano hinge, bar-lock type, Buckram (stiffened fabric cover) binders with block lettering for sheet size 8-1/2 x 11 inches with 2" to 3-1/2" expandable metal capacity as required for the project. The number of binders, on not filling them beyond 4".

A. Place the following information on the front cover and backbone:

1. "Operation and Maintenance Manual".

2. Project Name (and volume number if more than one volume).
Project Number (Per owner's project number).

3. Building name and number.

4. Owner's name.

5. (Architect's name.)

6. Engineer's name.

7. General Contractor's name.

8. HVAC Contractor's name.

Items 5 through 7 need not be printed on the backbone.

2.4 CONTENTS AND INDEXING:

A. Manuals shall contain descriptions of the building systems in sufficient detail to adequately indicate the type of systems installed and the basic details of their operation.

B. All purchased equipment data shall be used to designate the sections. Within each section additional indexing of component parts may be required.

C. Operation and Maintenance Manuals shall contain to the fullest extent all possible information pertinent to the equipment. The arrangement and type of information to be filed shall be as follows:

1. 11 x 17 size project drawings in "As-built" condition.

2. Outline drawings, special construction details, "As built" electrical wiring and control diagrams for all major and supplementary systems.

3. Manufacturer's test or calculated performance data and certified test curves.

4. Installation, operating, and maintenance instructions, including a complete parts list and sectional drawing with parts identification numbers. Mark with model, size and plan number.

5. Manufacturer's brochures marked to indicate exact equipment purchased. Brochures on component parts supplied by a manufacturer with his equipment, but not manufactured directly by him, shall also be included. Include performance data similar if not equivalent to the shop drawing submittal.

6. List the serial numbers of each item of equipment installed with the model numbers and plan symbols.

7. Include a Table of Contents. The contents shall be divided with tabbed index dividers into the following suggested parts:

Part I	Building and System Descriptions
Part II	Purchased Equipment Data
Part III	Test Reports and Valve Charts
Part IV	Start-Up and Operation
Part V	Preventative Maintenance Recommendations

8. A copy of the approved submittals for each piece of equipment.

9. A copy of all testing, adjusting and balancing reports.

10. Wiring diagrams, marked with model and size and plan symbol.

11. Operating and Maintenance Manuals data for Part I shall be obtained directly from the mechanical and electrical consultants. (Allow consultant preparation cost.)

12. The index for each section shall contain the name and address of the manufacturer and, if different, where replacement and repair parts may be obtained.

PART 3 – EXECUTION - (Not Used)

END OF SECTION

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SECTION 23 05 93
TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 GENERAL CONDITIONS:

A. Work of this section shall be subject to the requirements of the General Conditions of this contract, the Mechanical - General Requirements, HVAC General Requirements, General Electrical Requirements and other sections where this work shares a responsibility.

B. System commissioning and startup of the HVAC systems shall be the responsibility of the HVAC Division 23 Contractor and his subcontractors with the participation of the Divisions 26/40 Electrical and Instrumentation Contractor(s) related to electrical and instrumentation work and the General Contractor related to general construction items.

C. Testing and balancing shall be under the direction of the General Contractor with the full participation of all of the mechanical and electrical trades employed on the project and shall include the participation of an independent testing and balance subcontractor to coordinate all elements of the work and to perform special technical services outlined herein.

1.2 SYSTEM COMMISSIONING - SCOPE OF WORK:

A. The work required under this section shall include but not necessarily be limited to the following:

1. The pre-startup inspection of all HVAC systems and subsequent correction of any incorrect items.
2. The initial first run inspections.
3. System operations inspection.

B. The intent of this section is to provide for proper installation, startup, service and operation of the mechanical systems in preparation for system balancing. See section for balancing of air system. After completion of the balancing, the mechanical system shall be ready for owner occupancy, with all systems operating as intended.

C. Repair, replacement or adjustment of each item shall be performed by the respective installing subcontractor.

1.3 TESTING AND BALANCING - SCOPE OF WORK:

A. This work incorporates a checkout of construction work, individual component activation and overall system activation into one work program which shall serve as the transition period from the Contractor's job to Owner's facility.

B. The Contractor shall be skilled in the operation and manipulation of systems and in the direction of parties involved in the work.

C. The Contractor shall participate in the startup and shakedown of all mechanical systems installed and modified in this contract; test adjust and balance these systems to obtain optimum performance at a level which minimizes the required energy input, prepare and submit a complete report of work done and the final system condition obtained, participate in the instruction of Owner's personnel in the proper operation of systems and equipment.

1.4 QUALIFICATIONS OF SYSTEM COMMISSIONING AND TAB TEAM:

A. Representatives of Contractor shall be available on a daily basis through the commissioning and adjustment period. These men shall be experienced journeymen with prior experience in system operation and with specific experience on the construction of this project. Section 23 09 00 – HVAC Control Systems is a particular participant in the work.

B. Balancing shall be done at the Contractor's expense by an independent firm specializing in this work. A definition of independent shall mean the firm is not associated with any engineering, contracting, or manufacturing firm and derives its income solely from testing, adjusting and balancing mechanical systems. Approved firms to do this work include:

Bob's Test and Balance – Salt Lake City, UT
Certified Test and Balance – Salt Lake City, UT
Barnett, Inc. (Payson Sheet Metal) – Payson, UT

C. The balancing work including air portions shall be performed by the same firm having total professional responsibility for the final testing, adjusting and balancing of the entire system. A principal of the firm shall be directly involved in the project.

D. The testing and balancing firm shall furnish all necessary tools, scaffolding and ladders that are required and shall provide all required instruments, take all readings and make all necessary adjustments.

E. After all adjustments are made a detailed written report shall be prepared and submitted for approval and shall bear the signature of the professional supervising the work. Final acceptance of this project will not be made until a satisfactory report is received. Furnish an electronic copy of the report for Engineer Review.

F. Treat each individual system as separate elements for reporting purposes.

PART 2 – EXECUTION, SYSTEM COMMISSIONING

2.1 PRE-STARTUP INSPECTION:

A. The pre-startup inspection of all systems shall provide for verifying that each piece of equipment is properly installed and prepared for startup.

B. All pertinent items shall be checked, including but not necessarily limited to the following:
1. Removal of shipping stops.
2. Vibration isolators properly aligned and adjusted.
3. Flexible connections properly aligned.
4. Belts properly adjusted.

5. Belt guards and safety shields in place.
6. Safety controls and high or low limits in operation.
7. Filters in place and seal provided around edges.
8. All test stations and measuring devices installed.
9. Initial lubrication of equipment is complete.
10. Filters are clean.
11. Motor rotations are correct.
12. Voltages match nameplate.
13. Control system is in operation.
14. All interlocks are wired and verified.
15. All controls have been connected and verified.
16. All factory dampers and operators are properly installed and operating.
17. All supply diffusers and return air grilles with associated ductwork is installed and connected.
18. All other items necessary to provide for proper startup.

C. Correct all incomplete or defective items.

2.2 FIRST RUN INSPECTION:

A. Recheck all items outlined in pre-startup inspection to insure proper operation.

B. Check the following items:

1. Excessive vibration or noise.
2. Loose components.
3. Initial control settings.
4. Motor amperages.
5. Heat buildup in motors, bearings, etc.
6. Control system is properly calibrated and functioning as required.

C. Correct all items which are not operating properly.

2.3 SYSTEM OPERATION INSPECTION:

A. Observe the mechanical systems under operating conditions for sufficient time to verify proper operation under varying conditions, such as day-night and heating-cooling.

B. Periodically check the following items:

1. Filters.
2. Visual checks of air flow for "best guess" settings for preparation for system air balancing under section applying.
3. Control operation, on-off sequences, system cycling, etc.
4. Visual checks of seals, packings, operation pressures.
5. Cleaning of excessive oil or grease.
6. Dampers close tightly.
7. Refrigerant System leaks.
8. All other items pertaining to the proper operation of the mechanical system whether specifically listed or not.

PART 3 – EXECUTION – TESTING AND BALANCING

3.1 TOTAL MECHANICAL SYSTEM BALANCE:

A. The mechanical systems consist of many elements. Total system balance requires that all elements be not only individually correct, but also correct as a composite system. Therefore, participation of all parties is required in the test and balance procedure.

B. Prior to beginning work, submit a written description of the anticipated sequence of action to the Engineer for review and comment.

C. The testing and balance specialist shall review the contract drawings during the bid period and shall advise the Engineer of any modifications to the layout which he might suggest to facilitate the balance procedure. Modifications will be incorporated into the contract by Addendum during the bidding period.

D. The test and balance specialist shall visit the project from time to time during the rough installation making a thorough inspection of those items which will affect his subsequent work. He shall advise the Contractor in writing with a copy to the Engineer of any work required by the contract which is not being performed adequately. This is in addition to the regular review efforts of the Engineer.

3.2 AIR SYSTEMS BALANCE:

A. Before any adjustments are made, the systems shall be checked for such items as dirty filters, duct leakage, filter leakage, damper leakage, equipment vibrations, correct damper operations, etc. All fan systems are to be adjusted to deliver design air quantities within +5%. Design static pressure is based on filters approximately 50% loaded with dirt. Pressure drop across filters during balancing shall be simulated to that condition. After balancing is completed, check motor amperage with the filters clean.

B. Adjust wall mounted air conditioning air systems for air quantities shown on drawings and the proper relationship between supply and exhaust established.

C. Adjust the RPM of all fan ECM' motors so they handle specified air quantity.

1. Determine the ECM setting on supply fan motors so that the fan will deliver not less than 100% cfm with fully loaded filters.

D. Verify the proper operation of all air side related control functions.

3.3 MAJOR EQUIPMENT:

A. The Testing and Balancing subcontractor shall work with the HVAC Controls Contractor, Owners technical staff, and Electrician in placing new wall mounted air conditioning units in operation. The factory representative of the equipment manufacturer shall also participate in a team effort to place these systems in all anticipated operating modes and make adjustments as required to obtain correct operation. The Project Engineer shall witness the final operating sequence.

3.4 INSTRUMENTATION/CONTROL SYSTEMS:

A. The Testing and Balancing Contractor shall go through the entire HVAC control system with the HVAC Controls Contractor and Owner’s technical staff, verifying proper operation of each wall mounted air conditioning unit. The report shall indicate and certify such effort.

3.5 MISCELLANEOUS:

A. Observe all furnished thermal overload protection and note such in the data sheets. If thermal overload protection is incorrect, it shall be the responsibility of the trade or vendor which furnished the overload devices to furnish and install the correct size overload protection devices, and it is the responsibility of the balancing firm to verify that proper overload protection has been installed at the completion of the job.

B. The adjusting crew shall measure and set any special conditions such as minimum air quantities; coordinate outside air, return air and relief air damper operation; check and adjust outside and return air intakes so that the system will deliver substantially the same volume on either; make tests and record data as required in "REPORT" below.

C. When deemed necessary, take 24-hour space temperature recording and any required partial rebalance of the system shall be performed without additional cost. Successful function supercedes nominal settings in order of importance.

3.6 REPORT:

A. Provide a bound report in four copies which shall contain a general information sheet listing instruments used, method of balancing, altitude correction, and manufacturer's grille, register and diffuser data.

B. Provide equipment data sheets listing make, size, serial number, rating, etc., of all mechanical equipment including fans, motors, starters and drives. Operating data shall include rotational speed, pressure drop across filters, coils, and other system components and measured motor current and voltage.

C. Reports shall contain a reduced set of contract drawings with outlets marked thereon for easy identification of the nomenclature used in the data sheets.

D. The report shall contain any abnormal or notable conditions not covered in the above.

3.7 Keep and submit a copy of a daily log of all work performed with a list of work scheduled for the day and the workers on the job.

END OF SECTION

SECTION 23 06 03
SUPPORTING DEVICES FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

B. This section is a Division-23 Basic HVAC Materials and Methods section, and is part of each Division-23 HVAC section making reference to supports and anchors specified herein.

C. This section heavily references Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) manuals of standard practices.

1.2 SUMMARY:

A. Extent of supports and anchors described by this section is generally indicated on drawings and/or specified in other Division-23 HVAC sections. Much support and anchorage is implied in that all HVAC installations, equipment and specialties require support and restraint. Correlate this section with Section 23 06 05 related to sound, vibration and seismic restraint.

B. Types of supports and anchors specified in this section include the following:

1. Building Attachments.
2. Anchors.
3. Equipment Supports.

C. Supports and anchors furnished as part of factory-fabricated equipment are specified or presumed as part of equipment assembly.

D. Relate this section to Section 23 06 05 regarding seismic and vibration control.

1.3 QUALITY ASSURANCE:

A. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years. Typical vendors of support systems include Grinnell.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor.

B. Shop Drawings:

1. Submit manufacturer's assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.

C. Maintenance Data: Submit maintenance data and parts list for each type of support and anchor. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division-1.

1.5 REFERENCES:

A. Codes and Standards:

1. Code Compliance: Comply with applicable building, mechanical and plumbing codes pertaining to product materials and installation of supports and anchors.

2. UL and FM Compliance: Provide products which are UL-listed and FM approved.

PART 2 – PRODUCTS

2.1 OUTSIDE AREAS: Use galvanized attachments, rods, nuts, bolts and other accessories for all outside areas.

2.2 MISCELLANEOUS MATERIALS:

A. Metal Framing: Provide products complying with NEMA STD ML 1.

B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.

C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration. Use Embeco or Engineer approved equal grout for non-shrink applications.

PART 3 – EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PREPARATION:

A. Proceed with installation of supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.
B. Prior to installation of supports, anchors and associated work, Installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Engineer for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.

3.3 EQUIPMENT SUPPORTS:

A. Provide structural steel stands to support equipment where indicated on the contract documents. Construct of structural steel members or steel pipe and fittings.

3.6 ADJUSTING AND CLEANING:

A. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 23 06 05
MECHANICAL SOUND, VIBRATION AND SEISMIC CONTROL

PART 1 – GENERAL

1.1 RELATED DOCUMENTS: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

This section is a Division-23 Basic HVAC Materials and Methods section, and is part of each Division-23 HVAC section making reference to pipes and pipe fittings specified herein.

1.2 SUMMARY: Furnish and install complete support, restraint and vibration control systems for all work installed under Division 23 HVAC sections. Work to be responsive to the intent of the International Building Code, latest adopted edition, for the respective seismic zone. Correlate this work with Section 23 06 03 related to general supports of Mechanical / HVAC systems and equipment.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Engage the services of an independent support, restraint and vibration control subcontractor who has the technology, the experience, computer capabilities and manufactured products to prepare the required computations, shop drawings and special devices to meet the minimum requirements described herein.

The support, restraint and vibration control subcontractor shall visit the site during construction at a minimum of two specific periods.

1. When equipment is mounted in place, prior to placement of seismic restraint devices for the purposes of directing the contractor in properly locating and installing the approved devices.

2. At the completion of the project, prior to final mechanical inspection, for the purpose of verifying the correctness of the support, restraint and vibration isolation device installation and preparing certification of the vibration-isolation work.

3. The support, restraint, vibration control subcontractor shall exercise the quality control for this work and shall include, but not be limited to instructions direct to the Mechanical (Division-23 and Division-33) Contractor concerning:

    a. Anchoring of all mechanical equipment.
    b. Vibration mounting of equipment.
    c. Bracing and anchoring of conduit.
    d. Vibration isolation of supply air fans.

4. The subcontractor shall be responsible for identifying the need for the size and location of steel sole plates and their attachment to structural steel or concrete.

5. The subcontractor shall certify in writing that he has inspected the installation and that all isolation, anchors and seismic restraint materials are installed correctly and functioning properly. Certification shall be provided after all corrective work has been completed.

1.4 SUBMITTALS: Submittal data is required and shall consist of computations, vibration isolation selection, equipment anchors, anchor bolt sizes, supports, seismic restraints, sole plate data, restraint locations and type of restraints.

Submittal data shall identify dimensions, load deflection data, center of gravity, standard connections, manufacturer's recommendations, behavior problems including vibrations, thermal expansion, etc., associated with equipment, ductwork and conduit.

Calculations need not be submitted when restraint devices for piping, conduit and ductwork are proposed in accordance with the SMACNA Guidelines for Seismic Restraints.

Selection of isolator anchors and restraints shall be clearly made known along with the basis for selection so that proposed systems can be reviewed.

Calculations furnished for anchors, anchor bolts, sole plates and other support steel for restraining devices shall be signed and stamped by an engineer licensed in the State of Utah.

1.5 REFERENCES:

A. Codes and Standards:

International Building Codes	Latest Adopted Edition
NFPA bulletin 90A,	Latest Adopted Edition
UL Standard 181	Latest Adopted Edition
National Electric Code	Latest Adopted Edition

Guidelines for seismic restraint of Mechanical Systems and Plumbing Piping Systems. Published by the Sheet Metal Industry Fund of Los Angeles, California, and the Plumbing and Piping Industry Council, Inc., Los Angeles, California.

PART 2 - PRODUCTS

2.1 MATERIALS - PRODUCTS: Restraint devices shall be especially designed to resist system induced forces in all directions.

A. Conduit Restraints: Restraint materials for exposed installation shall be standard fabricated flat steel, angle rod and channel members.
Restraint members shall be bolt connected. Cabling materials and methods shall be used only in chases or concealed ceiling spaces.

PART 3 – EXECUTION

3.1 RESTRAINT GUIDELINE:

Guidelines for SMACNA seismic restraints for conduit, piping and ductwork are to serve as the basis for restraint methods. (Exception – Use rigid member bracing and attachment concepts. No cabling shall be used in the restraint systems except as noted.)

3.2 SEISMIC RESTRAINT- CONDUIT:

A. General: All conduit shall be protected in all planes by restraints, designed to accommodate thermal and physical movement.

B. Locations of the restraints shall include, but not be limited to:

1. At all drops or risers to equipment connections.

2. At all changes in direction of conduit.

3. At all horizontal runs of conduit to keep it in alignment and prevent sagging with restraints not to exceed the following:

   Transverse bracing at 40'-0" O.C. maximum.
   Longitudinal bracing at 80'-0" O.C. maximum.

4. Provide flexibility in joints where pipes pass through building expansion joints.

5. On both sides of flexible connectors.

C. Exceptions:

1. Seismic bracing may be omitted:

   When the top of the conduit is suspended 12" or less from the supporting structure member and the conduit is suspended by an individual hanger.

   On all conduit 3/4" and smaller.

3.3 VIBRATION ISOLATION:

A. General: Furnish and install devices to isolate moving equipment from the structure. (Or confirm that equipment may be securely fastened directly to the structure without negative effect.) Review isolation furnished with factory package equipment, require conformance with project criteria.

B. Basic Criteria: Vibration isolation devices which have natural frequencies approximately 1/10 that of the related driving frequency.

C. Equipment to Include:

Supply Air Fan(s): Verify that each supply fan is vibration isolated and seismic restrained on inertia base. Inertia base shall have 1.5 times total weight of assembly.

D. Field Verify: All required devices and installation.

END OF SECTION

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SECTION 23 06 07
MOTORS, DRIVES & ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Related Sections: Separate electrical components and materials required for field installation and electrical connections are specified in Division-26 and Division-40.

1.2 SUMMARY:

A. This section specifies the basic requirements for motors and drives furnished by Division-23 HVAC and for electrical components which are an integral part of packaged HVAC equipment. Package components include, but are not limited to factory installed motors, starters, and disconnect switches, etc.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for HVAC equipment are noted within these documents.

1.3 QUALITY ASSURANCE:

A. For items with electrical aspects furnished by this Division and these Sections, provide electrical components and materials which are UL labeled and assembled with U.L. listings.

1.4 SUBMITTALS:

A. Submit product data for motors, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections. Verify project electrical characteristics with submittal. Confirm suitability for altitude, maintaining full nameplate rating plus service factor. Include this data in maintenance manual in accordance with Section 23 05 30 "HVAC Operation and Maintenance Manuals".

1.5 REFERENCES:

A. NEMA Standards MG 1: Motors and Generators.

B. NEMA Standards ICS 2: Industrial Control Devices, Controllers, and Assemblies.

C. NEMA Standards 250: Enclosures for Electrical Equipment.

D. NEMA Standards KS 1: Enclosed Switches.

E. IEEE Standard 519: Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

F. Comply with National Electrical Code (NFPA 70).

PART 2 - PRODUCTS

2.1 MOTORS: See Section 26 05 74 “Electrical Motors” but not less than the following:

A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are given in the individual equipment specifications.

1. Torque characteristics shall be sufficient to satisfactorily accelerate and maintain the driven loads.

2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.

3. Provide two-speed motors with two separate windings for poly-phase motors. Confirm 2-speed starter requirements with Division-26.

4. Fraction Horsepower Single speed motors shall be of the permanent split capacitor type. (PSC)

5. Temperature Rating: Minimum rate for 40°C environment with maximum 90°C temperature rise for continuous duty at full load (Class H Insulation for altitude, Class B leads allowed).

6. Starting Capability: Capable of handling not less than 6 evenly timed/spaced starts per hour, (10 minute cycle time) or more as indicated by the automatic control system,

7. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors, 1.0 for TEFC motors.

8. Motor Construction: NEMA Standard MG 1, TEFC, continuous duty, design "B", except design "C" where required for high starting torque. Provide motors rated for “Inverter duty” where motors are fed power from variable frequency drives.

9. Motor Frames: NEMA Standard No. 48 or 54; T-frame, use driven equipment manufacturer's standards to suit specific application.

10. Bearings:

a. Ball or roller bearings with inner and outer shaft seals. Provide with electrically isolated bearings when the motor is fed power from a variable frequency drive.
b. Re-greasable with zerk fittings, except permanently sealed where motor is normally inaccessible for regular maintenance;
c. Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust on motor;
d. For fractional horsepower, light duty motors, sleeve type bearings are permitted;

11. Enclosure Type: Totally enclosed fan cooled (TEFC) for wet or harsh/dirty environments. Typical throughout this project.

12. Overload Protection: Provide motors with built-in thermal overload protection. Where indicated for industrial motor applications, Provide motors with an internal sensing device suitable for signaling and stopping motor at starter.

13 Noise Rating: "Quiet"

14. Efficiency: "Premium Energy Efficient" motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard 112, test method B. If efficiency not specified, motors shall have a higher efficiency than "average standard industry motors", in accordance with IEEE Standard 112.

15. Nameplate: indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

16. Acceptable Manufacturers: Allis-Chalmers, Baldor, General Electric, Louis-Allis, Reliance, Toshiba, U.S. Motors.

END OF SECTION

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SECTION 23 09 00
HVAC CONTROL SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23, Section 23 05 00 - General HVAC Requirements sections apply to work of this section.

C. Division 40 is responsible for the overall instrumentation and control work for the exhaust fans. The HVAC systems are supportive of, but in many ways are independent of the fundamental process control aspects of the project. This section is an integration of the HVAC work into the overall plant instrumentation and control system.

1.2 SUMMARY:

A. Extent of control systems work required by this section is indicated on “H” drawings and schedules, and by requirements of this section.

1. This work has a multi-faceted HVAC Controls responsibility.

   a. Provide Local Control Panels (LCPs) as described below to manage and control the HVAC devices and systems.

   b. Controls for the stand alone HVAC related systems is to be provided by the Division 23 HVAC controls contractor using components described in this Section.

2. Follow control sequences as described in these documents. It is common for sequences and set points to require adjustment in the field to accommodate the final character of overall assemblies. Allow time to make adaptations and adjustments as needed. System setups are often seasonally variable. Re-visit the operation at least four times during the first year to make sure that the functions of the systems are being satisfied.

3. During the bidding period, thoroughly review the documents and request clarification of insufficient, ambiguous or contradictory presentation. The fundamental assumption is that there is a duty to be met and that the documents require as a minimum that devices, materials and installation will be provided to result in fully coherent and functional systems. Provide devices with any and all optional features required to obtain required function. Provide devices of materials that are compatible with the plant environment.

B. Refer to other Section 23 31 10 – “Ductwork Accessories” for installation dampers in mechanical systems.

C. Refer to Division-26 sections for the following work.

1. Interlock wiring between electrically-operated equipment units; and between equipment and field-installed control devices.

a. Interlock wiring specified as factory-installed is work of this section.

D. Provide all field electrical work complying with and as work of the Division-26 sections.

1. Control wiring between field-installed equipment, controls, indicating devices, and unit control panels.

2. 120 volt service required by instrumentation and control systems.

E. Participate in Section 23 05 93 "Testing, Adjusting and Balancing".

1.3 QUALITY ASSURANCE:

A. MANUFACTURER'S QUALIFICATIONS: Firms regularly engaged in manufacture of instrumentation and electric control equipment, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. INSTALLER'S QUALIFICATIONS: Firms and workmen specializing and experienced in programmable logic control, pneumatic and electric control system installations for not less than 5 years. Installer shall be under the direction of the instrumentation subcontractor and able to act as an authorized agent thereof.

1.4 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, and including installation instructions and start-up instructions. Confirm that devices offered are suitable for the indicated duty, inherently hardened against the adverse environment of the wastewater treatment plant. Note that exposed copper and copper bearing materials (i.e. bronze) are inappropriate for this duty. Provide devices of stainless steel, etc.

B. SHOP DRAWINGS: Submit material catalog sheets and shop drawings for each control system, containing the following information:

1. Schematic flow diagram of system showing, but not limited to, fans, unit heaters, coils, dampers and control devices, etc.
2. Label each control device with final designated setting or adjustable range of control.

3. Indicate all required tubing and/or electrical wiring. Clearly differentiate between portions of work that are factory-installed and portions to be field-installed. Note contract responsibility to provide complete system regardless of delegation. Completely interface with and show existing installation in the existing building.

4. Provide details of faces of control panels, including controls, instruments, and labeling.

5. Include verbal written description of sequence of operation. Confirm correct function of proposed sequences.

C. SAMPLES: Submit sample of each type of proposed thermostat cover.

D. MAINTENANCE DATA: Submit maintenance instructions and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Section 23 05 93.

1.5 REFERENCES:

A. CODES AND STANDARDS:

1. Electrical Standards: Provide electrical products which have been tested, listed and labeled by UL and comply with NEMA standards.

2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for electric control systems.

3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.

4. Comply with NEPA 70, "National Electric Code" for all electrical installation.

1.6 DELIVERY, STORAGE, AND HANDLING: Provide factory shipping cartons for each piece of equipment, and control device. Maintain cartons through shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protected from weather.

1.7 INSTRUCTION OF OWNER'S PERSONNEL: (See Section 23 05 00)

A. Purpose is to provide a transition of the systems from the Contractor to the Owner, leaving the Owner's personnel familiar with and well qualified to operate and maintain the systems.

B. Instruction to cover purpose and function of each system and its components, to show proper operating technique, to show proper maintenance technique.

C. Prepare an outline of information to be conveyed, list materials available for reference. Submit to Engineer along with a proposed schedule of instruction. Schedule to allow individual time for each trade and each system.

D. Convey information in formal classroom session. Teachers to include qualified contractor personnel and sales representatives for each major piece of equipment. Go from the classroom to the actual location to graphically illustrate concepts discussed.

1.8 WARRANTIES:

A. As part of the overall project warranty, furnish individual manufacturer warranties for each piece of equipment for a period of not less than one year from date of Owner's beneficial use (substantial completion not date of delivery).

B. Warrant the overall assembly of equipment, materials and labor comprising these systems.

1.9 CLEANING AND LUBRICATION: All instruments, control panel and control piping shall be thoroughly cleaned before final acceptance. Provide lubrication for all furnished equipment.

1.10 TESTING AND ADJUSTING OF SYSTEM:

A. During the system commissioning, testing and balancing of the various building systems, have a controls representative(s) present and available to interpret and adjust controls as needed. Demonstrate and report the integrity and accuracy of each function and control point.

B. At the termination of the testing period, the Controls representative shall spend one working day instructing the Owner's operating personnel in the control system operation, and one working day checking each system for day-night and manual override with the Owner's operating personnel on each air handling system. A complete operating booklet shall be provided and used during the training period. Schedule this training with the Owner and Mechanical Contractor.

Since system performance is partly a function of climatic conditions, the Controls contractor shall be available during the changing seasons of the warranty period to make further adjustments and modifications if required. A final complete check of all systems shall be made at the conclusion of the one year warranty period.

PART 2 - PRODUCTS

2.1 ROOM THERMOSTATS:

A. The thermostats and controllers for the Unit Heaters and Wall Mounted A/C unit shall be furnished by the respective vendors. Coordinate field wiring requirements with each vendor’s installation instructions manual.

2.2 AUXILIARY RELAYS:

A. Light Duty - as required. (verify current model number)

B. Heavy Duty - Square D, Class 8501, Type X. (For motor control)

2.3 ACCESSORIES

A. Provide devices with all components needed to make a complete and functional installation.

2.4 SOURCE QUALITY CONTROL

A Factory-calibrate each instrument according to manufacturer's standard at a facility that is traceable to the NIST.

B. Provide complete documentation covering the traceability of all calibration instruments.

2.5 HVAC CONTROL DAMPERS:

A. A. In supplying dampers, vendor shall instruct workers in the proper installation of the dampers. Ductwork shall be reinforced and the damper properly supported at the point of insertion without strain. In mounting dampers at a wall, provide clearance for the damper actuator and linkages. Make the damper installation airtight in terms of the air flow path.

B. Protect all dampers with a phenolic epoxy powder coating.

Provide damper operators with motors of proper size, so that the motors will operate against the static pressure of the systems. Provide each damper motor with a bracket for attaching to ductwork, building structure or equivalent. Damper motors in plenums shall be rigidly mounted on damper frames. Do not install motors in ducts. Modulating motors shall be provided with end switches and with integral stops for both minimum and maximum stop. Voltage ranges or pressure ranges shall be adjustable, the equivalent of pilot positioning for pneumatic or electric functions.

C. Control dampers for handling of outside air, relief air, exhaust air, ventilating air and other dampers exposed to weather temperatures in built-up or factory assembled systems: shall be low leakage type with spring loaded side seals, inflatable butyl or neoprene fabric edge seals, sleeve type bearings of stainless steel, nylon or Teflon, reinforced extruded blades. Parallel or opposed action or a combination thereof. Air leakage not to exceed 6 CFM per square foot at 4" upstream static pressure.

D. Provide dampers equivalent to Ruskin CD-403 (3"), CD-40 (4"), CD-50 (6")

E. Provide actuators for control dampers with not less that 33% excess torque capacity over and above the minimum needed to drive a given damper, load at not more than 5 inch-lbs per square foot of damper, more if damper requires. Actuators shall be configured for the duty, typically modulating, explosion proof for rated areas, manual over-ride, dual end switches, 24 volt or 120 volt drive as indicated, on board choice of 2 – 10 volt DC or 4 – 20ma signal input, mounting bracket assemblies, jack shafting and adapters as needed.

F. Provide actuators equivalent to Belimo AF(SR).

PART 3 – CONTROL SEQUENCES AND EXECUTION

3.1 GENERAL:

A. Provide control systems to manage and manipulate mechanical equipment in a functional and energy conserving way.

B. Reference Division 40 for control sequences related to the exhaust fans under a separate contract.

3.2 ELECTRIC UNIT HEATER (EUH-1, 2, 3, 4, & 5):

A. Each electric unit heater cycles on its own controls to satisfy the heating set point temperature of 45°F (adj.) when activated by the local unit mounted thermostat.

3.3 ELECTRIC WALL HEATERS (EWH-1 & 2):

A. Each electric wall heater cycles on its own controls to satisfy the heating set point temperature of 45°F (adj.) when activated by the local unit mounted thermostat.

3.4 ROOFTOP EXHAUST FAN (REF-1, MD-1):

A. When the Fluoridation Room thermostat calls for cooling, motorized damper MD-1 shall open and rooftop exhaust fan REF-1 shall be energized to run to satisfy the local space temperature. The unit operates until the room temperature is satisfied and then powers off and MD-1 closes. Thermostat set point shall be 85°F (adj.).

B. Motorized damper MD-1 shall open and rooftop exhaust fan REF-1 shall run whenever the Fluoridation Room is occupied.

3.5 ROOFTOP EXHAUST FAN (REF-2, MD-2):

A. When the Electrical Room thermostat calls for cooling, motorized damper MD-2 shall open and rooftop exhaust fan REF-2 shall be energized to run to satisfy the local space temperature. The unit operates until the room temperature is satisfied and then powers off and MD-2 closes. Thermostat set point shall be 85°F (adj.).

3.6 SLIT SYSTEM A/C UNIT (SAC-1, 2, & 3):

A. Each split A/C unit operates through its own controller to start the indoor unit fan and cycle on the outdoor unit in order to satisfy the local cooling space set point temperature.
B. The programmable thermostat shall initially be set at 80°F (adj.) set point in the cooling mode.

END OF SECTION

SECTION 23 31 00
DUCTWORK

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23 Basic HVAC Materials and Methods Sections apply to work of this section.

1.2 SUMMARY:

A. Extent of metal and high density polypropylene ductwork is indicated on drawings and in schedules, and by requirements of this section.

B. Types of ductwork required for the project include the following:

1. Rectangular

C. Refer to Section 23 05 93 for system commissioning, testing and balancing.

D. Refer to Section 23 09 00 for mechanical controls and control dampers (HVAC related only).

E. Refer to Section 23 31 10 for ductwork accessories.

F. Refer to Section 23 37 00 for louvers.

G. Refer to Section 23 82 00 for power ventilators.

H. Refer to Section 23 90 00 for filters.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of metal and high density polypropylene ductwork products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects with metal and high density polypropylene ductwork systems work similar to that required for project.

The installer shall have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the Contractor.

All workmen on the project shall carry Utah state licenses as journeymen or apprentice sheet metal workers with additional certification for welders.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data and installation instructions for metal and high density polypropylene ductwork materials and products.

B. Shop Drawings: Submit coordinated scaled layout drawings of metal ductwork and fittings including, but not limited to, duct sizes, locations, elevations, and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spacial relationship between ductwork and proximate equipment. Show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that free area, materials, and rigidity are not reduced.

C. Record Drawings: At project closeout, submit record drawings of installed metal ductwork and ductwork products, in accordance with requirements of Division-1.

D. Maintenance Data: Submit maintenance data and parts lists for metal ductwork materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual; in accordance with requirements of Division-1.

1.5 REFERENCES:

A. Codes and Standards:

1. SMACNA Standards: Comply with SMACNA "HVAC Duct Construction Standards, Metal and Flexible" for fabrication and installation of metal ductwork.

2. ASHRAE Standards: Comply with ASHRAE Handbook, Equipment Volume, Chapter 1 "Duct Construction", for fabrication and installation of metal ductwork.

3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air-Conditioning and Ventilating Systems" and NFPA 90B "Standard for the Installation of Warm Air Heating and Air-Conditioning Systems".

4. International Building Code/International Mechanical Code/equivalent Utah Codes: Comply with all sections pertaining to mechanical work.

B. Field Reference Manual: Have available for reference at project field office, copy of SMACNA "HVAC Duct Construction Standards, Metal and Flexible".

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Protection: Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

B. Storage: Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclosed with waterproof wrapping.

PART 2 - PRODUCTS

2.1 DUCTWORK - GENERAL:

A. Standards: All duct fabrications shall comply with standards and techniques detailed by SMACNA "Duct Construction Manuals" for the appropriate pressure class, and with the ASHRAE Handbook, HVAC Systems and Equipment, 2016 edition, Chapter 19, Duct Construction

2.2 SHEET METAL DUCTWORK:

A. General: For all rectangular ductwork and fittings construct/fabricate from aluminum, PVC coated galvanized steel or stainless steel. Contractor may choose between aluminum, PVC coated galvanized steel or stainless steel except where specifically directed on the drawings.

If using galvanized sheet steel, provide galvanized sheet steel complying with ASTM A 527, lock forming quality, with G 120 zinc coating in accordance with ASTM A 525; mill phosphatized for exposed locations.

If using stainless steel, fabricate of Type 304 SS or Type 316 SS stainless steel sheet complying with ASTM A-167 with all welded joints and seams. Provide polished No. 4 satin finish for all duct exposed to view, No. 1 finish elsewhere. Protect finished surfaces with mill applied adhesive protective paper through fabrication and installation.

If using aluminum ductwork, aluminum ductwork shall be constructed of 3003-H-14 aluminum using construction for nominal 4" SMACNA rated systems. Seal all transverse joints with duct cement.

B. Exposed Ductwork Materials: Provide materials which are free from visual imperfections including pitting, seam marks, roller marks, stains and discolorations, and other imperfections, including those which would impair painting. Installation of exposed ductwork shall be laid out in advance and submitted for review. Ductwork shall be hung straight and uniform, points shall be true, and seams shall show continuity.

C. Note a special requirement for hangers and supports for process areas. Project rejects strap hangers for ductwork. Make angle, insert, or clamp attachment to structure and hang suspended duct with rod or angle iron verticals and angle, channel or Unistrut horizontals. Brace and restrain ductwork as for piping with rigid assemblies. Do not use a cabling system for such duty.

2.3 FITTINGS AND FABRICATION:

A. Fittings: Provide radius type fittings fabricated of multiple sections with maximum 15^{o} change of direction per section.

B. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to associated duct width. Limit angular tapers to 30^{o} for contracting tapers and 20^{o} for expanding tapers.

C. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Division-23 section "Duct Accessories' for accessory requirements.

D. Offset, transition, and adapt ductwork to structural obstacles and work of other trades in a coordinated effort. Layout work to avoid conflict with piping, etc. With review of conditions, teardrop around conflicting piping, lights, etc., all at no added cost to the project.

2.3 MISCELLANEOUS DUCTWORK MATERIALS:

A. General: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.

B. Duct Sealing Compound for metal ductwork: Use a U.L. listed, fiber reinforced, water based adhesive duct sealing compound by Foster, Hard cast, United-McGill, Nova, Miracle, 3M, Duct mate, Duro Dyne. Verify that the material is listed for use in a moist, corrosive environment compatible with duct material. Follow manufacturer's directions for joint cleaning and preparation; seal all duct and plenum joints prior to and during assembly. Use mastics that will not weep if the duct is warmed above room temperature.

PART 3 – EXECUTION

3.1 INSPECTION:

A. General: Examine areas and conditions under which metal ductwork is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF METAL DUCTWORK:

A. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve air tight (5% leakage for systems rated 3" and under; 1% for systems rated over 3") and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true to shape and to prevent buckling. Support vertical ducts at every floor.

All necessary allowance and provisions shall be made in the installation of sheet metal ducts for the structural conditions of the building, and ducts shall be transformed or divided as may be required. Whenever this is necessary, the required area shall be maintained. All of these changes, however, must be approved and installed as directed at project. During the installation, the open ends of ducts shall be protected to prevent debris and dirt from entering.

B. Field Fabrication: Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.

C. Routing: Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to 1/2" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

D. Electrical Equipment Spaces: Except as indicated, do not run ductwork through transformer vaults and other electrical equipment spaces and enclosures. Maintain clearances above of and in front of electrical panels.

E. Ducts at Structural and Architectural Penetrations: Where ducts are shown connecting to or passing through concrete, gypsum board, masonry openings and along edges of all plenums at floors and walls, provide a continuous 2" x 2-1/8" stainless steel angle iron which shall be bolted to the construction and made airtight to the same by applying caulking compound. Sheet metal in these locations shall be bolted to the angle iron. Round high velocity ducts in vertical chases shall be supported with rolled angle rings. Close openings between duct and structure.

F. Cross Breaking: Rectangular sheet metal ducts shall be cross broken or rolled rib reinforced on the four sides of each 4-foot panel. All vertical and horizontal sheet metal barriers, duct offsets, elbows, as well as 4-foot panels of straight sections of ducts shall be cross broken. Cross breaking shall be applied to the sheet metal between the standing seams or reinforcing angles; the center of cross break shall be of the required height to assure surfaces being rigid. Larger ducts shall include intermediate reinforcing angles or members to stiffen the panel faces.

G. Coordination: Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.

H. Installation: Install metal ductwork in accordance with SMACNA HVAC Duct Construction Standards.

Related to final installation cleanliness, damp wipe all ductwork on installation. Cap open duct ends, cover fan inlets, vacuum fan plenums and related installation before starting fans. Run fans only with filters in place.

3.4 HANGERS AND SUPPORTS FOR METAL DUCTWORK.

A. It is essential that all ducts shall be rigidly supported. Hangers for low velocity ducts up to 18" in width shall be placed on not more than 10' centers.

Low velocity ducts 19" through 35" in width and greater shall be supported on not more than 5' centers. Where vertical ducts pass through floors or roofs, heavy supporting angles shall be attached to ducts, and to structure. Angles shall be of sufficient size to support the ductwork rigidly and shall be placed on at least two sides of the duct.

B. For rectangular ducts 36" and greater in width, construct hangers with all-thread rods and aluminum channel, galvanized iron channel, or Unistrut sections, minimum dimension 2” x 2” x 1/8".

C. Ductwork Support Materials for ductwork in Process Areas: Provide 316 stainless steel fasteners, anchors, and rods, washers, nuts and provide 316 stainless steel or 6061-T6 aluminum alloy angles for support of ductwork in process areas. Do not use straps.

D. Supporting Dampers: Parallel and opposed blade motor operated dampers shall be supported by reinforcing the ductwork or sheet metal walls at the damper locations to carry the weight of the dampers and the force exerted on the dampers due to air pressure, or shall be supported independent of ductwork from the ceiling or floor, as conditions at the site determine.

3.5 CONNECTIONS: All duct joints, transverse and longitudinal, shall be made airtight by coating joints with duct sealing compound before joining, and then sealing the joint with one layer of "Glass Fab" reinforcing tape set in a coating of the compound. Tape and sealant shall not exceed a flame spread of 25 or a smoke development of 50.

3.6 WELDED JOINTS: Welded metal ductwork shall have either an angle or a piece of 1/8" steel bar behind each weld to allow lying of a neat and continuous bead.

3.7 FIELD QUALITY CONTROL:

A. Leakage Tests: After each duct system which is constructed for duct classes over 3" is completed, test for duct leakage in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Air leaks which are in excess of that required to bubble the soap suds (that is, actually blow the suds away) shall be sealed by additional taping and caulking to reduce the leakage to a rate not to exceed slow bubbles forming. Repair leaks and repeat tests until total leakage conforms with Chart of Figure 4-1, Seal Class A, Leakage Class 3 for round/oval, 6 for rectangular.

B. Allow 24 hours for the HDPE ductwork sealant to cure after final assembly before testing the duct system. Additional curing time may be required in high ambient conditions.

3.8 EQUIPMENT CONNECTION:

A. General: Connect metal and high density polypropylene ductwork to equipment as indicated; provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors where indicated.

3.9 ADJUSTING AND CLEANING:

A. Clean ductwork internally of dust and debris, as follows: With filters in place where applicable, operate the fans at full capacity to blow out dirt and debris from ducts. If it is not practical to use the main supply blower for this test, the ducts may be blown out in sections by a portable fan.

B. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.

C. Balancing:

1. Refer to Section 23 05 93 section "Testing, Adjusting and Balancing" for air distribution balancing of metal or high density propylene ductwork; not work of this section. However, the Sheet Metal Contractor shall participate fully in this work. Seal any leaks in ductwork that become apparent in balancing process.

2. If specified conditions cannot be obtained due to deficiencies in equipment performance or improper installation or workmanship, the Mechanical Contractor and his subcontractors shall make any changes necessary to obtain the specified conditions.

END OF SECTION

SECTION 23 31 10
DUCTWORK ACCESSORIES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23 Basic HVAC Materials and Methods sections apply to work of this section.

1.2 SUMMARY:

A. Extent of ductwork accessories work is indicated on drawings and in schedules, and by requirements of this section.

B. Types of ductwork accessories required for project include the following:

1. Duct hardware.
2. Flexible connections.

C. Refer to 23 05 93 for testing, adjusting, and balancing of ductwork accessories; not work of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of ductwork accessories, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction; and installation instructions.

B. Shop Drawings: Submit manufacturer's assembly type shop drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components.

C. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division-1.

1.5 REFERENCES:

A. Codes and Standards:

1. SMACNA Compliance: Comply with applicable portions of SMACNA "HVAC Duct Construction Standards, Metal and Flexible".
2. Industry Standards: Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.

3. UL Compliance: Construct, test, and label fire dampers in accordance with UL

Standard 555 "Fire Dampers and Ceiling Dampers".

4. NFPA Compliance: Comply with applicable provisions of NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of ductwork accessories.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Protection: Protect shop-fabricated and factory-fabricated accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

B. Storage: Where possible, store accessories inside and protect from weather. Where necessary to store outside, store above grade and enclosed with waterproof wrapping.

PART 2 - PRODUCTS

2.1 DUCT HARDWARE:

A. General: Provide duct hardware, typically of one manufacturer, for all items on project, for the following:

1. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, cover, for instrument tests. Ventlok No. 699 closures shall be provided and installed for each test hole, with sufficient neck length to penetrate the insulation.

B. Manufacturer: Subject to compliance with requirements, provide duct hardware of one of the following:

1. Ventfabrics, Inc.
2. Young Regulator Co.

2.2 FLEXIBLE CONNECTIONS:

A. Extent of Work: Provide flexible connections between ductwork and equipment, such as at fan inlets and discharges, and at other places indicated on the drawings or called for by note or specification.

B. Non-Corrosive Environment or Airstream: For system pressures up to 5” w.c, provide material of heavy waterproof woven glass fabric double coated with neoprene or Hypalon equivalent to “Ventglas” for interior locations and “Ventlon” for exterior locations, fabric not less than 3-1/4" wide clamped between strips of 24 gauge stainless steel or 20 gauge aluminum alloy. Material by Ventfabrics, Inc., Chicago, Ill.

C. Corrosive Environments or Airstream: Provide material of heavy waterproof woven fiberglass fabric coated with Teflon equivalent to “Ventel” by Ventfabrics, Inc., Chicago, Ill.

By nature, the material is slippery and requires rigid clamping in the field installation. Install with the coated side to the corrosive air stream. Clamp the material into a stainless steel edging or hinge with a folded fabric edge. Be careful in securing the clamped fabric to the fan or duct as to not penetrate or disturb any protective coatings or surfaces.

PART 3 – EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF DUCTWORK ACCESSORIES:

A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

B. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.

C. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.3 FIELD QUALITY CONTROL:

A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leak proof performance.

3.4 ADJUSTING AND CLEANING:

A. Adjusting: Adjust ductwork accessories for proper settings

Label access doors in accordance with Division-23 section "Mechanical Identification".

Cleaning: Clean factory finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 SUMMARY:

A. Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this section.

B. Types of outlets and inlets required for project include the following:

1. Louvers

C. Refer to other Division-23 sections for ductwork and duct accessories required in conjunction with air outlets and inlets; not work of this section.

D. Refer to other Division-23 sections for balancing of air outlets and inlets; not work of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firms with at least 3 years of successful installation experience on projects with metal ductwork systems work similar to that required for project.

The Installer shall have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the Installer.

All workmen on the project shall carry state licenses as journeymen or apprentice sheet metal workers with additional certification for welders.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:

1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.

2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.

3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings. Indicate selections on data.

B. Samples: 3 samples of each type of finish furnished.

C. Shop Drawings: Submit manufacturer's assembly type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.

D. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division-1.

1.5 REFERENCES:

A. Codes and Standards:

1. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".

2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".

3. AMCA Compliance: Test and rate louvers in accordance with AMCA 500 "Test Method for Louvers, Dampers and Shutters".

4. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.

5. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver air outlets and inlets wrapped in factory fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

B. Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.1 DRAINABLE BLADE LOUVERS:

A. Extent of Work: At air openings in the outside wall where indicated on drawings, install AMCA rated drainable stationary extruded aluminum 6" deep weather louvers with bird screens.

B. Material: Blades shall be 6 inches deep with integral downspouts to drain the water from the louver blades. Stationary louvers shall pass 1000 fpm free area velocity with less than 0.15" static pressure drop and shall carry less than .03 ounces of water per square foot when tested in accordance with AMCA Standard 500. Install screens on interior face and louver.

C. Finish system shall be 2.0-mil, PVF2 Kynar 500, formulated by a licensed formulator to contain 70 percent PVF resin and applied by a licensed applicator.

1. Epoxy prime coat shall be applied to exposed sides to a dry film thickness of approximately 0.2-mil. One coat of PVF color coating shall be applied to exposed sides to provide a dry film thickness of not less than 0.8-mil, for a total of 1.0-mil total coating.

2. The surface condition of this finish coat shall be 100 percent free of holidays, drip marks, scratches, roll marks, or abrasions that are visible from a distance of 5-feet in good light when in installed position. Surfaces shall be free of checking, crazing, peeling, or loss of adhesion.

3. Finish shall meet or exceed AAMA 2605.

4. Color shall be selected and approved by owner from manufacturer's standard color selections.

    a. Color shall be uniform with no variation in shade, and louvers or accessories of different color batches will not be acceptable.

    b. The Owner reserves the option of changing this tentative color selection during the submittal process at no additional cost to Owner.

D. Manufacturer: Louvers shall be equal to American Warming and Ventilating, Louvers and Dampers, Krueger, Ruskin, Cesco, NCA Manufacturing or U.S. Louvers.

2.2 Contractor is required to coordinate louver size, flange type, and construction with structural and architectural openings to assure fit and appearance. Except for very large units, louvers shall be one piece.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which air outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

A. General: Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to ensure that products serve intended function.

B. Coordinate with other work, including ductwork, as necessary to interface installation of air outlets and inlets with other work.

END OF SECTION

SECTION 23 76 00
TERMINAL ELECTRIC HEAT TRANSFER UNITS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23 Motors Drives and Electrical Requirements for Mechanical Systems, General Mechanical Requirements, and General Pipes and Fittings sections apply to work of this section.

1.2 SUMMARY:

A. Types of terminal units required for project include the following:

1. Unit heaters, electric

PART 2 - PRODUCTS

2.1 WASH DOWN TYPE ELECTRIC UNIT HEATERS (EUH):

A. General: Provide wash down type electric unit heaters in location as indicated, and of capacities, and style and having accessories as scheduled. The heater shall be constructed from 18-gauge type 304 Stainless Steel.

B. Unit shall be complete factory assembled, wired and tested. Ready for installation and connection to electrical power source and control package.

C. Electric unit heaters shall be provided with totally enclosed, corrosion-resistant, UL listed motor with permanently lubricated ball bearings, NEMA 4X enclosure, epoxy coated. Single point power connection. Furnish with heavy duty hanging bracket.

D. Heating elements and motor shall be enclosed in a, heavy-gauge stainless steel shroud.

E. Provide unit heaters with an adjustable stainless steel louvered air outlet grille, heavy gauge plate rear grille for protection against accidental contact with the fan blade.

F. Provide with automatic temperature controls built into unit with fan mounted thermostat, 40 degree to 100 degree temperature range, three position switch wired to control for on, standby and fan only settings, indicating light for when heating elements are energized.

G. Manufacturer: Subject to compliance with requirements, provide electric unit heaters of one of the following:

1. King
2. Reznor

2.2 ELECTRIC WALL HEATERS: (EWH)

A. Cabinet constructed of steel with epoxy / polyester powder coat finish. With adjustable louvers.

B. Safeties and Controls:

1. High temperature control with automatic reset.
2. Built-in tamper proof thermostat.
3. Fan delay to purge heater of residual heat.

C. Aluminum-finned, copper clad steel sheath heating element

D. See equipment schedules on drawings for supply voltage.

E. Appropriate mounting brackets for recessed mount.

F. Manufacturer: Subject to compliance with requirements, provide electric wall heaters of one of the following:

1. Reznor
2. King
3. Raywall,
4. Brasch Manufacturing Co.
5. Indeeco
6. Heatrex

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which terminal units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

3.2 INSTALLATION OF TERMINAL HEAT TRANSFER UNITS:

A. General: Install heaters as indicated, and in accordance with manufacturer's installation instructions.

B. Locate heaters where indicated.

C. Provide and install hangers and supports for heater.

3.3 ELECTRICAL WIRING:

A. General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted.

3.4 ADJUSTING AND CLEANING:

A. General: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets.

B. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

END OF SECTION

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SECTION 23 81 26
SPLIT SYSTEM AIR CONDITIONING UNITS

PART 1 GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install heat pumps as described in Contract Documents.

B. Related Sections:
   1. Division: Concrete pads.
   2. Section 230500: General Mechanical Requirements.

1.2 SUBMITTALS

A. Quality Assurance / Control: Equipment check-out sheets.

1.3 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Each unit shall be UL / ULC or ETL labeled.

1.4 WARRANTY

A. Provide five-year warranty on compressors beginning from date of start-up. Record start-up date on warranty certificate for each unit.

PART 2 PRODUCTS

2.1 SPLIT SYSTEM AIR CONDITIONING UNITS (SAC)

A. Cooling Only Units:
   1. Indoor Units:
      a. Wall mounted units as scheduled.
      b. Isolate moving parts from cabinets to reduce noise.
      c. Provide with condensate pump.

   2. Outdoor Units:
      a. Compressor serving the multi-split system shall be of swing rocker design, provided with multi-ports to match indoor units served with inverter power modulating control.
      b. Fans shall be direct driven and discharge horizontally.

c. Casings shall be fully weatherproof for outdoor installations.
d. Microprocessor Controls shall be factory wired with field installed remote pendant station.
e. Refrigerant shall be R-410a.
f. Isolate moving parts from cabinets to reduce noise.
g. Use dry-charged tubing for connection of unit's refrigerant system.

3. Accessories:
   a. Provide all indoor units with wired remote controllers installed in secure housings.

4. In addition to that specified above, provide air conditioning split systems with all standard features to match features of those scheduled.

5. Approved Manufacturers:
   a. Mitsubishi Electronics America Inc, HVAC Div, Norcross, GA www.mrslim.com.
   b. Daikin Air Conditioning (Americas) Inc, Carrollton, TX www.daikinac.com.
   c. Carrier Corp, Syracuse, NY www.commercial.carrier.com.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Units shall be started up, checked out, and adjusted by Unit Manufacturer's authorized factory trained service mechanic. Use equipment check-out sheet provided by Manufacturer. Complete and sign all items on sheet.

END OF SECTION

SECTION 23 82 00
POWER VENTILATORS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23 General Mechanical Requirements sections apply to work of this section.

C. See Section 23 06 07 Motors, Drives and Electrical Requirements for Mechanical Work.

1.2 SUMMARY:

A. Extent of power and gravity ventilator work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of power and gravity ventilators specified in this section include the following:

1. Centrifugal Rooftop Mounted Exhaust Fans.

C. Refer to Division 23, Section 23 05 93 "System Commissioning, Testing and Balancing" for balancing of power and gravity ventilators; not work of this section.

D. Refer to Division-23 and 40 temperature control and instrumentation systems sections for control work required in conjunction with power and gravity ventilators; not work of this section.

E. Refer to Division-26 sections for the following work; not work of this section.

1. Power supply wiring from power source to power connection on ventilators. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory installed, by manufacturer.

2. Interlock wiring between ventilators; and between ventilators and field installed control devices as shown in Division-26.

Interlock wiring specified as factory installed is work of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of power and gravity ventilators, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical data for power and gravity ventilators, including specifications, capacity ratings, dimensions, weights, materials, accessories furnished, and installation instructions.

B. Shop Drawings: Submit assembly type shop drawings showing unit dimensions, construction details, methods of assembly of components, and field connection details.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to power ventilators. Submit manufacturer's ladder type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.

D. Maintenance Data: Submit maintenance data and parts list for each type of power and gravity ventilator, accessory, and control. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division-23.

1.5 REFERENCES:

A. Codes and Standards:

1. AMCA Compliance: Provide power ventilators which have been tested and rated in accordance with AMCA standards, and bear AMCA Certified Rating Seal.

2. UL Compliance: Provide power ventilators which are listed by UL and have UL label affixed.

3. NEMA Compliance: Provide motors and electrical accessories complying with NEMA standards.

PART 2 – PRODUCTS

2.1 ROOFTOP MOUNTED CENTRIFUGAL EXHAUST FAN - UPBLAST (REF-1&2):

A. General: Fans shall be spun aluminum, curb mounted, direct drive, upblast, with air flow capacity as scheduled, centrifugal exhaust ventilator.

B. Fan shall be listed by Underwriters Laboratories (UL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance. Fan shall be provided with a phenolic coating for all components exposed to the airstream.

C. The fans shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.

D. Fans shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure.

E. Provide fans with a wind band or discharge baffle having a rolled bead for added strength.

F. Provide fans with a two piece cap having stainless steel quick release latches to provide access into the motor compartment without the use of tools.

G. An integral conduit chase shall be provided into the motor compartment to facilitate wiring connections.

H. The motor, bearings and drive shall be mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust air stream. Lifting lugs shall be provided to help prevent damage from improper lifting.

I. The fan wheels shall be non-sparking centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic inlet cone. Wheel shall be statically and dynamically balanced in accordance with AMCA Standard 204-96.

J. The Motor shall be an electronically commutated motor rated for continuous duty and furnished either with internally mounted potentiometer speed controller or with leads for connection to 0-10 VDC external controller.

K. Accessories:

1. Provide fans with galvanized wire insect screen on fan outlets and motorized control damper.

L. Manufacturer: Subject to compliance with requirements, provide wall mounted centrifugal exhaust fans of one of the following:

2. Cook
3. Pace
4. Greenheck
5. Penn
6. Twin-City

PART 3 - GENERAL

3.1 INSPECTION:

A. General: Examine areas and conditions under which power ventilators are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF POWER VENTILATORS AND FANS:

A. General: Except as otherwise indicated or specified, install power ventilators in accordance with manufacturer's installation instructions and recognized industry practices to insure that products serve the intended function.

B. Coordinate ventilator work with work of roofs, walls and ceilings, as necessary for

proper interfacing.

C. Ductwork: Refer to Divisions-23 sections 23 31 00 "Ductwork" and 23 31 10 “Ductwork Accessories.” Connect ducts to ventilators in accordance with manufacturer's installation instructions.

D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory mounted.

E. Remove shipping bolts and temporary supports within ventilators. Adjust dampers for free operation.

3.3 FIELD QUALITY CONTROL:

A. Testing: After installation ventilators have been completed, test each ventilator to demonstrate proper operation of unit at performance requirements specified. When possible, field correct malfunctioning units, and then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

3.4 ADJUSTING AND CLEANING:

A. Cleaning: Clean factory finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 23 90 00
AIR FILTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-23, Section 23 05 00 General HVAC Requirements sections apply to work of this section.

1.2 SUMMARY:

A. Extent of air cleaning work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of air cleaning equipment specified in this section include the following:

1. Air Filters.

a. Extended surface self-supporting.

C. Refer to Division-23 duct accessories section for duct access door work required in conjunction with air filters; not work of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air cleaning equipment of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data including, dimensions, weights, required clearances and access, flow capacity including initial and final pressure drop at rated air flow, efficiency and test method, fire classification, and installation instructions.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for filter rack assemblies indicating dimensions, materials, and methods of assembly of components.

C. Maintenance Data: Submit maintenance data and spare parts lists for each type of filter and rack required. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division-23.

1.5 REFERENCES:

A. Codes and Standards:

1. UL Compliance: Comply with UL Standards pertaining to safety performance of air filter units.

2. ASHRAE Compliance: Comply with provisions of ASHRAE Standard 52 for method of testing, and for recording and calculating air flow rates.

3. ARI Compliance: Comply with provisions of ARI Standard 850 pertaining to test and performance of air filter units.

PART 2 - PRODUCTS

2.1 AIR FILTERS:

A. Manufacturers: Subject to compliance with requirements, replaceable filter media and holding frames shall be a product of one of the following:

1. American Air Filter
2. Continental
3. Farr

B. Holding Frames: Suitable for filters specified. Frame and brace into solid assemblies.

1. May be side access, factory fabricated type.

C. Replaceable pleated media type filters.

1. Pleated, medium efficiency in a cardboard holding frame, 2" or 4" thick as scheduled, 0.32" s.p. maximum initial pressure drop at 500 feet/minute, to change out at 0.50". U.L. Class 2, 25-30% efficiency, 90-95% arrestance per ASHRAE Standard 52-76. Typical selection for 300 feet/min, or less.

2. Equivalent to Farr 30/30.

D. Startup Set:

1. Install a set of filters immediately upon fabrication of any filter bank. Install scheduled set of filters at completion of construction at the time of testing and balancing.

E. Replacement Set:

1. Furnish a second set of filters for each unit to be turned over to Owner as initial replacement stock.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which air filters and filter housings will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION:

A. General: Comply with installation requirements as specified elsewhere in these specifications pertaining to air filters housing/casings, and associated supporting devices.

B. Install air filters and holding devices of types indicated, and where shown; in accordance with air filter manufacturer's written instructions and with recognized industry practices; to ensure that filters comply with requirements and serve intended purposes.

C. Locate each filter unit accurately in position indicated, in relation to other work. Position unit with sufficient clearance for normal service and maintenance. Anchor filter holding frames securely to substrate.

D. Coordinate with other work including ductwork and air handling unit work, as necessary to interface installation of filters properly with other work.

E. Install filters in proper position to prevent passage of unfiltered air.

F. Install air filter gage pressure tips upstream and downstream of filters to indicate air pressure drop through air filter. Mount filter gages on outside of filter housing or filter plenum, in accessible position. Adjust and level inclined gages if any, for proper readings.

3.3 FIELD QUALITY CONTROL:

A. Operate installed air filters to demonstrate compliance with requirements. Test for air leakage of unfiltered air while system is operating. Correct malfunctioning units at site, then retest to demonstrate compliance; otherwise remove and replace with new units, and proceed with retesting.

END OF SECTION

SECTION 26 05 07 – ELECTRICAL POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. The licensed professional electrical ENGINEER of record, directly contracted with the owner, with the assistance of the CONTRACTOR shall provide electrical power system studies for the project. The type and content of each study is specified in the following articles.

1.2 SUBMITTALS

A. Completed electrical power system studies shall be submitted to the OWNER.
   1. A PDF Copy of the completed study report shall be provided.
   2. The software database and library used to model the power system shall be submitted in native file format zipped together into a single ZIP file.

B. The OWNER shall provide to the ENGINEER the following information:
   1. The utility available fault current
   2. The utility minimum, normal, and maximum operating service voltage levels, three-phase short circuit MVA and X/R ratio, as well as line-to-ground short circuit MVA and X/R ratio at the point of connection as shown on the drawings.
   3. The utility protective device settings for all service entrance over-current devices affecting coordination of the facility

C. The CONTRACTOR shall provide to the ENGINEER the following information:
   1. The length of feeders used, new or previously installed affecting the new equipment.
   2. The gauge of feeders used, new or previously installed affecting the new equipment.
   3. The count of runs of feeders used, new or previously installed affecting the new equipment.
   4. The feeder breaker information, new or previously installed affecting the new equipment.
      a. Cut sheet of the breaker
      b. Make and model and part number
      c. Photo of the breaker
      d. Available settings
      e. KAIC
   5. Transformer information, new or previously installed affecting the new equipment.
      a. Cut sheet of the transformer
      b. Make and model and part number
      c. Photo of the nameplate
      d. kVA
      e. Primary and Secondary Voltage
      f. Primary and Secondary Phases
      g. Primary and Secondary Winding type
      h. Impedance Z%
   6. As-Built one-line diagram

D. The ENGINEER shall submit to owner in a single zip file all images and files used containing the information used in preparing the model including those received by the CONTRACTOR.

E. The CONTRACTOR is responsible for compliance with all performance specifications in this proposal. Any deviation from complete compliance must be noted on the performance specification submitted for review and approved before work begins.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The analysis software shall be the latest version SKM Analysis Software or equal meeting all performance specifications.

2.2 ELECTRICAL POWER SYSTEM STUDIES

A. An electrical arc flash hazard analysis, including:
   1. The development of an up-to-date electrical system one-line diagram and model to provide staff members with an accurate representation of the installed electrical system.
   2. Determination of system operating modes and conditions that can impact short circuit currents and arc flash hazard energy levels.
   3. Short circuit and equipment duty study to verify that equipment is rated to safely handle short circuit currents without creating hazardous conditions.
   4. Protective device coordination study and review to help ensure proper electrical system reliability and to determine if arc flash hazard energy levels can be reduced.
   5. Arc flash hazard analysis study to determine arc flash energy levels and Personal Protective Equipment (PPE).
   6. Power System Modeling and Arc Flash Analysis software for ongoing use by the staff members maintaining and updating the system study as the plant changes.
   7. Arc flash hazard labeling.
      a. INDOOR Labels shall be waterproof and vinyl / plastic / similar. Paper labels are not acceptable.
      b. OUTDOOR Labels shall be waterproof, fade resistant, and UV resistant completely legible for a minimum 5 years. Labels that fail shall be provided to OWNER free of charge for any labels that fail within the 5 year period.
      c. ENGINEER shall provide to OWNER a PDF document with a separate label per sheet, and a PDF document with labels arranged with 4 labels on each sheet of standard 8-1/2” x 11” Letter sized sheets.

B. An electrical arc flash hazard analysis shall be performed to determine incident energy, arc flash protection boundaries, and required PPE for all electrical equipment in the facility. The calculations shall comply with the latest adopted NFPA-70E, and the latest adopted IEEE-1584. An integral part of NFPA-70E compliance is integrating work permits with arc flash assessment for all equipment in this facility. OWNER is responsible for integrating arc flash assessment information into their work permit documentation and procedures.

C. The purpose of this study is to provide a comprehensive software model of the electrical distribution system, which will document facility compliance with NFPA 70E mandates as described below.

1. Article 205.3, 120.2(F)(1): Updated and verified one-line diagram for all electrical distribution voltages including all sources for lock-out and tag out procedures.
2. Article 400.5, 400.6: Updated short circuit and equipment duty verification study showing all electrical equipment is properly rated to withstand and interrupt the available short circuit duty per ANSI Standards and NEMA/UL/NEC requirements.
3. Article 400.6, 410.9: Updated protective device coordination study showing the system protective devices are properly set to coordinate and clear a fault without extensive equipment damage or personnel risk.
4. Article 130.3(A)(B), 110.8: Updated arc flash study providing maximum incident energies, arc flash boundaries, and PPE requirements for each equipment in the system.
5. Article 130.16(E), 400.11, 400.14, 400.21(C)(2), 410.8: Updated labeling displaying the worst-case arc hazard values for each equipment in the facility.

D. The analysis shall consist of the following:
1. Field data collection by qualified personnel (as defined by NFPA 70E).
2. Data entry and system one-line modeling in commercially available power system software.
3. Model verification.
4. Short Circuit and equipment verification study.
5. Protective device coordination study.
6. Arc flash hazard study.
7. Detailed report and findings of the analysis.
8. Electronic copies of the Project Report and the System Modeling File.

E. The analysis and procedures shall comply with the latest adopted revision of the following standards and recommended practices for power system studies.
1. NFPA-70E, Standard for Electrical Safety in the Workplace
2. IEEE-1584
3. IEEE-242 “Buff Book” Protection and Coordination of Industrial Power Systems
4. IEEE-399 “Brown Book” Power System Analysis
5. IEEE-141 “Red Book” Electric Power Distribution for Industrial Plants

2.3 DATA COLLECTION

A. Field data collection shall be performed by qualified individuals (as defined by the latest adopted NFPA 70E) to ensure accurate equipment modeling.

B. Field data collection and system modeling shall be based on the system installed.

C. Equipment shall be visually inspected to collect the necessary nameplate data used in the analysis, including transformers, switchgear and breakers, relays, direct-acting trip units, etc. Data that may not be readily accessible or may not have nameplate data such as conductors, busway, etc. can be taken from drawings.

D. Data collection shall include the step down transformer from the utility service (including primary relaying) down through each 480-volt motor control center (MCC) and 240/208 volt panels for all systems served by transformers rated greater than 125 kVA as per the latest adopted IEEE-1584.

E. The OWNER shall obtain from the utility the minimum, normal, and maximum operating service voltage levels, three-phase short circuit MVA and X/R ratio, as well as line-to-ground short circuit MVA and X/R ratio at the point of connection as shown on the drawings.

2.4 SYSTEM MODELING

A. The system model shall be developed using a commercially available, fully integrated software package that meets the performance specifications developed in this Section. To ensure compliance with the latest adopted NFPA-70E, ANSI, and IEEE Standards, and OSHA mandates, no exceptions or substitutions to the performance specification are allowed.

B. The system model shall be laid out in one drawing/view and in a manner that provides for easy viewing of all analysis results. The one drawing/view requirement ensures that problem areas found and highlighted by the program are easily seen and not hidden or buried in multiple drawings, eliminating potential human errors where multiple drawing verification is required.

C. All one-line symbols shall be spaced properly to facilitate viewing results on the one-line.

D. Equipment names used in the modeling software shall be identical to the equipment and naming convention shown on the drawings and equipment unless conflicts exist. The CONTRACTOR shall bring all naming convention conflicts or deficiencies to the attention of the ENGINEER for clarification.

E. The facility may have multiple operating conditions, including, but not limited to, generation on/off, shutdown, bus-ties, start-up, emergency operation, etc. Each of the operating modes shall be documented and modeled in the software in order to determine the worst-case arc flash hazard and associated parameters for the electrical equipment. For the purpose, assume that up to four (4) operating modes are possible.

F. The software shall model each operating mode in a manner such that each mode is a scenario or change case from the base case. Each scenario shall be a simple differential algorithm storing only the difference from the base case and the scenario. Modifications to the base case model shall automatically update all scenarios to eliminate the necessity to store complete databases for each condition, providing for a manageable file size that can be Emailed and eliminating the associated time, man hours, and errors with updating each database individually.

G. Project files created by the software shall be single files and not project directories containing multiple files. The file shall be self-contained and have all necessary information to describe the one-line, system data, settings, and analysis information. Files shall be easily transferable to any site via Email or disk and operable with no setting changes to the database file to eliminate the maintenance and administrative problems associated with multi-file project directories, and to provide an easy method to transfer the file for engineering review.

H. The software shall accurately model daisy-chained MCC’s, panels, and sub-transformers without the use of intermediate buses, nodes or fake impedances.

I. Lumped motor groups for MCC’s shall be modeled per IEEE standards using groups >50 Hp, and <50 Hp. Where motor list data is not available, single lumped groups may be modeled per IEEE-141 “Red Book”.

J. Medium voltage motors greater than 1.0 kV shall be modeled individually on their respective buses including all protective phase and ground overcurrent relays and fuses.

K. All low voltage power circuit breaker (LVPCB), insulated case (ICCB), molded case (MCCB) and fuse data shall be modeled based on the actual nameplate data including manufacturer, type, style, trip device, and actual settings. Generic substitutions or assumptions shall not be allowed unless data cannot be field verified. All assumptions shall be documented in the report.

L. All relay data shall be modeled based on the actual nameplate data including manufacturer, type, style, trip device, and actual settings. Generic substitutions or assumptions shall not be allowed unless data cannot be field verified. All assumptions shall be documented in the report.

M. All overcurrent relay types for the distribution system shall be modeled on the one-line diagram (and database) including phase and ground overcurrent, differential, residual, ground neutral, etc. to establish a complete and detailed system model where protective device data can be easily modified and updated by the facility and all data is available for a comprehensive protective device coordination study if required in the future.

N. Relay models shall depict the actual connection requirements. See Figure-1.3M. Programs using symbols as shown in Figure-1.3M(na) are not acceptable since they do not depict the actual system and can lead to confusion in determining arc flash results and proper protective device modeling.

O. Multi-function relays shall have all their overcurrent devices modeled in a single device and shall be able to accept multiple CT's.

P. All equipment modeling must have a corresponding one-line diagram symbol. This means that there can be no hidden database models. The purpose is for the facility to easily see all equipment, its associated data, to be able to link documents to the equipment as a data repository, etc. and to see problems right on the one-line.

Q. All system modeling shall conform to accepted modeling practices as outlined in IEEE-399 "Brown Book". Contractor/consultant may provide more advanced modeling techniques where compliance with the specification is maintained.

2.5 MODEL VERIFICATION

A. The system model shall be verified by reviewing the results of short circuit current flows for all buses/equipment in the system. The results shall be viewed on each branch and total flow into a bus/equipment on the system one-line diagram. The purpose is to visually spot check values with recognized industry benchmarks as to the expected amount of short circuit current, and correct any problem areas.

2.6 SHORT CIRCUIT STUDY

A. A short circuit study shall be performed to verify all equipment duties in the system. The calculations shall comply with ANSI C37.010, C37.13, C37.5, IEEE-141, and IEEE-399. The short circuit study shall verify the system electrical equipment is properly rated to withstand and interrupt the expected bolted and arcing faults in the system. Improperly rated and applied equipment may not protect personnel against arc flash hazards even if properly applied PPE is used. The software program must comply with the above standards in order to properly verify equipment installed in North America. No substitutions will be allowed.

B. The equipment duty verification shall determine both the line side and load side fault current through each equipment and use the highest current to verify equipment ratings. Standard bus faults are not acceptable for protective devices in that they do not accurately model the current through the device and consequently they provide erroneous results. For solidly grounded systems, both three-phase and single-line-to-ground faults should be modeled. For other grounding configurations only a three-phase fault is required.

C. Equipment duty results shall be graphically displayed on the electrical one-line as well as tabular report format.

D. The results of the equipment duty verification tabular format report shall provide the following data:
   1. Equipment name and kV
   2. Manufacture, type, style, and ratings of the device
   3. Actual line or load side currents through the device and percent over/under duty
   4. Flag for the device showing VIOLATION or WARNING level for visual identification

E. A report of all problem areas shall be provided. Contractor shall notify owner immediately of all problems found in this system before proceeding in the study. A recommended action list shall be provided for all underrated equipment in the system.

2.7 PROTECTIVE DEVICE COORDINATION (PDC) STUDY

A. A PDC study shall be performed in order to determine if the system protection characteristics are sufficient to provide reliable power to the facility. The PDC study will also determine if the settings entered in the software will provide proper personnel protection in the arc flash portion of this study. For facilities where the main distribution is low voltage (under 600 volts) and only instantaneous breakers or fuses are used, this section may not apply.

B. The PDC study shall consist of system feeders and branch circuits 100amps and larger, and plotting the time-current curves (TCC's) to verify proper selective operation of the protective devices. The study should also determine if the settings can be enhanced to provide increased personnel/equipment protection without sacrificing selective coordination.

C. The CONTRACTOR shall notify the ENGINEER of any potential problems in the protective device settings that affect either selective operation and reliability or personnel protection and shall provide recommendations for changes in writing before continuing with the study.

D. As specified in the data collection and modeling sections, all PDC data shall be modeled on the one-line diagram and in the equipment database.

E. The OWNER in coordination with the ENGINEER shall contact the serving utility and obtain protective device settings for all service entrance over current devices in series with the facility and affecting coordination with facilities distribution system.

F. TCC Specifics: The TCC's shall graphically illustrate on log-log paper that adequate time separation exists between series devices. The specific time - current characteristics of each protective device shall be plotted in such a manner that sufficient upstream devices will be clearly depicted on one sheet to prove selective coordination.

1. TCC's shall include a system one-line diagram and protective device coordination curves for each device in the selected area. The TCC shall be in color on 8 ½ x 11" paper – full size portrait mode, using a log-log scale. The one-line diagram shall be part of the TCC and include all protective devices, equipment names, and short circuit currents calculated from the main one-line. The purpose of this requirement is to provide all necessary information on one sheet, in a format easily readable and standard to the industry.
2. For low voltage systems, TCC's shall be developed for both phase and ground protective devices. One phase and one ground TCC should be developed for each unit substation. The TCC should show the largest feeder/motor protective device in the MCC or panel up through the switchgear/switchboard feeder breaker, transformer secondary main, unit substation primary fuse, and medium voltage feeder breaker. For secondary switchboards serving large loads or a wide variety of loads that may affect upstream coordination, additional TCC's may be required.
3. For medium voltage systems, TCC's shall be developed for both phase and ground protective devices. The TCC should show the largest feeder/motor protective device in the lineup up through the switchgear/transformer secondary main, unit substation primary fuse, and medium voltage feeder breaker.
4. The following specific information shall also be shown on the coordination curves:
    a. Device identification.
    b. Voltage and current ratio for curves.
    c. Transformer three - phase and single-line-to-ground ANSI damage curves.
    d. Transformer inrush points.
    e. Minimum melting, and clearing curves for fuses, and if available the no-damage curve.
    f. Cable damage curves.
    g. Motor starting locked rotor curves, and if available the motor locked rotor damage point.
    h. Maximum short circuit cut-off point.
    i. Clearly marked short circuit current levels through each protective device/branch, which should be based on the appropriate current through the device, i.e. Momentary, Interrupting or 30 Cycle current.
    j. Protective device one-line diagram clearly showing all protective devices on the time-current curve, labels for each device, open breakers, faulted buses, and the short circuit current flowing in each branch.
    k. Each TCC sheet shall have appropriate identification and a one-line diagram that applies to the specific portion of the system associated with time-current curves on that sheet.
    l. Each protective device curve shall be terminated at a point reflecting maximum symmetrical or asymmetrical fault current through the device.
    m. Identify the device associated with each curve by its name on the included one-line diagram.
    n. Primary Protective Device Settings for Delta-Wye Connected Transformer:
        1) Secondary Line-To-Ground Fault Protection: Provide primary protective device operating band within the transformer's characteristics curve, including a point equal to 58 percent of ANSI C57.12.00 withstand point.
        2) Secondary Line-To-Line Faults: Provide 16 percent current margin between primary protective device and associated secondary device characteristic curves.

G. A setting table shall be developed to summarize the settings selected/existing for the protective devices. The table shall include the following:
   1. Device identification.
   2. For low voltage breakers, the circuit breaker manufacturer, type, and style, sensor rating, long-time, short-time, instantaneous settings, and time bands. For breakers with ground fault capability, the pickup and time delay.
   3. Fuse manufacturer, type, style, and rating.
   4. Protective relay manufacturer, type, style, function (51, 50, 67, etc.) pickup, current multiplier, time dial, and delay. For multi-function units, list all devices being used. Include the CT and/or PT ratios for each function.

H. The software shall provide complete integration of the one-line, database, short circuit, protective device coordination and arc flash analysis functions to provide accurate calculations and avoid errors associated with multiple data entry programs. Programs using separate PDC or TCC plotting packages are not allowed. Complete PDC integration is defined as the following:
   1. The TCC shall automatically be plotted for the selected area including all short circuit levels. The TCC plot shall automatically include the selected one-line area in a drag and drop window on the TCC showing all one-line attributes without user additions required. These attributes shall automatically include all short circuit currents and voltages displayed on the main one-line, equipment names, etc. and update automatically without additional user input.
   2. Programs requiring the user to build a separate TCC one-line are not integral with system short circuit calculations and do not automatically update as the system one-line changes, requiring additional man-hours for one-line development and are consequently prone to errors as the system changes. These types of programs shall not be considered for the study.
   3. Each TCC shall have momentary (1/2 cycle), interrupting (1-4 cycle), and 30 cycle short circuit currents (tick marks) displayed on the TCC plot for each protective device or as required to properly model the tripping characteristics of the device. The tick marks shall be user adjustable for visual appearance. The purpose is to provide accurate tripping currents for each device.
   4. The software model shall allow each protective device to model momentary (1/2 cycle), interrupting (1-4 cycle), and 30 cycle short circuit currents simultaneously depending on the characteristics of the device.
   5. The software shall model remote voltages and currents for any single fault and display them on the TCC showing all trip cutoffs based on the remote currents. The purpose is to accurately model and verify backup relaying to ensure selective operation under all fault conditions. PDC programs that perform only batch faults, or fail to model remote voltages and currents for all fault types shall not be considered.
   6. The software shall model and display time difference calculations for any selected pair of protective devices. The difference calculator shall include bracketing bars with the calculated difference to clearly show the selective time between the devices. The calculated time shall update dynamically for instant visual setting as the devices are dragged (settings modified). In addition, tool tips shall clearly show the time difference and the protective device settings for all devices as they are dynamically changed or set to allow the user to accurately determine the proper setting between devices in the most efficient manner, reducing coordination time and providing more accurate results.

7. TCC's shall have the ability to display short circuit currents and arc flash hazard results within the fully integrated system one-line in the PDC focus. Short circuit currents and arc flash hazard values shall change on the fly as the protective device settings change, allowing the user to instantly see the results of PDC changes and the associated impact to short circuit currents and arc flash hazard values.
8. The software model shall provide a detailed library for the most common protective devices available in North America. The library shall be user definable.

2.8 ARC FLASH STUDY

A. A detailed arc flash study shall be performed to determine potential arc flash incident energies, arc flash boundaries, shock hazard boundaries and proper personal protective equipment (PPE) for all energized electrical system equipment tasks for the electrical system studied. The calculations shall comply with the latest adopted NFPA-70E, and IEEE-1584. Bolted short circuit calculations used in the above standards shall comply with ANSI C37.010, C37.13, C37.5, IEEE-141, and IEEE-399. The purpose of this study is to determine arc flash hazards in conformance with NFPA-70E, and to provide a comprehensive software model of the electrical distribution system, which provides integral arc flash calculations in compliance with NFPA 70E Article 130.1(A)(2) for all equipment in the facility. The OWNER is responsible for integrating information from the power system studies into their safety and work permit documentation and procedures. The software program used in this study shall comply with the above standards. No substitutions in calculation methods will be allowed.

B. The arc flash study shall determine the following results for each system mode of operation. The results shall be provided in spreadsheet format for each mode and electrical system location to provide easy viewing and comparison. Worst-case arc flash energy levels shall be flagged and the spreadsheet comparison table shall be capable of providing its output directly to high quality vinyl label printers. The calculations shall, as a minimum, include a comparison of both 100% and 85% arcing currents for low voltage equipment for each electrical system configuration or operating mode, indicating worst-case arc flash hazards. The spreadsheet results shall include:
   1. Equipment name and voltage.
   2. Upstream equipment device name and ANSI function, i.e. 51/50, etc.
   3. Equipment type, i.e. switchgear, MCC, Panel, VFD, etc.
   4. Equipment arc gap.
   5. Bolted and estimated arcing fault current at the fault point (equipment) in symmetrical amperes. The estimated arcing current should be based on the arcing current equations used.
   6. Trip time, opening time, and total clearing time (total Arc time) of the protective device.
   7. Worst-case arc flash boundary for each bus/equipment in the model.
   8. Worst-case arc flash hazard incident energy in cal/cm^2 for each bus/equipment in the model.
   9. Worst-case personal protective equipment (PPE) for each bus/equipment in the model.
   10. Working distances for up to five different distances showing items 7, 8, and 9 for each distance.

11. Indicate “Danger/Hazardous” areas where incident energy is greater than 40 cal/cm^2 and provide recommendations to reduced arc flash energy levels for these areas.
12. Flag results where 85% arcing current provided worst-case results.

C. Each mode of operation shall include a detailed write-up indicating areas where incident energy calculations and PPE requirements are higher than calculated in the normal operating mode.

D. ENGINEER shall provide a detailed arc flash analysis report including as a minimum:
1. Introduction.
2. Methodology.
3. Information Sources.
4. Key Assumptions.
5. Arc Flash Energy and other consideration for various System Modes of Operation (maintenance mode, bus-tie, co-gen on/off, etc.).
6. Arc Energy at 100% and reduced currents.
7. IEEE 1584 Considerations.
8. Overcurrent Protective Device Changes, Replacements or Setting Changes implemented in study to reduce arc flash hazard exposure.
9. Explanation of Data in Arc Flash Hazard Report Tables.
10. NFPA 70E Information.
    a. Shock Hazards with covers removed.
    b. Shock Hazard Approach Boundaries.
        1) Limited Approach Boundary.
        2) Restricted Approach Boundary.
        3) Prohibited Approach Boundary.
    c. Arc Flash Hazard Boundaries.
11. Results of Arc flash Hazard Analysis for high voltage, medium voltage and low voltage systems, including:
    a. Working distances.
    b. Energy Levels.
    c. PPE Requirements.
    d. Recommendations to reduce arc flash hazard energy and exposure.
12. Arc Flash Hazard Report.
    a. 5 Hard Copies.
    b. 1 Electronic Copy in Adobe Acrobat format (5.0 or later).
13. Electronic file for Power System Modeling Software as developed and utilized for this analysis.

E. The ENGINEER shall provide printed labels for all equipment in the system from the project study file. Assume three (3) labels per equipment/bus in your estimate using 4” x 6” labels or one (1) 6” x 8” label per equipment bus. The labels shall be UV resistant vinyl labels (white with orange warning strip and black letters) conforming to ANSI-Z535. The labels shall be printable directly from the power system software utilized for the study with a Duralabel, Brady PowerMark or GlobalMark printer to ensure that the OWNER’s personnel have the option of printing the labels without the extra expense of going to an outside printing service, converting arc flash results to spreadsheet format or performing tedious manual data entry.

F. Software Requirements: The software shall provide complete integration of the one-line, database, short circuit, PDC and Arc flash functions. Software using separate short circuit, PDC, TCC or arc flash programs is not allowed. Spreadsheet calculations and hand calculations are not allowed except as confirmation of the master software and correct configuration of the master software. If a spreadsheet or hand calculation is used, include a copy in the zip file sent to the OWNER. The purpose of this section is to ensure that the arc flash hazard calculations comply with NFPA-70E and IEEE-1584, and that the calculations are programmed with necessary requirements to help eliminate possible errors in the arc flash calculations. The additional purpose is to establish a detailed software model of the electrical distribution system, which will document compliance with the OSHA requirements and NFPA 70E mandates. The OWNER is responsible for integrating information from the power system studies into their safety and work permit documentation and procedures.
   1. Arc flash calculations shall be performed with enhanced IEEE-1584 equations, which eliminate voltage discontinuities and the non-conservative/average results of the standard equations. The purpose of this requirement is to ensure that the calculated incident energies are closer to actual test results insuring a conservative calculation minimizing personnel risk.
   2. Arc flash calculations shall be based on the fastest clearing upstream protective device protecting the equipment for single sources and the slowest upstream protective device for multiple sources. The calculations shall automatically compare all series and parallel upstream protective devices in the system to determine the fastest series device or a conservative parallel clearing time. The algorithm shall incorporate a traversing routine that can search back an unlimited number of buses/nodes and consider all series and parallel branches in the comparison to ensure accurate answers and to prevent hazards associated with incorrect results. Software shall not have trace back limits (5-10 buses) that can provide incorrect answers for low voltage faults that require high voltage protective device clearing to prevent potential errors.
   3. The arc flash calculations including arc flash boundary, incident energy, PPE requirements, and working distance shall be displayed on the software one-line diagram and TCC simultaneously. The software must show visually the arc flash values as the settings are incrementally changed (dragging curves) so the protection can be optimized in the most efficient manner, allowing the protection engineer to visually balance the competing objectives of personnel protection with that of system selectivity.
   4. The arc flash calculations shall include four (4) calculation options to ensure that the software provides the flexibility required to meet any system configuration or training requirement that may be considered. Each calculation option shall comply with the graphic and spreadsheet display requirements of this section. Each option is more specifically described below.
      a. The detailed option shall provide the let-through energy for each protective device in the system. This is the energy on the load side of the protective device. The equipment shall be highlighted when the let-through energy exceeds a user defined threshold-clothing limit.

b. Worst-case including main protective device. This option shall provide the worst-case arc-hazard energy for the equipment based on the let-through energy of the equipment's main protective device. If the equipment is not equipped with a main device, the program must traverse back the entire system to determine the fastest series upstream protective device. The equipment shall be highlighted when the let-through energy exceeds a user defined threshold-clothing limit.
c. Worst-case excluding main protective device. This option shall provide the worst-case arc-hazard energy for the equipment based on the let-through energy of the fastest upstream series protective device in the system. The program shall traverse back the entire system to determine the fastest upstream protective device. The equipment shall be highlighted when the let-through energy exceeds a user defined threshold-clothing limit.
d. Worst-case excluding and including the main protective device. A combination of options 'b' and 'c' as stated above.

5. The power system software shall be fully compatible with facility arc flash hazard and electrical safety implementation software that provides the following capabilities:
   a. Calculates shock hazards, shock hazard boundaries, arc flash boundaries, incident energies, PPE requirements, etc. for power systems modeled in EasyPower or EasyPower EasySolv.
   b. Program shall support creation of arc flash labels with direct output to high quality UV resistant vinyl label printers.
   c. Program shall also have customizable output. Includes one-line printing, text report creation, export to AutoCAD, etc.
   d. Program shall be a Windows based operating system and shall use Windows conventions.

2.9 REPORTING AND ANALYSIS SUMMARY

A. Executive Summary: The executive summary shall be brief 1-2 pages maximum and cover at an executive level the findings of the study, recommendations, and requirements for maintaining NFPA-70E compliance.

B. Scope of studies performed: The scope shall provide details of what actions were intended to be performed for each aspect of the study, including short circuit, protective device coordination, and arc flash.

C. Description of system and explanation of bus and branch numbering system.

D. Modes of operation studied: Each scenario/plant operating condition shall be thoroughly documented.

E. Detailed report and results of short circuit, coordination, and arc flash studies including:
   1. Recommendations and additions to equipment rating and/or PDC characteristics.
   2. Recommendations to reduce arc flash hazards for equipment with incident energies over 40 cal/cm^2.

F. Prioritized recommendations for all studies.

G. Action list and check off column for all recommendations.

2.10 QUALITY ASSURANCE

A. The studies shall be in conformance with the NFPA and ANSI Standards, and IEEE recommended practices detailed in this section. No substitutions in study methods or software conformance will be allowed.

END OF SECTION

SECTION 26 05 05 – OPERATION AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.

B. Division-26 Electrical General Requirements sections apply to work of this section.

1.2 SUMMARY

A. Furnish four sets of bound operation and maintenance manuals. Manuals shall contain descriptive drawings and data which identify equipment installed at the project and detail the procedures and parts required to maintain and repair the equipment. Copies of approved submittals shall be included for all equipment.

B. Refer to Section 01 34 00 for additional requirements.

1.3 OPERATION AND MAINTENANCE MANUAL FOR ELECTRICAL AND INSTRUMENTATION SYSTEMS

A. General:
   1. The "Operating and Maintenance Manual" (Electrical and Instrumentation) is a bound compilation of drawings and data that the owner requires for each building or project. These manuals, complete with drawings and data, shall be furnished to the Owner.
   2. The electrical CONTRACTOR has overall responsibility to obtain the necessary data and compile the data as set forth in this specification, including items or equipment purchased by the Owner and delivered to the CONTRACTOR for installation.
   3. The number of binders (or "volumes") required will depend on the amount of information to be catalogued. Total "sets" see paragraph 1.02A.
   4. Make all information legible and sufficiently marked to indicate the exact size, model, type, etc., of equipment furnished and installed.

B. Purpose: The Operating and Maintenance Manual is prepared to provide a ready reference to all important pieces of mechanical and electrical equipment installed on the project. It is also to provide the necessary operating and maintenance data for use by service personnel. It is also to provide information required for checking equipment performance or for planning of plant expansion or redesign.

PART 2 - PRODUCTS

2.1 PAGE SIZE:

A. All pages shall be standard 8-1/2 x 11 inches size or approximate multiples (preferably 11 x 17 inches) folded to 8-1/2 x 11 inch.

2.2 DRAWINGS:

A. All drawings larger than 8-1/2" x 11" shall be folded and inserted in individual 8-1/2" x 11" manila pockets, which shall have standard three-ring side punching for insertion in the binders. The equipment name, drawing description and number shall be written on the face of each manila pocket.

2.3 BINDERS:

A. Binders shall be Buckram (stiffened fabric), bar-lock type binders with block lettering for sheet size 8-1/2 x 11 inches with 2" to 3-1/2" expandable metal capacity as required for the project. The number of binders, however, shall be based on not filling them beyond 4".

B. Place the following information on the front cover and backbone:
   1. "Operation and Maintenance Manual".
   2. Project Name and Number (and volume number if more than one volume).
   3. Equipment name and number.
   4. ENGINEER's name.
   5. General CONTRACTOR's name.
   6. Electrical CONTRACTOR's name.
      (Items 4 through 6 need not be printed on the backbone.)

2.4 CONTENTS AND INDEXING

A. Manuals shall contain descriptions of the electrical, control, and instrumentation systems in sufficient detail to adequately indicate the type of systems installed and the basic details of their operation.

B. All purchased equipment data shall be used to designate the sections. Within each section additional indexing of component parts may be required.

C. Operation and Maintenance Manuals shall contain to the fullest extent all possible information pertinent to the equipment. The arrangement and type of information to be filed shall be as follows:
   1. Copy of purchase order change (if any).
   2. Outline drawings, special construction details, “as-built” electrical wiring and control diagrams with wire and terminal number for panel and field wiring for all major and supplementary systems.
   3. Manufacturer’s test or calculated performance data and certified test curves.
   4. Installation, operating, and maintenance instructions, including a complete parts list and sectional drawing with parts identification numbers. Mark with model, size and plan number.
   5. Manufacturer’s brochure marked to indicate exact equipment purchased. Brochures on component parts supplied by a manufacturer with his equipment, but not manufactured directly by him, shall also be included.
   6. The serial numbers of each item of equipment installed are to be listed with the model numbers and plan symbols.
   7. Include a Table of Contents. The contents shall be divided with tabbed index dividers into the following suggested parts:
      Part I Building and System Descriptions
      Part II Purchased Equipment Data

Part III Test Reports and Charts
Part IV Start-Up and Operation
Part V Preventative Maintenance Recommendations
Part VI Software/Programming Data/Program CD's

8. A copy of the approved submittals for each piece of equipment.
9. A copy of all testing reports.
10. Wiring diagrams, marked with model and size and plan symbol.
11. The index shall contain the name and address of the manufacturer and, if different, where replacement and repair parts may be obtained.
12. Copies of developed software, programmed setpoints, screens, etc. on C.D.

END OF SECTION

SECTION 26 05 07 – ELECTRICAL POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. The electrical equipment manufacturer shall provide electrical power system studies for the project. The studies shall be prepared by the licensed professional electrical engineer of record for the plant. The type and content of each study is specified in the following articles.

1.2 SUBMITTALS

A. Completed electrical power system studies shall be bound and submitted to the ENGINEER.
   1. Five (5) printed copies (hardcopies) of the completed study report shall be provided and one (1) copy in Microsoft Word or Adobe Acrobat format.
   2. The software database and library used to model the power system shall be submitted in native file format including all updates to the library necessary to complete the model.

B. The CONTRACTOR shall attach brochures, resumes, references and other information indicating how your firm is qualified to provide the services outlined in this document.

C. The CONTRACTOR is responsible for compliance with all performance specifications in this proposal. Any deviation from complete compliance must be noted on the performance specification submitted for review and approved before work begins.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The analysis software shall be SKM Analysis Software or equal meeting all performance specifications.

2.2 ELECTRICAL POWER SYSTEM STUDIES

A. An electrical arc flash hazard analysis, including:
   1. The development of an up-to-date electrical system one-line diagram and model to provide staff members with an accurate representation of the installed electrical system.
   2. Determination of system operating modes and conditions that can impact short circuit currents and arc flash hazard energy levels.
   3. Short circuit and equipment duty study to verify that equipment is rated to safely handle short circuit currents without creating hazardous conditions.
   4. Protective device coordination study and review to help ensure proper electrical system reliability and to determine if arc flash hazard energy levels can be reduced.
   5. Arc flash hazard analysis study to determine arc flash energy levels and Personal Protective Equipment (PPE).
   6. Power System Modeling and Arc Flash Analysis software for ongoing use by the staff members maintaining and updating the system study as the plant changes.

7. Arc flash and safety program implementation software for ongoing use by the staff members for arc flash and safety program management and tracking.
8. Arc flash hazard labeling.
9. Assistance with the development of Energized Work Permits.
10. Arc flash and electrical safety training.
11. Personal Protective Equipment (PPE) training.

B. An electrical arc flash hazard analysis shall be performed to determine incident energy, arc flash protection boundaries, and required PPE for all electrical equipment in the facility. The calculations shall comply with NFPA-70E 2004, and IEEE-1584-2002. An integral part of NFPA-70E compliance is integrating work permits with arc flash assessment for all equipment in this facility. This section describes in detail the requirements for the study as well as integrating work permits in the system model for 70E compliance.

C. The purpose of this study is to provide a comprehensive software model of the electrical distribution system, which will document facility compliance with NFPA 70E mandates as described below. This model will serve as an integral part of an ongoing safety program by providing integral work permits and arc flash calculations in compliance with NFPA-70E 2004 Article 130.1(A)(2) for each electrical equipment in the facility.
1. Article 205.3, 120.2(F)(1): Updated and verified one-line diagram for all electrical distribution voltages including all sources for lock-out and tag out procedures.
2. Article 400.5, 400.6: Updated short circuit and equipment duty verification study showing all electrical equipment is properly rated to withstand and interrupt the available short circuit duty per ANSI Standards and NEMA/UL/NEC requirements.
3. Article 400.6, 410.9: Updated protective device coordination study showing the system protective devices are properly set to coordinate and clear a fault without extensive equipment damage or personnel risk.
4. Article 130.3(A)(B), 110.8: Updated arc flash study providing maximum incident energies, arc flash boundaries, and PPE requirements for each equipment in the system. In addition, these calculations shall be integrated with 70E compliant work permits as part of an ongoing safety program.
5. Article 130.16(E), 400.11, 400.14, 400.21(C)(2), 410.8: Updated labeling displaying the worst-case arc hazard values for each equipment in the facility.

D. The analysis shall consist of the following:
1. Field data collection by qualified personnel (as defined by NFPA 70E).
2. Data entry and system one-line modeling in commercially available power system software.
3. Model verification.
4. Short Circuit and equipment verification study.
5. Protective device coordination study.
6. Arc flash hazard study.
7. Detailed report and findings of the analysis.
8. Electronic copies of the Project Report and the System Modeling File.

E. The analysis and procedures shall comply with the following standards and recommended practices for power system studies.
1. NFPA-70E, 2004 Standard for Electrical Safety in the Workplace
2. IEEE-1584-2002
3. IEEE-242 “Buff Book” Protection and Coordination of Industrial Power Systems

4. IEEE-399 “Brown Book” Power System Analysis
5. IEEE-141 “Red Book” Electric Power Distribution for Industrial Plants

2.3 DATA COLLECTION

A. Field data collection shall be performed by qualified individuals (as defined by NFPA 70E – 2004) to ensure accurate equipment modeling.

B. Field data collection and system modeling shall be based on the system installed.

C. Equipment shall be visually inspected to collect the necessary nameplate data used in the analysis, including transformers, switchgear and breakers, relays, direct-acting trip units, etc. Data that may not be readily accessible or may not have nameplate data such as conductors, busway, etc. can be taken from drawings.

D. Data collection shall include the step down transformer from the utility service (including primary relaying) down through each 480-volt motor control center (MCC) and 240/208 volt panels for all systems served by transformers rated greater than 125 kVA as per IEEE-1584-2002.

E. The CONTRACTOR shall obtain from the utility the minimum, normal, and maximum operating service voltage levels, three-phase short circuit MVA and X/R ratio, as well as line-to-ground short circuit MVA and X/R ratio at the point of connection as shown on the drawings.

2.4 SYSTEM MODELING

A. The system model shall be developed using a commercially available, fully integrated software package that meets the performance specifications developed in this Section. To ensure compliance with NFPA-70E 2004, ANSI, and IEEE Standards, and OSHA mandates, no exceptions or substitutions to the performance specification are allowed.

B. The system model shall be laid out in one drawing/view and in a manner that provides for easy viewing of all analysis results. The one drawing/view requirement ensures that problem areas found and highlighted by the program are easily seen and not hidden or buried in multiple drawings, eliminating potential human errors where multiple drawing verification is required.

C. All one-line symbols shall be spaced properly to facilitate viewing results on the one-line.

D. Equipment names used in the modeling software shall be identical to the equipment and naming convention shown on the drawings and equipment unless conflicts exist. The CONTRACTOR shall bring all naming convention conflicts or deficiencies to the attention of the ENGINEER for clarification.

E. The facility may have multiple operating conditions, including, but not limited to, generation on/off, shutdown, bus-ties, start-up, emergency operation, etc. Each of the operating modes shall be documented and modeled in the software in order to determine the worst-case arc flash hazard and associated parameters for the electrical equipment. For the purpose, assume that up to four (4) operating modes are possible.

F. The software shall model each operating mode in a manner such that each mode is a scenario or change case from the base case. Each scenario shall be a simple differential algorithm storing only the difference from the base case and the scenario. Modifications to the base case model shall automatically update all scenarios to eliminate the necessity to store complete databases for each condition, providing for a manageable file size that can be Emailed and eliminating the associated time, man hours, and errors with updating each database individually.

G. Project files created by the software shall be single files and not project directories containing multiple files. The file shall be self-contained and have all necessary information to describe the one-line, system data, settings, and analysis information. Files shall be easily transferable to any site via Email or disk and operable with no setting changes to the database file to eliminate the maintenance and administrative problems associated with multi-file project directories, and to provide an easy method to transfer the file for engineering review.

H. The software shall accurately model daisy-chained MCC's, panels, and sub-transformers without the use of intermediate buses, nodes or fake impedances.

I. Lumped motor groups for MCC's shall be modeled per IEEE standards using groups >50 Hp, and <50 Hp. Where motor list data is not available, single lumped groups may be modeled per IEEE-141 "Red Book".

J. Medium voltage motors greater than 1.0 kV shall be modeled individually on their respective buses including all protective phase and ground overcurrent relays and fuses. This model will provide individual work permits for each starter/motor on the one-line.

K. All low voltage power circuit breaker (LVPCB), insulated case (ICCB), molded case (MCCB) and fuse data shall be modeled based on the actual nameplate data including manufacturer, type, style, trip device, and actual settings. Generic substitutions or assumptions shall not be allowed unless data cannot be field verified. All assumptions shall be documented in the report.

L. All relay data shall be modeled based on the actual nameplate data including manufacturer, type, style, trip device, and actual settings. Generic substitutions or assumptions shall not be allowed unless data cannot be field verified. All assumptions shall be documented in the report.

M. All overcurrent relay types for the distribution system shall be modeled on the one-line diagram (and database) including phase and ground overcurrent, differential, residual, ground neutral, etc. to establish a complete and detailed system model where protective device data can be easily modified and updated by the facility and all data is available for a comprehensive protective device coordination study if required in the future.

N. Relay models shall depict the actual connection requirements. See Figure-1.3M. Programs using symbols as shown in Figure-1.3M(na) are not acceptable since they do not depict the actual system and can lead to confusion in determining arc flash results and proper protective device modeling.

O. Multi-function relays shall have all their overcurrent devices modeled in a single device and shall be able to accept multiple CT's.

P. All equipment modeling must have a corresponding one-line diagram symbol. This means that there can be no hidden database models. The purpose is for the facility to easily see all equipment, its associated data, to be able to link documents to the equipment as a data repository, etc. and to see problems right on the one-line.

Q. All system modeling shall conform to accepted modeling practices as outlined in IEEE-399 “Brown Book”. Contractor/consultant may provide more advanced modeling techniques where compliance with the specification is maintained.

2.5 MODEL VERIFICATION

A. The system model shall be verified by reviewing the results of short circuit current flows for all buses/equipment in the system. The results shall be viewed on each branch and total flow into a bus/equipment on the system one-line diagram. The purpose is to visually spot check values with recognized industry benchmarks as to the expected amount of short circuit current, and correct any problem areas.

2.6 SHORT CIRCUIT STUDY

A. A short circuit study shall be performed to verify all equipment duties in the system. The calculations shall comply with ANSI C37.010, C37.13, C37.5, IEEE-141, and IEEE-399. The short circuit study shall verify the system electrical equipment is properly rated to withstand and interrupt the expected bolted and arcing faults in the system. Improperly rated and applied equipment may not protect personnel against arc flash hazards even if properly applied PPE is used. The software program must comply with the above standards in order to properly verify equipment installed in North America. No substitutions will be allowed.

B. The equipment duty verification shall determine both the line side and load side fault current through each equipment and use the highest current to verify equipment ratings. Standard bus faults are not acceptable for protective devices in that they do not accurately model the current through the device and consequently they provide erroneous results. For solidly grounded systems, both three-phase and single-line-to-ground faults should be modeled. For other grounding configurations only a three-phase fault is required.

C. Equipment duty results shall be graphically displayed on the electrical one-line as well as tabular report format.

D. The results of the equipment duty verification tabular format report shall provide the following data:
   1. Equipment name and kV
   2. Manufacture, type, style, and ratings of the device
   3. Actual line or load side currents through the device and percent over/under duty
   4. Flag for the device showing VIOLATION or WARNING level for visual identification

E. A report of all problem areas shall be provided. Contractor shall notify owner immediately of all problems found in this system before proceeding in the study. A recommended action list shall be provided for all underrated equipment in the system.

2.7 PROTECTIVE DEVICE COORDINATION (PDC) STUDY

A. A PDC study shall be performed in order to determine if the system protection characteristics are sufficient to provide reliable power to the facility. The PDC study will also determine if the settings entered in the software will provide proper personnel protection in the arc flash portion of this study. For facilities where the main distribution is low voltage (under 600 volts) and only instantaneous breakers or fuses are used, this section may not apply.

B. The PDC study shall consist of system feeders and branch circuits 100amps and larger, and plotting the time-current curves (TCC's) to verify proper selective operation of the protective devices. The study should also determine if the settings can be enhanced to provide increased personnel/equipment protection without sacrificing selective coordination.

C. The CONTRACTOR shall notify the ENGINEER of any potential problems in the protective device settings that affect either selective operation and reliability or personnel protection and shall provide recommendations for changes in writing before continuing with the study.

D. As specified in the data collection and modeling sections, all PDC data shall be modeled on the one-line diagram and in the equipment database.

E. The CONTRACTOR shall contact the serving utility and obtain protective device settings for all service entrance over current devices in series with the facility and affecting coordination with facilities distribution system.

F. TCC Specifics: The TCC's shall graphically illustrate on log-log paper that adequate time separation exists between series devices. The specific time - current characteristics of each protective device shall be plotted in such a manner that sufficient upstream devices will be clearly depicted on one sheet to prove selective coordination.
   1. TCC's shall include a system one-line diagram and protective device coordination curves for each device in the selected area. The TCC shall be printed in color on 8 ½ x 11" paper – full size portrait mode, using a log-log scale. The one-line diagram shall be part of the TCC and include all protective devices, equipment names, and short circuit currents calculated from the main one-line. The purpose of this requirement is to provide all necessary information on one sheet, in a format easily readable and standard to the industry.
   2. For low voltage systems, TCC's shall be developed for both phase and ground protective devices. One phase and one ground TCC should be developed for each unit substation. The TCC should show the largest feeder/motor protective device in the MCC or panel up through the switchgear/switchboard feeder breaker, transformer secondary main, unit substation primary fuse, and medium voltage feeder breaker. For secondary switchboards serving large loads or a wide variety of loads that may affect upstream coordination, additional TCC's may be required.
   3. For medium voltage systems, TCC's shall be developed for both phase and ground protective devices. The TCC should show the largest feeder/motor protective device in the lineup up through the switchgear/transformer secondary main, unit substation primary fuse, and medium voltage feeder breaker.

   4. The following specific information shall also be shown on the coordination curves:
      a. Device identification.
      b. Voltage and current ratio for curves.

c. Transformer three - phase and single-line-to-ground ANSI damage curves.
d. Transformer inrush points.
e. Minimum melting, and clearing curves for fuses, and if available the no-damage curve.
f. Cable damage curves.
g. Motor starting locked rotor curves, and if available the motor locked rotor damage point.
h. Maximum short circuit cut-off point.
i. Clearly marked short circuit current levels through each protective device/branch, which should be based on the appropriate current through the device, i.e. Momentary, Interrupting or 30 Cycle current.
j. Protective device one-line diagram clearly showing all protective devices on the time-current curve, labels for each device, open breakers, faulted buses, and the short circuit current flowing in each branch.
k. Each TCC sheet shall have appropriate identification and a one-line diagram that applies to the specific portion of the system associated with time-current curves on that sheet.
l. Each protective device curve shall be terminated at a point reflecting maximum symmetrical or asymmetrical fault current through the device.
m. Identify the device associated with each curve by manufacturer type, function, and setting – i.e. tap, time delay, and instantaneous, pickup, etc.
n. Primary Protective Device Settings for Delta-Wye Connected Transformer:
    1) Secondary Line-To-Ground Fault Protection: Provide primary protective device operating band within the transformer's characteristics curve, including a point equal to 58 percent of ANSI C57.12.00 withstand point.
    2) Secondary Line-To-Line Faults: Provide 16 percent current margin between primary protective device and associated secondary device characteristic curves.

G. A setting table shall be developed to summarize the settings selected/existing for the protective devices. The table shall include the following:
    1. Device identification.
    2. For low voltage breakers, the circuit breaker manufacturer, type, and style, sensor rating, long-time, short-time, instantaneous settings, and time bands. For breakers with ground fault capability, the pickup and time delay.
    3. Fuse manufacturer, type, style, and rating.
    4. Protective relay manufacturer, type, style, function (51, 50, 67, etc.) pickup, current multiplier, time dial, and delay. For multi-function units, list all devices being used. Include the CT and/or PT ratios for each function.

H. The software shall provide complete integration of the one-line, database, short circuit, protective device coordination and arc flash analysis functions to provide accurate calculations and avoid errors and inefficiencies associated with multiple data entry programs. Programs using separate PDC or TCC plotting packages are not allowed. Complete PDC integration is defined as the following:

1. TCC's shall be developed by simply selecting (highlighting) with the mouse the one-line area to be coordinated. The TCC shall automatically be plotted for the selected area including all short circuit levels. The TCC plot shall automatically include the selected one-line area in a drag and drop window on the TCC showing all one-line attributes without user additions required. These attributes shall automatically include all short circuit currents and voltages displayed on the main one-line, equipment names, etc. and update automatically without additional user input.
2. Programs requiring the user to build a separate TCC one-line are not integral with system short circuit calculations and do not automatically update as the system one-line changes, requiring additional man-hours for one-line development and are consequently prone to errors as the system changes. These types of programs shall not be considered for the study.
3. Each TCC shall have momentary (1/2 cycle), interrupting (1-4 cycle), and 30 cycle short circuit currents (tick marks) displayed on the TCC plot for each protective device or as required to properly model the tripping characteristics of the device. The tick marks shall be user adjustable for visual appearance. The purpose is to provide accurate tripping currents for each device.
4. The software model shall allow each protective device to model momentary (1/2 cycle), interrupting (1-4 cycle), and 30 cycle short circuit currents simultaneously depending on the characteristics of the device.
5. The software shall model remote voltages and currents for any single fault and display them on the TCC showing all trip cutoffs based on the remote currents. The purpose is to accurately model and verify backup relaying to ensure selective operation under all fault conditions. PDC programs that perform only batch faults, or fail to model remote voltages and currents for all fault types shall not be considered.
6. The software shall model and display time difference calculations for any selected pair of protective devices. The difference calculator shall include bracketing bars with the calculated difference to clearly show the selective time between the devices. The calculated time shall update dynamically for instant visual setting as the devices are dragged (settings modified). In addition, tool tips shall clearly show the time difference and the protective device settings for all devices as they are dynamically changed or set to allow the user to accurately determine the proper setting between devices in the most efficient manner, reducing coordination time and providing more accurate results.
7. The software model shall provide for WYSIWYG drag and drop modeling of all protective devices and provide for tool tips and notes to display all settings dynamically. The purpose is to provide accurate adjustments and settings in the most time efficient and accurate manner.
8. TCC's shall have the ability to display short circuit currents and arc flash hazard results within the fully integrated system one-line in the PDC focus. Short circuit currents are available at any equipment with a single mouse click. Short circuit currents and arc flash hazard values shall change on the fly as the protective device settings change, allowing the user to instantly see the results of PDC changes and the associated impact to short circuit currents and arc flash hazard values.
9. The software model shall provide a detailed library for the most common protective devices available in North America. The library shall be user definable.

2.8 ARC FLASH STUDY

A. A detailed arc flash study shall be performed to determine potential arc flash incident energies, arc flash boundaries, shock hazard boundaries and proper personal protective equipment (PPE) for all energized electrical system equipment tasks for the electrical system studied. The calculations shall comply with NFPA-70E 2004, and IEEE-1584. Bolted short circuit calculations used in the above standards shall comply with ANSI C37.010, C37.13, C37.5, IEEE-141, and IEEE-399. The purpose of this study is to determine arc flash hazards in conformance with NFPA-70E and to facilitate a safety program for the OWNER, and to provide a comprehensive software model of the electrical distribution system, which provides integral work permits and arc flash calculations in compliance with NFPA 70E Article 130.1(A)(2) for all equipment in the facility. The software program used in this study shall comply with the above standards. No substitutions in calculation methods will be allowed.

B. The arc flash study shall determine the following results for each system mode of operation. The results shall be provided in spreadsheet format for each mode and electrical system location to provide easy viewing and comparison. Worst-case arc flash energy levels shall be flagged and the spreadsheet comparison table shall be capable of providing its output directly to high quality vinyl label printers. The calculations shall, as a minimum, include a comparison of both 100% and 85% arcing currents for low voltage equipment for each electrical system configuration or operating mode, indicating worst-case arc flash hazards. The spreadsheet results shall include:
   1. Equipment name and voltage.
   2. Upstream equipment device name and ANSI function, i.e. 51/50, etc.
   3. Equipment type, i.e. switchgear, MCC, Panel, VFD, etc.
   4. Equipment arc gap.
   5. Bolted and estimated arcing fault current at the fault point (equipment) in symmetrical amperes. The estimated arcing current should be based on the arcing current equations used.
   6. Trip time, opening time, and total clearing time (total Arc time) of the protective device.
   7. Worst-case arc flash boundary for each bus/equipment in the model.
   8. Worst-case arc flash hazard incident energy in cal/cm^2 for each bus/equipment in the model.
   9. Worst-case personal protective equipment (PPE) for each bus/equipment in the model.
   10. Working distances for up to five different distances showing items 7, 8, and 9 for each distance.
   11. Indicate “Danger/Hazardous” areas where incident energy is greater than 40 cal/cm^2 and provide recommendations to reduced arc flash energy levels for these areas.
   12. Flag results where 85% arcing current provided worst-case results.

C. Each mode of operation shall include a detailed write-up indicating areas where incident energy calculations and PPE requirements are higher than calculated in the normal operating mode.

D. Consultant/contractor shall provide a detailed arc flash analysis report including as a minimum:
   1. Introduction.
   2. Methodology.

3. Information Sources.
4. Key Assumptions.
5. Arc Flash Energy and other consideration for various System Modes of Operation (maintenance mode, bus-tie, co-gen on/off, etc.).
6. Arc Energy at 100% and reduced currents.
7. IEEE 1584-2002 Considerations.
8. Overcurrent Protective Device Changes, Replacements or Setting Changes implemented in study to reduce arc flash hazard exposure.
9. Explanation of Data in Arc Flash Hazard Report Tables.
10. NFPA 70E Information.
    a. Shock Hazards with covers removed.
    b. Shock Hazard Approach Boundaries.
        1) Limited Approach Boundary.
        2) Restricted Approach Boundary.
        3) Prohibited Approach Boundary.
    c. Arc Flash Hazard Boundaries.
11. Results of Arc flash Hazard Analysis for high voltage, medium voltage and low voltage systems, including:
    a. Working distances.
    b. Energy Levels.
    c. PPE Requirements.
    d. Recommendations to reduce arc flash hazard energy and exposure.
12. Arc Flash Hazard Report.
    a. 5 Hard Copies.
    b. 1 Electronic Copy in Adobe Acrobat format (5.0 or later).
13. Electronic file for Power System Modeling Software as developed and utilized for this analysis.

E. The CONTRACTOR shall provide printed labels for labels for all equipment in the system from the project study file. Assume three (3) labels per equipment/bus in your estimate using 4” x 6” labels or one (1) 6” x 8” label per equipment bus. The labels shall be UV resistant vinyl labels (white with orange warning strip and black letters) conforming to ANSI-Z535. The labels shall be printable directly from the power system software utilized for the study with a Duralabel, Brady PowerMark or GlobalMark printer to ensure that the OWNER’s personnel have the option of printing the labels without the extra expense of going to an outside printing service, converting arc flash results to spreadsheet format or performing tedious manual data entry.

F. Software Requirements: The software shall provide complete integration of the one-line, database, short circuit, PDC and Arc flash functions. Software using separate short circuit, PDC, TCC or arc flash programs is not allowed. Spreadsheet calculations are not allowed. The purpose of this section is to ensure that the arc flash hazard calculations comply with NFPA-70E and IEEE-1584, and that the calculations are programmed with necessary requirements to help eliminate possible errors in the arc flash calculations. The additional purpose is to establish a detailed software model of the XYZ Corporation – Abc Facility electrical distribution system, which will document compliance with the OSHA requirements and NFPA 70E mandates. This model will serve as an integral part of the OWNER’s safety program by providing integral work permits and arc flash calculations in compliance with NFPA-70E Article 130.1(A)(2) for each electrical equipment in the facility.

1. Arc flash calculations shall be performed with enhanced IEEE-1584 equations, which eliminate voltage discontinuities and the non-conservative/average results of the standard equations. The purpose of this requirement is to ensure that the calculated incident energies are closer to actual test results insuring a conservative calculation minimizing personnel risk.
2. Arc flash calculations shall be based on the fastest clearing upstream protective device protecting the equipment for single sources and the slowest upstream protective device for multiple sources. The calculations shall automatically compare all series and parallel upstream protective devices in the system to determine the fastest series device or a conservative parallel clearing time. The algorithm shall incorporate a traversing routine that can search back an unlimited number of buses/nodes and consider all series and parallel branches in the comparison to ensure accurate answers and to prevent hazards associated with incorrect results. Software shall not have trace back limits (5-10 buses) that can provide incorrect answers for low voltage faults that require high voltage protective device clearing to prevent potential errors.
3. The arc flash calculations including arc flash boundary, incident energy, PPE requirements, and working distance shall be displayed on the software one-line diagram and TCC simultaneously. The software must show visually the arc flash values as the settings are incrementally changed (dragging curves) so the protection can be optimized in the most efficient manner, allowing the protection engineer to visually balance the competing objectives of personnel protection with that of system selectivity.
4. The arc flash calculations shall include four (4) calculation options to ensure that the software provides the flexibility required to meet any system configuration or training requirement that may be considered. Each calculation option shall comply with the graphic and spreadsheet display requirements of this section. Each option is more specifically described below.
    a. The detailed option shall provide the let-through energy for each protective device in the system. This is the energy on the load side of the protective device. The equipment shall be highlighted when the let-through energy exceeds a user defined threshold-clothing limit.
    b. Worst-case including main protective device. This option shall provide the worst-case arc-hazard energy for the equipment based on the let-through energy of the equipment's main protective device. If the equipment is not equipped with a main device, the program must traverse back the entire system to determine the fastest series upstream protective device. The equipment shall be highlighted when the let-through energy exceeds a user defined threshold-clothing limit.
    c. Worst-case excluding main protective device. This option shall provide the worst-case arc-hazard energy for the equipment based on the let-through energy of the fastest upstream series protective device in the system. The program shall traverse back the entire system to determine the fastest upstream protective device. The equipment shall be highlighted when the let-through energy exceeds a user defined threshold-clothing limit.
    d. Worst-case excluding and including the main protective device. A combination of options 'b' and 'c' as stated above.

5. The arc flash calculations shall provide integral “Work Tasks” for the listed equipment types. The tasks shall be derived from 70E Table 130.7(C)(9)(a) and be specific to the equipment type. Work tasks shall be user definable in the software to allow customization and integral with the “Work Permit” feature of the software. Listed equipment types shall include:
    a. Switchgear, Switchboards, Panelboards, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 100-200 volt equipment.
    b. Switchgear, Switchboards, Panelboards, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 200-1000 volt equipment.
    c. Switchgear, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 1.0-5.0 kV equipment.
    d. Switchgear, MCC, VFD, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 5.0-15.0 kV equipment.
    e. Switchgear, Interrupting Switch, Conductor, Open Air for 15.0-38.0 kV equipment.
    f. Interrupting Switch, Conductor, and Open Air for 38.0-1500 kV equipment.
6. Work Tasks shall have a user-defined library that provides the following customizable features for each work task:
    a. Work Tasks for each specific equipment type and voltage range.
    b. Working distance units English or Metric.
    c. Work distance for each task.
    d. V-rated gloves and tool requirements.
    e. Job description and procedures.
    f. Safe work practices description.
    g. Hazard Risk Category (HRC) reduction. *Note: HRC reduction can only be used based on a documented risk assessment as an integral part of a safety program.
7. Work tasks shall be accessible from the one-line diagram for any equipment through a mouse click on the equipment in the electrical system model one-line. A dialog box shall appear listing all 70E and user definable work tasks for the specific equipment selected. The work task dialog shall include a user definable working distance for each work task and allow the user to select tasks specific to any equipment feeder or the incoming main. Work tasks for each equipment type shall be voltage specific and user definable in the library. The purpose of these requirements is to integrate 70E work tasks to the one-line diagram for specific equipment types. This will provide the basis for a customized safety program and work permit process compliant with 70E mandates. The level of detailed requirements for the “work task” software is necessary to ensure that any variation of equipment type, equipment layout, or work procedure can be handled and documented in the software.
    a. The software interface shall allow the user to select any breaker fuse or switch on the one-line, and get a specific work task generated for that device showing the load side arc flash hazard (let-through energy) for that device. The purpose of this requirement is to detail specific feeder hazards when work tasks dictate working downstream from a feeder protective device.
    b. The arc flash calculations shall provide integral work permits for compliance with NFPA-70E, 2004 Article 130.1 (A). The work permits shall be integral with the system one-line diagram and the arc flash calculations and shall detect and account for work between feeder and main breaker.

8. Work permits shall be activated by mouse click, for all equipment types listed in K5. Work permits shall have the following calculated values and provide the following information specific to the “work task” and equipment selected:
    a. Shock hazard.
    b. Shock hazard boundaries.
    c. Arc flash boundary – worst-case for each equipment.
    d. Arc flash hazard incident energy in cal/cm2 for the equipment.
    e. Hazard Risk Category (HRC) and any applicable risk reduction.
    f. Required PPE category based on calculated energy level and optional risk reduction.
    g. Required PPE description based on PPE category.
    h. Determination of V-rated gloves and tools.
    i. Auto fill job description and procedures for each work task.
    j. Auto fill safe work practices description for each work task.
    k. Job briefing and planning check list.
    l. Approval sign off section.
    m. Working distance measurements in English or Metric units.
    n. Required work distance for each task.
    o. Documentation for safety program in compliance with 70E 130.1(A).
9. The work permits shall be created by the software in MS Word and have the following user customizable features:
    a. Work Tasks for each specific equipment type and voltage range.
    b. Restricted shock boundary.
    c. Arc flash boundary – worst-case for each equipment.
    d. Arc flash hazard incident energy in cal/cm2 for the equipment.
    e. Hazard Risk Category (HRC) reduction for low risk tasks.
    f. Required PPE category based on risk reduction.
    g. Working distance in English or Metric units.
    h. Working distance for each task.
    i. V-rated gloves and tool requirements.
    j. Flame Resistant clothing requirements.
    k. Job description and procedures for each work task.
    l. Safe work practices description for each work task.
    m. Job briefing and planning check list.
    n. Approval sign off section.
10. The power system software shall allow the created work permits to be linked via Windows “hyperlinks” to each equipment on the one-line diagram. The purpose is to provide a data repository of work permits performed on each equipment for 70E review, as well as providing a one-stop location where documents pertaining to the equipment can be accessed by maintenance and job planning.
11. The power system software shall be fully compatible with facility arc flash hazard and electrical safety implementation software that provides the following capabilities:
    a. Calculates shock hazards, shock hazard boundaries, arc flash boundaries, incident energies, PPE requirements, etc. for power systems modeled in EasyPower or EasyPower EasySolv.

b. Built in Work Permit Feature for creation of custom Energized Work Permits complying with the NFPA-70E requirements. Work permit feature shall include NFPA risk assessment categories based on the task performed for all types of electrical equipment and voltage ranges. The work permit feature shall include an extensive library of user definable work tasks, safety procedures and safe work practices, saving XYZ Corporation – Abc Facility plant engineering staff, maintenance staff and contractors hours of productive time.
c. Energized work permits, safety procedures, equipment instruction manuals, etc., shall be capable of being directly linked to the equipment one-line through a Hyperlinks feature, providing a one-stop data repository easily accessible to all plant and safety personnel, saving plant personnel and contractors significant productive time in locating the right instruction manual, equipment safety procedure, drawing, pictures and maps for the equipment. This feature shall also help XYZ Corporation – Abc Facility comply with OSHA and NFPA 70E record keeping requirements.
d. Additional equipment information and records such as Maintenance Records, Maintenance Manuals, Operations Manuals, Lock out / Tag out procedures, etc. shall also be capable of being Hyperlinked to the equipment on the graphical one-line.
e. Program shall support creation of arc flash labels with direct output to high quality UV resistant vinyl label printers.
f. Program shall also have customizable output. Includes one-line printing, text report creation, export to AutoCAD, etc.
g. Program shall be a Windows based operating system and shall use Windows conventions.
h. Program shall be capable of being installed on stand alone personal computers or on networked systems.
i. Program shall be easily operable by the OWNER's staff without any specialized training.

12. The software shall be licensed to the OWNER and the original software package will be delivered at project completion.

2.9 REPORTING AND ANALYSIS SUMMARY

A. Executive Summary: The executive summary shall be brief 1-2 pages maximum and cover at an executive level the findings of the study, recommendations, and requirements for maintaining NFPA-70E compliance.

B. Scope of studies performed: The scope shall provide details of what actions were intended to be performed for each aspect of the study, including short circuit, protective device coordination, and arc flash.

C. Description of system and explanation of bus and branch numbering system.

D. Modes of operation studied: Each scenario/plant operating condition shall be thoroughly documented.

E. Detailed report and results of short circuit, coordination, and arc flash studies including:
   1. Recommendations and additions to equipment rating and/or PDC characteristics.
   2. Recommendations to reduce arc flash hazards for equipment with incident energies over 40 cal/cm^2.

F. Prioritized recommendations for all studies.

G. Action list and check off column for all recommendations.

2.10 QUALITY ASSURANCE

A. The studies shall be in conformance with the NFPA and ANSI Standards, and IEEE recommended practices detailed in this section. No substitutions in study methods or software conformance will be allowed.

END OF SECTION

SECTION 26 05 09 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

1. Nameplates.
2. Labels.
3. Wire and cable markers.
4. Conduit markers.

1.2 APPLICABLE SECTIONS:

A. Section 26 05 00 - Electrical General Requirements.

1.3 SUBMITTALS:

A. Submit product literature including manufacturer name, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

PART 2 - PRODUCTS

2.1 NAMEPLATES:

A. Nameplates: Engraved three-layer laminated plastic, black letters on white background.

B. Locations:

1. Each electrical distribution and control equipment enclosure.
2. Communication cabinets.
3. Each junction box.

C. Letter Size:

1. 1/8" letters for identifying individual equipment and loads.
2. 1/4" letters for identifying grouped equipment and loads.

D. Identify control device stations, motor control equipment, process equipment and instrumentation equipment. All such devices shall be labeled with equipment served, identifying name, and circuit number with panel.

2.2 WIRE MARKERS:

A. Manufacturers:

1. 3M
2. Thomas & Betts
3. Panduit

B. Description: Heat shrink tubing, imprinted, type wire markers.

C. Locations: Each conductor at panel-board gutters, pull boxes, outlet and junction boxes, and each load connection, PLC panels, instrument panels, instruments, MCC's, etc.

D. Legend:

1. Power and Lighting Circuits: Branch circuit or feeder number shall be indicated on project Record Drawings.

E. Control Circuits: Control wire number shall be indicated on schematic and interconnection diagrams.

F. Data Wiring: Address number shall be indicated on each end of conductor on the face of the outlet cover, and on the space of the patch panel.

G. All conductor numbers and terminal block numbers shall be reflected on the CONTRACTOR submitted Record Drawings.

2.3 CONDUIT MARKERS:

A. Manufacturers:

1. Tech Products
2. Thomas & Betts
3. Panduit

B. Description: 3/16" poly tag in poly tag holder. Tie wrapped to conduit.

C. Location: Furnish markers for each conduit longer than 6 feet.

D. Spacing: Label at each junction and terminal end.

E. Legend: Number as indicated in contractor prepared Record Drawings.

2.4 UNDERGROUND WARNING TAPE:

A. Description: 4" wide detectable plastic tape, colored red with suitable warning legend describing buried electrical lines.

B. Location: Along length of each underground conduit, 12" above conduit.

2.5 LABELS:

A. Self adhesive, plastic coated, machine printed.

B. Manufacturer: Brother or equal.

C. Locations:

1. Convenience outlet circuit adhered to outlet faceplate showing panel and circuit number.
2. Data address number to outlet faceplate and patch panel face plate.
3. Light switches, indicating lighting switched panel and circuit number.
4. Process wiring indicating connection point terminal block and cabinet.

PART 3 - EXECUTION

3.1 PREPARATION:

A. De-grease and clean surfaces to receive nameplates and labels.

3.2 INSTALLATION:

A. Install nameplate and label parallel to equipment lines.

B. Secure nameplate to equipment front using screws.

C. Secure nameplate to inside surface of door on panel-board that is recessed in finished locations.

D. Identify each conduit at each end.

E. Identify underground conduits using one underground warning tape per trench at 12" above conduit.

END OF SECTION

SECTION 26 05 19 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install conductors and cables as required, and as shown on the Drawings. Materials employed shall be as indicated on the Drawings and specified herein.

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

B. Shop Drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work. Show proposed routing of conduits buried under floor slabs-on-grade, conduit and rebar embedded in floor slabs, columns, etc. Identify conduit by tag number of equipment served and by conduit schedule number.

1.3 QUALITY ASSURANCE

A. MANUFACTURERS: Firms regularly engaged in manufacture of conduits and raceway systems of type and sizes required, whose products have been in satisfactory use in similar service for not less than (3) years.

B. STANDARDS: Comply with applicable portions of the NEMA standards pertaining to raceways. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL listed and labeled. Comply with NEC requirements as applicable to construction of raceway systems.

1.4 APPLICABLE SECTIONS

A. Section 26 05 00: Electrical General Requirements.

B. Section 26 05 08: Electrical Acceptance Tests

PART 2 - PRODUCTS

2.1 COMPONENTS

A. 600 Voltage Conductors:

1. Copper with AWG sizes as shown or required:

a. Minimum size shall be No. 12 except where specified otherwise.

b. Conductors shall be stranded.

1) Insulation:

a) Conductor Size No. 2 And Smaller: 600V type XHHW (75° C). All conductors run in underground conduits shall be XHHW.

b) Conductor Size No. 1 And Larger: 600V Type XHHW-2 (90° C).

2) Colors:

a) 120/240 V System

(1) Black: Line 1.

(2) Red: Line 2.

(3) Green: Ground.

(4) White: Neutral.

b) 208Y / 120 V System:

(1) Black: Phase A.

(2) Red: Phase B.

(3) Blue: Phase C.

(4) Green: Ground.

(5) White: Neutral.

c) 480Y / 277 Volt System:

(1) Brown: Phase A.

(2) Orange: Phase B.

(3) Yellow: Phase C.

(4) Neutral: Gray.

(5) Ground: Green.

d) Conductors size No. 10 and smaller shall be colored full length. Tagging or other methods for coding of conductors size No. 10 and smaller not allowed.

e) For feeder conductors larger than No. 10 at pull boxes, gutters, and panels, use taped band or color tag color-coded as specified above.

B. Instrumentation Cables:

1. Instrument cable shall be Type TC, and have the number of individually shielded twisted pairs indicated on the Drawings and shall be insulated for not less than 600 volts. Unless otherwise indicated, conductor size shall be No. 16 AWG minimum. Shielded, grounded instrumentation cable shall be used for all analog and low voltage digital signals.

2. The jacket shall be flame retardant with 90 degrees C temperature rating. The cable shield shall be a minimum of 2.3 mil aluminum or copper tape overlapped to provide 100 percent coverage and a tinned copper drain wire.

3. The conductors shall be bare soft annealed copper, Class B, 7 strand minimum concentric lay with 15 mils nominal thickness, nylon jacket, 4 mil nominal thickness, 90 degrees C temperature rating. One conductor within each pair shall be numerically identified.

4. Pairs shall be assembled with a nominal 2-inch lay and shall then be group shielded with a minimum of 1.3 mil aluminum or copper tape overlapped to provide 100 percent coverage. All group shields shall be completely isolated from each other.

C. Control Wires:

1. Copper with AWG sizes as shown or required:

a. Minimum size shall be No. 14 except where specified otherwise.

b. Conductors shall be stranded.

1) Insulation:

a) 600V type XHHW (75° C). All conductors run in underground conduits shall be XHHW.

2. Control wires may be run in same conduits as instrumentation cables.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Conductors and cables shall be continuous from source to equipment.

2. Do not use direct burial cable.

3. Instrumentation and control wires shall be run in conduits separate from power conduits.

B. 600 Voltage Conductors:

1. Install conductors in raceway except where specifically indicated otherwise. Run conductors of different voltage systems in separate conduits. All raceways shall include an equipment ground conductor.

2. Route circuits at own discretion, however, circuiting shall be as indicated or required. Group circuit homeruns to panels as shown on Drawings. No other groupings of circuits will be allowed.

3. Neutrals:

a. On three-phase, 4-wire systems: Do not use common neutral for more than one three phase circuit.

b. On single-phase, 3-wire systems: Do not use common neutral for more than one circuit per phase.

c. Run separate neutrals for each circuit where specifically noted on Drawings.

d. Where common neutral is run for two or three home run circuits, connect phase conductors to breakers in panel which are attached to separate phase legs so neutral conductors will carry only unbalanced current. Neutral shall be sized at 200% of full load.

4. Pulling Conductors:

a. Do not pull conductors into conduit until raceway system is complete and enclosures, cabinets, and boxes are free of foreign matter and moisture.

b. Install conductors in accordance with the manufacture's requirements.

c. Use only listed non-hardening wire pulling lubricants.

5. Provide positive supports for conductors in vertical raceways at following spacing minimum, unless shorter is recommended by manufacturer.

a.	No. 18 to 1/0	100 feet.
b.	No. 2/0 to 4/0	80 feet.
c.	250MCM to 350MCM	60 feet.
d.	d. 350MCM to 500MCM	50 feet.

C. Feeder and branch circuits shall be isolated from each other, and from instrumentation and control circuits. Instrumentation cables shall be installed in separate raceways from other cables and wiring. This includes portions running through manholes. Instrumentation cable shall be continuous between instruments or between field devices and instrument enclosures. There shall be no intermediate splices or terminal boards, unless otherwise shown on the Drawings.

D. Maintain electrical continuity of the shield when splicing twisted shielded pair conductors. Drain wires shall be terminated inside enclosures at grounded terminal blocks. Only one end of each instrument loop cable drain wire shall be grounded. Ground drain wire of shielded conductors at one end only.

E. Terminate instrumentation and control wiring, including spare wires, at control panels and motor control centers on terminal boards mounted inside the equipment.

1. CONTRACTOR shall supply terminal boards as required.
2. Do not field wire directly to devices.

F. Low Voltage Cables In Office Spaces (70 Volts or Less):

1. In inaccessible, concealed spaces, run cables in raceway. In accessible, unfinished areas, cables may be run exposed without raceway.
2. Run exposed cables parallel to or at right angles to building structure lines. Do not run exposed cables on floors or in such a way that they obstruct access to, operation of, or servicing of equipment. Keep cables 6 inches minimum from hot water pipes.

a. Support cables every 3 feet with permanent clips, straps, staples, or tie wraps approved for application and which will not cause cables to be pinched or deformed.

b. Securely attach clips and straps with nails or screws. Do not use wire or tape to support cables.

3. Bundle only cables of same systems together.

END OF SECTION

SECTION 26 05 22 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install wiring devices as required, and as shown on the Drawings. Materials employed shall be as indicated on the Drawings and specified herein.

1.2 SUBMITTALS

A. Submit product literature including manufacturer, model or part number, materials of construction, size, ratings, and listings as a minimum.

1.3 QUALITY ASSURANCE

A. NECA - Standard of Installation.

B. NEMA WD 1 - General Requirements for Wiring Devices.

C. NEMA WD 6 - Wiring Device -Dimensional Requirements.

D. NFPA 70 - National Electrical Code.

E. UL - Underwriters Laboratories, Inc.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers:
   1. Hubbell, Model HBL-1221, 1223, 1224 series.
   2. Arrow Hart, Model 1991.

B. Description: NEMA WD 1, Heavy-Duty Specification Grade AC only general-use snap switch.

C. Body and Handle: Gray plastic with toggle handle.

D. Indicator Light: Lighted handle type switch red color handle.

E. Locator Light: Lighted handle type switch; red color handle.

F. Ratings:
   1. Voltage: 120-277 volts, AC.
   2. Current: 20 amperes.

2.2 RECEPTACLES

A. Manufacturers:
   1. Hubbell, Model HBL 5362-SP.
   2. Arrow Hart, Model 5362-CR.

B. Description: NEMA WD 1, Heavy-duty specification grade general use receptacle.

C. Device Body: Gray plastic.

D. Configuration: NEMA WD 6, type as specified and indicated.

E. Convenience Receptacle: Type 5-20.

F. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

2.3 WALL PLATES

A. Decorative Cover Plate: Brushed stainless steel in electrical/control/blower rooms.

B. Process Room/Exterior Cover Plate: Gasketed cast metal with hinged gasketed device cover. Lever type switch cover. Classified hazardous as required for process areas per drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that outlet or device boxes are installed at proper height.

B. Verify that wall openings are neatly cut and will be completely covered by wall plates.

C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install in accordance with NECA "Standard of Installation."

B. Install devices plumb and level.

C. Install switches with OFF position down.

D. Install receptacles with grounding pole on bottom.

E. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.

F. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

G. Connect wiring devices by wrapping conductor around screw terminal.

H. Use jumbo size plates for outlets installed in masonry walls.

I. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Install wall switch 48 inches above finished floor.

B. Install convenience receptacle 18 inches above finished floor unless otherwise indicated.

C. Install convenience receptacle 6 inches above back-splash of counter.

D. Install dimmer 48 inches above finished floor.

E. Install telephone jack 18 inches above finished floor.

F. Install telephone jack for side-reach wall telephone to position top of telephone at 54 inches above finished floor.

G. Install telephone jack for forward-reach wall telephone to position top of telephone at 48 inches above finished floor.

3.5 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

F. Verify that each telephone jack is properly connected and circuit is operational.

3.6 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.7 CLEANING

A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

SECTION 26 05 24 - EQUIPMENT WIRING

PART 1 - GENERAL

1.1 SCOPE

Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

A. This section includes wiring connections to equipment specified in other sections.

B. Electrical connections to equipment: Provide the materials and make the electrical connections to all equipment having electrical requirements as indicated in the architectural and/or mechanical section of the specifications and drawings.

C. Provide conduit, wiring, connect motors and other mechanical equipment and electrical devices in other sections; also install, provide, support for, and connect starters, other control devices, control panels, furnished for such motors and equipment; complete all circuit leave in satisfactory operating conditions.

D. Provide control devices for equipment in addition to those furnished by the trades providing such equipment; refer to schedules on electrical and mechanical drawings for control devices to be furnished under scope of the electrical work.

E. Control devices and panels furnished by trades providing equipment will be delivered to electrician at site of project; acknowledge acceptance in writing; assume responsibility for particular installation before proceeding with installing and wiring them. Follow each manufacturer's printed installation directions and wiring diagrams for installing and making connections to his equipment and controls.

F. Consult contract drawings and specifications of trades providing equipment and controls, for control wiring diagrams, also refer to their shop drawings in order to become familiar with equipment type and operation of controls, their locations and extent of work required for installing, wiring and connecting them.

G. Starters for all motors requiring same shall be furnished by electrical contractor.

1.2 APPLICABLE SECTIONS

The General Conditions, Supplementary Conditions, Special Conditions, alternates, and addenda, applicable drawings, and the specifications including but not limited to the following:

A. Section 26 05 00 - Electrical General Requirements.

1.3 REFERENCES

A. Section 01 50 00 - Quality Control:

B. NEMA WD 1 - General Purpose Wiring Devices.

C. NEMA WD 6 - Wiring Devices - Dimensional Requirements.

D. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

A. Section 01 30 00 – Submittals: General.

B. Section 26 05 00 - Submittals: Procedures for submittals.

C. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

1.5 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.6 COORDINATION

A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.

B. Determine connection locations and requirements.

C. Sequence rough-in of electrical connections to coordinate with installation of equipment.

D. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 - PRODUCTS

2.1 CORDS AND CAPS

A. Manufacturers:
   1. Hubbell.
   2. Or equal.

B. Attachment Plug Construction: Conform to NEMA WD 1.

C. Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.

D. Cord Construction: NFPA 70, Type SJO multi-conductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

E. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit over-current protection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energizing

3.2 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

SECTION 26 05 26 – GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

1. Grounding electrodes and conductors.
2. Equipment grounding conductors.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following:

1. Section 26 05 00 - Electrical General Requirements.

1.3 REFERENCES

A. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association).

B. NFPA 70 - National Electrical Code.

1.4 GROUNDING SYSTEM DESCRIPTION

A. Metal underground water pipe.

B. Metal frame of the building.

C. Concrete-encased electrode.

D. Rod electrode.

E. Plate electrode.

F. Active electrode.

1.5 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 25 ohms maximum.

1.6 SUBMITTALS FOR REVIEW

A. Section 01 30 00 – Submittals: General.

B. Section 26 05 00 - Submittals: Procedures for submittals.

C. Product Data: Provide for grounding and bonding equipment.

D. All submittals shall include a list of all items being submitted by description, manufacturer and catalog number.

1.7 SUBMITTALS FOR CLOSEOUT

A. Section 26 05 05 - Operation and Maintenance Manuals.

B. Project Record Documents: Record actual locations of components and grounding electrodes.

C. Certificate of Compliance: Indicate approval of installation by the authority having jurisdiction.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 5 years documented experience.

1.9 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 ROD ELECTRODES

A. Material: Copper Clad Steel.

B. Diameter: ¾ inch.

C. Length: 10 feet (3000 mm).

2.2 CONNECTORS

A. Manufacturers:
   1. T&B
   2. Burndy - Hi-Ground
   3. ERICO® - Cadweld®

B. Material: Irreversible Crimp Style or Exothermic Weld.

2.3 WIRE

A. Material: Stranded copper, tinned.

B. Grounding Electrode Conductor: Size as indicated in the Drawings, or if modified or not indicated, size to meet NFPA 70 requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

A. Install electrodes at locations indicated and in accordance with manufacturer's instructions. Install additional rod electrodes as required to achieve specified resistance to ground.

B. Provide grounding electrode conductor (UFER) and connect to reinforcing steel in foundation footing. Bond steel together.

C. Provide bonding to meet Regulatory Requirements.

3.3 FIELD QUALITY CONTROL

A. Perform inspections and tests listed in NFPA ATS, Section 7.13.

END OF SECTION

SECTION 26 05 30 - CONDUIT

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install conduits and raceway systems as required, and as shown on the Drawings. Materials employed shall be as indicated on the Drawings and specified herein.

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

B. Shop Drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work. Show proposed routing of conduits buried under floor slabs-on-grade, conduit and rebar embedded in floor slabs, columns, etc. Identify conduit by tag number of equipment served and by conduit schedule number.

C. Proposed location and details of construction for openings in slabs and walls for conduit runs.

1.3 QUALITY ASSURANCE

A. MANUFACTURERS: Firms regularly engaged in manufacture of conduits and raceway systems of type and sizes required, whose products have been in satisfactory use in similar service for not less than (3) years.

B. STANDARDS: Comply with applicable portions of the NEMA standards pertaining to raceways. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL listed and labeled. Comply with NEC requirements as applicable to construction of raceway systems.

1.4 PROJECT/SITE CONDITIONS

A. GENERAL:

1. Unless otherwise specified, equipment and materials shall be sized and derated for ambient site conditions, but in no case less than an ambient temperature of 40 degrees C at an elevation ranging from seal level to 4,300 feet without exceeding the manufacturer’s stated tolerances.

B. AREA CLASSIFICATIONS

1. For the purpose of delineating the basic electrical construction materials and installation requirements for this project, areas of the project have been classified on the contract drawings as defined below. Electrical work within these areas shall conform to the requirements described below as well as the referenced code requirements.

a. General Purpose (NEMA 1): Areas requiring general purpose (NEMA 1) construction are indoor areas typically architecturally finished, always dry, and occupied by plant personnel.

b. Corrosive Process Areas (NEMA 4X): Areas requiring corrosion resistant (NEMA 4X) construction. Corrosive process areas typically contain pumping or piping systems and are subject to spills and washdown. Corrosive process areas shall also include those areas containing corrosive chemicals.

c. Outdoor Areas (NEMA 3R): Areas outdoors require weather resistant (NEMA 3R) rating.

d. Hazardous Areas (NEMA 7): Unless otherwise indicated on the contract drawings, areas requiring hazardous location (NEMA 7) construction are classified as Class 1, Division 2 or Class1, Division 1 hazardous locations per Articles 500 and 501 of the National Electrical Code. See classification drawings.

e. Process Areas (NEMA 12): Areas requiring drip-proof (NEMA 12) construction are indoor process and support system areas and are not typically subject to spills, direct washdown, or corrosive chemicals under normal operating conditions, but may experience occasional or unintended wetness.

C. CONSTRUCTION MATERIALS:

1. Construction materials required for each area classification are listed in table A below. Refer to the individual specification section for each component for material composition and installation practices.

	Area Classification				
Component	NEMA 1	NEMA 3R[1] Outdoor	NEMA 4X[1] Indoor Corrosive	NEMA 12[1]	NEMA 7 Classified Explosion Proof/Process Area
Conduit (exposed)	GRS	RA PGRS	RA PGRS	RA PGRS	PGRS
Conduit (concealed)[4]	EMT[3]	PGRS GRS	RA	GRS	GRS
Flexible conduit[5]	LFS	LFS	LFN	LFN	Classified
Support systems	Galvanized Steel	Aluminum	Stainless steel	Aluminum	Stainless steel

Fastening hardware and hanger rods	Cadmium plated steel	Stainless steel	Stainless steel	Cadmium plated steel	Stainless steel
Control Stations[2,6]	Painted Steel	Non-Metallic	Non-Metallic	Painted Steel	Classified
Enclosures[2,6]	Painted Steel	Non-Metallic	Non-Metallic	Painted Steel	Classified
Receptacles[2] Surface Recessed	General General	WP[8] WP[8]	WP[8] N/A	WP[8] WP[8]	Classified N/A
Switches[2] Surface Recessed	General General	WP[8] WP[8]	WP[8] N/A	WP[8] WP[8]	Classified N/A

Notes:

1. Enclosures, device boxes, control stations and raceway systems shall be mounted with ¼-inch (minimum) space between the electrical system and supporting structure.
2. Conduit terminations to control stations, enclosures, and device boxes in NEMA 3R, 4X, 7 and 12 areas shall be made through threaded hubs.
3. Rigid conduit concealed in framed walls, block walls and ceiling spaces shall be electrical metallic tubing, type EMT.
4. Conduit ductbank or beneath slab on grade shall be rigid PVC-40 conduit, without pullboxes, and with waterproof conduit splices beneath grade to limit water penetration.
5. Flexible conduit shall be utilized for final connections to equipment.
6. Control station and enclosure sealing ratings shall meet or exceed the rating designated by the area classification.
7. Exposed conduit systems in areas containing equipment handling Ferric Chloride shall be PGRS.
8. Use gasketed lever type switches and up-in use red dot steel receptacle covers.

Legend:

EMT	Electrical Metallic Tubing
GRS	Galvanized Rigid Steel
LFS	Liquid Tight Flexible Steel
LFN	Liquid Tight Flexible Non-Metallic
PGRS	PVC Coated Galvanized Rigid Steel
PVC4	PVC Schedule 40

PVC8	PVC Schedule 80
RA	Rigid Aluminum
WP	Weatherproof – Use cast device boxes with threaded hubs
XP	Explosion proof – Approved conduit systems per classification listing
N/A	Non applicable

PART 2 - PRODUCTS

2.1 CONDUIT AND TUBING

A. GENERAL: Provide conduit and fittings of types, grades, sizes and weights (wall thicknesses) as indicated; with minimum trade size of 3/4".

B. ELECTRICAL METALLIC TUBING (EMT):

1. Per UL "Standard for Electrical Metallic Tubing" No. 797. Galvanized mild steel with interior coat of enamel.
2. Fitting shall be steel, compression type. Cast type or indenter type fittings are not acceptable.
3. Approved for interior locations of the Electrical Room.

C. GALVANIZED RIGID METAL CONDUIT (GRC): FS WW-C-0581 and ANSI C80.1.

1. Per USAS C80.1, zinc-coated by hot-dip galvanizing or sherardizing with additional enamel or lacquer coating.
2. Couplings shall be threaded type of same material and finish as conduit. Connectors shall be Myers hubs or equal of same material and finish as conduit.
3. Approved Locations: Interior where exposed, where not exposed to moisture or corrosive atmosphere. Shall not be used in the pumping pit or the metering rooms.

D. POLY VINYL CHLORIDE PLASTIC PIPE (PVC), SCHEDULE 40, Based on Outside Diameter:

1. PVC heavy wall (PVC-40) suitable for direct burial. 1” minimum size.
2. Fittings shall be of same material as conduit. Water-tight splices required to limit water penetration. All elbows shall be PVC coated GRS
3. Approved for underground direct burial, May be used where buried in earth under floor slabs.
4. Minimum depth of bury under slab shall be 18 inches or of sufficient depth to allow for bending radius to rise out of the slab vertically. Shall have an exposed grounding electrode conductor in each trench.
5. Not approved for above grade installation nor for embedding in concrete slabs.

E. PVC COATED GALVANIZED RIGID METAL CONDUIT (PGRC): NEMA RN 1.

1. Rigid galvanized conduit, prior to plastic coating, shall conform to ANSI Standard C80.1, UL 6, and CSA Standard C22.2 #45.
2. Nominal thickness of exterior PVC coating shall be 40 mils. A two-part red urethane coating of 2 mil thickness shall be applied to the interior of all conduits and fittings.
3. All hollow conduit fittings which serve as part of the raceway system shall be coated with exterior PVC coating and red interior urethane coating as described above.
4. Coated conduit shall conform to NEMA Standard No. RN1-1989. Shall be "Plastic-Bond Red" as manufactured by Robroy Industries, Inc.
    a. Approved Locations: Shall be used in all locations where conduits are buried, in contact with earth, and in wet and corrosive areas, and as noted on the drawings. All buried conduit between VFDs and motors. All risers through concrete floors, all embedded conduit, and all elbows of ductbanks underground.
5. Taped GRC will not be permitted.

F. LIQUIDTIGHT FLEXIBLE METAL CONDUIT: UL 360.

1. Galvanized steel with an extruded liquidtight PVC cover that is moisture and oil-proof, and UV resistant.
2. Fittings shall be liquidtight compression type, listed for grounding. Provide fittings with external bonding jumper where required for bonding.
3. Approved for flexible connections to equipment subject to vibration such as motors, fan, pumps, dry transformers, etc., 36-inch maximum, 18" minimum length for each connection.

G. FLEXIBLE METAL CONDUIT: UL 1.

1. Galvanized steel.
2. Approved for flexible connections to equipment in unclassified areas of the Administration Building.

H. RIDGED ALUMINUM CONDUIT:

Couplings shall be threaded type of same material and finish as conduit. Connectors shall be Myers hubs or equal of same material and finish as conduit.
Approved Locations: Interior where exposed, on the exterior exposed to moisture or corrosive atmosphere. Approved for above grade installation. May be used within the process area of the plant.

I. CONDUIT BODIES:

1. Form 7 malleable iron with hot dip galvanized finish, PVC coated in wet or process areas of plant.
2. Gasketed cast iron, zinc plated cover with stainless steel screws.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL RACEWAYS

A. General Requirements: Unless otherwise indicated, wiring shall consist of insulated conductors installed in conduits or raceways.

3.2 CONDUIT AND TUBING SYSTEMS

A. Conduit and tubing systems shall be installed as indicated. Conduit sizes are based on the use of insulated, copper conductors. Minimum size of raceways shall be as noted. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or when required by conformance to NFPA 70. PVC coated rigid metal conduit will be used in damp, wet or corrosive locations and the conduit or tubing system will be provided with the appropriate boxes, covers, clamps, screws or other appropriate type of fittings. Any exposed threads or metal shall be touched up with 3 coats of touch up material provided with conduit. Raceways shall be kept 6" away from parallel runs of any mechanical piping. Raceways shall be concealed where possible. Raceways crossing structural expansion joints shall be provided with suitable expansion fittings and will provide continuity for grounding.

3.3 BELOW SLAB-ON-GRADE OR IN THE GROUND

A. All electrical wiring below slab-on-grade shall be protected by a conduit system. Conduit passing through slabs-on-grade shall be PVC coated rigid metal conduit. PVC conduits shall be installed below slab-on-grade or in the earth. All underground bends over 22º and risers through concrete slab shall be PVC coated GRC.

3.4 INSTALLED IN SLABS INCLUDING SLABS ON GRADE

A. Conduit shall not be embedded in concrete slabs except as specifically detailed.

3.5 EXPOSED RACEWAYS

A. Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Raceways under raised floors and above ceilings shall be considered as exposed installations.

3.6 CHANGES IN DIRECTION OF RUNS

A. Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field made bends and offsets shall be made with an approved hickey or conduit bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp or wet locations shall be avoided where possible. Care shall be taken to prevent the lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment during the course of construction. Clogged raceways shall be entirely freed from obstructions or shall be replaced.

3.7 SUPPORTS

A. Metallic conduits and tubing shall be securely and rigidly fastened in place at intervals of not more than 10' and within 3' of boxes, cabinets, enclosures, and fittings, with U-channel support systems, one hole conduit straps with clamp backs, and conduit hangers. All supports mounted in exterior, process, or exposed areas subject to corrosive atmosphere shall be stainless steel. Supports in other areas shall be hot dipped galvanized. C-clamps or beam clamps shall have strap or rod type retainers. Rigid plastic conduits (if permitted as wiring method) shall be supported as indicated above, except that they shall be supported at 3’-0” maximum on centers and as indicated in the NEC (NFPA 70). Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structures, but no load shall be applied to joist bridging.

B. Fastenings shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a power charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or supports shall not be welded to steel structures. Holes cut to a depth of more than 1-1/2 inches in reinforced concrete beams or to a depth of more than 3/4" in concrete joints shall avoid cutting the main reinforcement bars. Holes not used shall be filled. In partitions of light steel construction, sheet metal screws shall be used. Conduits shall not be supported using wire or nylon ties.

C. Raceways shall be installed as a complete system and shall be independently supported from the structure. Upper raceways shall not be supported of lower raceways. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts and shall not be fastened to hung ceiling supports.

D. Support Installations:

1. U-channel supports generally are not detailed but must be adequate to support combined weights of conduit and conductors.

2. Clamps: Galvanized malleable iron one-hole straps with clamp backs, beam clamps or other approved device with necessary bolts, expansion shields. Perforated metal straps shall not be used.

3. Adjustable U-channel Supports: Used to support horizontal runs only, use trapeze hangers for parallel runs of conducts.

4. Surface mounted raceway bases shall be anchored to ceiling members or block walls on 5'-0" centers maximum spacing and at all junction and device boxes and at angle fittings. Anchors shall be: Expansion shields on concrete or solid masonry, toggle bolts on hollow masonry units or on suspended ceilings.

3.8 INSTALLATION OF RACEWAYS AND FITTINGS:

A. General:

1. All Conduit: In accordance with requirement of National Electrical Code and applicable local codes.
2. Steel Conduit: In accordance with recommendations of American Iron and Steel Institute "Design Manual on Steel Electrical Raceways," latest edition.

B. Electrical Continuity:

1. All metallic conduit systems shall be electrically continuous throughout.

C. Moisture:

1. All conduit systems shall be essentially moisture tight.

D. Alignment of Exposed Conduit:

1. Parallel with or at right angles to lines of structure.

E. Field Cuts and Threads:

1. Cuts shall be square, threads clean and sharp. Remove sharp or rough edges by reaming burrs. Before couplings or fittings are attached, apply one coat of red lead or zinc chromate to male threads of rigid steel conduit. Apply coat of red lead, zinc chromate or special compound recommended by manufacturer of conduit where conduit protective coating is damaged.

F. Bends:

1. Uniform, whether job-fabricated or made with standard fittings or boxes. Do not dent or flatten conduit.
2. Exposed Conduit: Symmetrical insofar as practicable.

G. Location:

1. Routing: Generally shown in schematic fashion, unless dimensioned or noted to contrary. Contractor shall determine actual routing as approved.
2. Conduit Not Shown: Contractor shall route as required to connect equipment as specified.
3. Vertical Risers, Equipment and Device Locations: Approximately as shown. Contractor shall coordinate installation of conduit, in locations indicated, with structure and equipment.
4. Conduit in Relation to Steam or Hot Water Lines or Other Hot Surfaces: Locate minimum of 6" away. If such separation is impracticable, protect from heat as approved.

H. Buried Conduit:

1. Depth of Burial: Minimum of 24" below finished grade with warning tape 12" above conduit.

I. Wall Penetrations: Required for passage of conduits installed by CONTRACTOR through walls, or partitions.

1. Penetrations Through Exterior Building Walls: Cast in sleeve/Core drill wall and provided conduit entrance seals as detailed. All penetrations shall be with rigid steel conduit PVC coated within the plant process areas.
2. Openings Required Through Existing Partitions: Shall be provided at CONTRACTOR's expense. Holes through masonry construction shall be cast/ drilled with suitable coring machine. Perform work neatly. Patches shall match original material in composition and appearance.
3. Provide fire seals where a fire rated partition or wall is penetrated.

J. Expansion Fittings:

1. Install in all conduit runs crossing structural expansion joint or in straight runs 75 feet or more in length.

K. Conduit Ends:

1. Cap spare conduits.
2. Open Conduit Ends Terminating in Switchboards, Cabinets or Similar Locations Where Exposed to Entrance of Foreign Material: Install insulating grounding bushing. Plug space around cables with sealing compound.
3. Cap or plug conduit ends to prevent entrance of foreign material during construction.

L. Conduit Connections:

1. Cabinets, Enclosures, and Boxes: Double lock nuts and insulating bushings for rigid conduits in unclassified areas, NEMA 1. Hubs for rigid conduits in damp, wet, exterior, or corrosive areas, NEMA 12, 3R, 4, 4X. Bushings, insulating type, bell ends, or insulated throat fittings shall be installed on the ends of all conduits. Grounding type fittings and bushings shall be utilized as required for bonding.
    a. All hubs 3 piece gasketed.
2. Metallic Conduit Terminating in Non-Metallic Manholes or Pull Boxes: Insulated grounding bushing with lay-in ground lugs.
3. Flexible conduit for connection to movable equipment shall be liquidtight, utilizing listed liquidtight fittings.

M. Cleaning:

1. Clean and swab inside of conduits by mechanical means to remove foreign materials and moisture before conductors are installed.

N. Spare Conduits:

1. Install nylon pull line for future installation of cables. Cap all conduits and mark where end is located on Record Drawings with dimensions.

END OF SECTION

SECTION 26 05 32 - CONDUIT DUCTBANKS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install conduit ductbanks as required, and as shown on the Drawings. Materials employed shall be as indicated on the Drawings and specified herein. All exterior conduit shall be buried underground and embedded in sand as detailed. No splices are allowed underground due to high water table at the site.

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

B. Shop Drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work. Show proposed routing of conduits buried under floor slabs-on-grade, conduit and rebar embedded in floor slabs, columns, etc. Identify conduit by tag number of equipment served and by conduit schedule number.

1.3 QUALITY ASSURANCE

A. MATERIAL MANUFACTURERS: Firms regularly engaged in manufacture of duct system components of type and sizes required, whose products have been in satisfactory use in similar service for not less than (3) years.

B. STANDARDS: Comply with applicable portions of the NEMA standards pertaining to underground ducts. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL listed and labeled. Comply with NEC requirements as applicable to construction of raceway systems.

1.4 APPLICABLE SECTIONS

A. Section 31 22 00 - Earthworks

B. Section 26 05 00 - Electrical General Requirements.

C. Section 26 05 19 – Conductors and Cables.

PART 2 - PRODUCTS

2.1 DUCTS

A. Ducts shall be a single continuous length, round-bore, size as indicated, Nonmetallic Conduit, PVC.

B. Duct elbows, bends, and off-sets shall be per the manufacturer’s requirements. Metal conduits underground are not allowed. 90’s and offsets shall be PVC coated GRC (tape not permitted.)

C. Splices shall be water-tight underground in order to minimize the entrance of water.

PART 3 - EXECUTION

3.1 CONDUIT BANKS

A. Each ductbank shall be completely encased in red concrete. Thickness of sand over, under and around ductbank shall be not less than 3 inches as detailed. All ductbanks shall include a grounding electrode conductor as detailed.

B. Unless noted otherwise, the top of the concrete envelope shall be not less than 2'-6" below finished grade or paving.

C. Ducts shall be installed to provide a water-tight, continuous length duct. If required, joints in duct shall be as per the manufacturer's requirements, and staggered at least 6 inches.

D. Saddles shall be used for support as indicated on the drawings. Hold down anchors shall be provided as indicated and required to prevent duct from floating on wet concrete.

E. During construction, ends of ducts shall be plugged to prevent debris from entering into ducts. Particular care shall be taken to keep ducts clean of concrete or any other substance during the course of construction.

F. After each duct line has been completed, a mandrel not less than 12 inches long, having a cross section approximately 1/2" less than the inside cross section of the duct, shall be pulled through to clean out the duct of earth, sand or gravel.

G. Trenching, backfilling and surface repair shall be done in accordance with Division 2 of these specifications.

H. Ductbanks shall be straight without bends or off-sets if at all possible.

I. Over each ductbank at approximately 12 inches below grade, provide a detectable continuous red plastic warning tape to alert future excavators of the presence of the ductbank.

J. Provide nylon pull line in all ducts.

END OF SECTION

SECTION 26 05 34 - ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install electrical boxes and electrical fittings as required, and as shown on the Drawings. Materials employed shall be as indicated on the specified herein.

B. Types of electrical boxes and fittings in this section include the following:
   1. Outlet boxes
   2. Junction boxes
   3. Pull boxes
   4. Conduit bodies
   5. Bushings
   6. Locknuts and hubs
   7. Knockout closures
   8. Miscellaneous boxes and fittings.

1.2 SUBMITTALS

A. Submit product literature including manufacturer, model or part number, materials of construction, size, ratings, and listings as a minimum.

1.3 QUALITY ASSURANCE

A. Comply with NEC as applicable to construction and installation of electrical boxes and fittings.

B. Comply with ANSI C 134.1 (NEMA Standards Pub No. OS 1) as applicable to sheet-steel outlet boxes, device boxed, covers and box supports. Provide electrical boxes and fittings, which have been UL listed and labeled.

PART 2 - PRODUCTS

2.1 FABRICATED MATERIALS

A. Flush Interior Outlet or Device Boxes: Provide one piece, galvanized flat rolled sheet steel interior wiring boxes of types, shapes and sizes, including box depths, to suit each respective location and installation; construct with stamped knockouts in back and sides, and with threaded screw holes with corrosion-resistant screws for securing box covers and wiring devices; minimum depth 1-1/2". Provide minimum 2-1/8" depth for boxes with three or more conduit entries.

B. Interior Outlet or Device Box Accessories: Provide box accessories as required for each installation, including mounting brackets, hangers, extension or plaster rings, fixture studs, cable clamps and metal straps for supporting boxes, which are compatible with boxes being used and fulfilling requirements of individual wiring applications.

C. Exposed Outlet or Device Boxes: Provide corrosion- resistant cast-metal type FD weatherproof wiring boxes of types, shapes and sizes (including depth) required, with integral threaded conduit hubs, face plates with spring-hinged waterproof caps suitable configured for each application, with face plate gaskets and corrosion-resistant fasteners.

D. Junction and Pull Boxes: Provide junction and pull boxes with covers of types, shapes and sizes to suit each respective location and installation; with welded seams and equipped with stainless hardware. Provide underground concrete junction boxes as required or indicated on the Drawings. Provide cast steel boxes with threaded hubs and gasketed cover as required or indicated on the Drawings.

E. Conduit Bodies: Provide galvanized cast-metal Form 7 conduit bodies of types, shapes and sizes to suit respective locations and installation, construct with threaded-conduit-entrance ends, removable covers, and corrosion-resistant screws.

F. Bushings, Knockout Closures, Locknuts, and Hubs: Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and hubs, and conduit bushings and offset connectors of types, and sizes to suit respective uses and installation.

G. All boxes, fittings, and conduit bodies shall be PVC coated wherever PVC coated conduits are required elsewhere in this specification.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS:

A. General: Install electrical boxes and fittings where indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work.

C. Provide cover plates for all boxes. See Section 26 05 22, Wiring Devices.

D. Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture.

E. Provide knockout closures to cap unused knockout holes where blanks have been removed.

F. Install boxes and conduit bodies to ensure ready accessibility of electrical wiring. Install recessed boxes with face of box or ring flush with adjacent surface.

G. Fasten boxes rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry. Use bar hangers for stud construction. Use of nails for securing boxes is prohibited. Set boxes on opposite sides of common wall with minimum 10" of conduit between them.

H. Provide electrical connections for installed boxes.

END OF SECTION

SECTION 26 05 74 - ELECTRICAL MOTORS

PART 1 - GENERAL

1.1 SCOPE

A. This section specifies alternating current induction motors 300 horsepower and less to be provided with the driven equipment. This section refers to motors by the enclosure type as defined in NEMA MG 1. Compliance by the supplier to the requirement of the specification does not relieve them of responsibility of furnishing motors and motor accessories that are suitable for the specified service conditions.

1.2 QUALITY ASSURANCE

A. General

1. Motors shall be built in accordance with UL 1004, NEMA Standard MG 1, and to the requirements specified herein.

B. References

1. This section references the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
FORM A-1 1	Motor Data Sheet
IEEE 85	Test Procedure for Airborne Sound Measurements on Rotating Machinery
NEMA ICS 6	Enclosure for Industrial Controls and Systems
NEMA MG 1	Motors and Generators
UL 1004	Motors, Electric
NEC	National Electric Code, Latest Edition

1.3 SUBMITTAL DATA

A. Complete motor data shall be submitted with the driven machinery submittals. Motor data shall include.

1. Machine tag and loop number, as identified in the P&IDs, and specifications number of driven machine.
2. Motor manufacturer.
3. Motor Type or model and dimension drawing.
4. Nominal horsepower at installed altitude, 4,800’.
5. Nominal efficiency.
6. NEMA design.
7. Frame size.
8. Enclosure.
9. Winding insulation class and treatment, Class H.
10. Rated ambient temperature.
11. Service factor.
12. Voltage, phase, and frequency rating.
13. Full load current at rated horsepower for application voltage.
14. Starting code letter, or locked rotor KVA, or current.
15. Special winding configuration such as part winding, star-delta.
16. Rated full load speed.
17. Power factor at full load.
18. Power and connection requirements of motor winding heaters.
19. Temperature protective devise ratings and connection information.
20. Recommended maximum size power factor correction capacitor.

21. Motor insulation dielectric withstand rating.
22. If driven from a variable frequency drive:

a. Certification that the motor meets the requirements of NEMA MG-1 1993 part 31.
b. Certification that the motor and mechanical drive are matched in design and suitable for use together for the specific installation and driven equipment conditions.

B. The CONTRACTOR shall complete the motor data sheet at the end of this Section for the motor supplied, and submit the completed form to the OWNER for review, as part of the submittal package for each piece of equipment.

C. Motor insulation resistance test report.

1.4 SERVICE CONDITIONS

A. Environmental Conditions

1. All motors are subject to hose directed spray and up to a temperature 40°C. Motors shall be totally enclosed unless otherwise specified and shall be rated for service at elevation 4,800 feet above mean sea level. Motors shall meet the criteria as specified in NEMA MG 1 for usual environmental conditions.

B. Operating Conditions

1. Motors shall be selected for the operating conditions of the driven equipment in accordance with NEMA MG 1. Motors shall be subject to the vibration performance limits as follows:
   a. The rotor shall be dynamically balanced according to NEMA Standards. Balance limits shall be 1/2 the limits shown on NEMA MG 1-12.06. The depositing of metal on the rotor (solder, weld, etc.) to achieve balance is not acceptable. Pavement metal is to be removed to achieve a balance only without effecting the structural strength of the rotor. Chiseling or sawing parent metal is prohibited. The addition of weights is acceptable.

1.5 PERFORMANCE REQUIREMENTS

A. Motors shall be continuous duty of the type generally described as having normal starting torque with low current, NEMA design “B”.

B. Starting current for fully loaded motors shall be as defined by NEMA design “B”.

C. Motors shall be sized for operation at their respective horsepower rating, never at their service factor rating. All motors shall be rated with a service factor of at least 1.15.

D. The motor must develop sufficient locked rotor torque to provide breakaway of the load and to provide adequate torque during the acceleration period to overcome the load and inertial forces.

E. Acceleration time must be short enough to be within the thermal limits of the motor, but not so short that it over stresses the driven equipment.

F. Overhung load requirements such as the number and pitch radius of the motor-shaft-mounted pulley sprocket, etc., and the distance from the motor front bearing to the center of the pulley, sprocket, etc. must be determined and included in the purchase order.

G. Motors are to be manufactured with multiple dips of Class H varnish in order to accommodate the application of adjustable speed drive systems voltage and severe duty environments.

H. All equipment manufacturers shall provide a totally enclosed fan cooled motor, corrosion resistant and rated for severe, continuous duty operation.

I. Motors shall operate successfully at rated load under the various combinations of voltage and frequency variations specified in section 12.44 of NEMA MG1-1998.

J. Motors shall operate successfully under running conditions at rated load and frequency when the voltage unbalance at the motors terminals does not exceed 1%.

K. Motor balance and vibration shall meet NEMA standards as defined in MG1-1998 part 7. The motor shall be dynamically balanced to meet 0.08 in/s maximum velocity at the bearing housing when measured in the horizontal, vertical and axial plane (0.12 in/s on 2-pole motors frame 280 and above).

L. Unless otherwise specified in the equipment description, the motor rotation shall be possible in either direction – application permitting. See motor data sheet.

1.6 MOTOR CONSTRUCTION

A. Guiding requirements
   1. Motor shall have class H insulation and be Inverter duty rated.
   2. Motor shall have grounding provisions on the shaft and the terminal box with an Inpre-MGS or equal for shaft grounding protection and IP55 ingress protection. The bearings shall also be insulated with shaft grounding device.
   3. Motor shall have a no reversing ratchet device.
   4. The pump contractor shall coordinate with the motor manufacture such that all required mounting plates, jackscrews, shims, anchor bolts, lifting lugs, grouting, coatings and all other items necessary for the frame installation are provided.
   5. Provide a steady bushing to eliminate vibration.
   6. Provide self-cooled, oil-ring type lubrication system. Bearing housing shall be equipped with constant level sight-feed oilers.
   7. Provide low power density, 120-volt 60 HZ single phase space heater with leads brought out to a separate terminal box.
   8. The guaranteed motor efficiency at rated voltage and frequency shall not be less than 95.5 percent at full load, 95.5 at ¾ load, and 94.8 percent at ½ load. Al expected efficiencies shall be determined in accordance with IEEE 112, Method F.

B. Mechanical and Electrical Features:
   1. All motors ¼ Hp through 2 Hp may have either NEMA C-Face or floor mounted feet, or both. Motors above 2 Hp shall be foot mounted in preference to any other method. Mounting requirements are provided in the horsepower descriptive section of the documents.
   2. All motors controlled by a variable speed drives shall be equipped with motor shaft ground rings.

3. Long shaft motors are preferred over short shaft for close-coupled applications. Shafts shall have Impro seal supplied on both bearings. Motor shaft diameter shall comply with NEMA standard size for the motor frame size specified. Reduced, custom, or special shaft diameter motors are not acceptable unless specifically required by the application and approved, in writing, by project engineer. Notification of such variance must be submitted with bid proposals.
4. Motor speeds are dictated in the equipment descriptive documents included with this specification.
5. The following NEMA frame size shall be provided unless specifically approved by the project engineer (1800 RPM):

a. 125 Hp through 300 Hp on a 445TS to 5010 US

6. Stator frame, end brackets, fan cover and conduit box shall be manufactured of high 25 grade cast iron. All frames shall be designed and constructed such that on direct-coupled applications the motor can be mounted and aligned without distortion of the feet, and sufficient strength to withstand overhung loads for belt drive applications. The motor shall be designed with the capabilities for mounting the drive side vertically up or down as required by the application.
7. Ventilating fans shall be non-sparking bronze alloy or non-conductive nylon 66 materials. The ventilation shall be such that cool air is drawn in and hot air expelled to avoid mixing with the incoming air.
8. All motors 1 Hp to 300 Hp shall be rated and wired as 3 phase, 60 Hertz 460 volt operation. Exceptions to this requirement must be reviewed and authorized by the owner. If wired for 230/460 volt, a wiring diagram shall be illustrated on the inside of the conduit box or name plate.
9. Moisture inhibiting coating shall protect the rotor and stator. These coatings must match or exceed the anticipated full load thermal conditions, vibration, and shock electrical insulation ratings of the motor.
10. All cast iron motor parts shall be primed and painted with epoxy or polyester resin enamel or similar coatings for additional corrosion and moisture protection.
11. Motor stator and rotor steel shall be low-loss C-5 electrical grade silicon steel with interlamination insulation capable of withstanding a minimum of 1000 ^{o}F burnout. Stator random windings shall be copper and shall be insulated with class H insulation.
12. Bearings shall be either 300 series ball bearings or cylindrical roller bearings on the drive end and opposite drive end. Bearings shall be selected to provide a minimum L-10 life of 50,000 hours with an external load per NEMA MG 1-14 and a L-10 life of 100,000 hours in direct coupled applications. Bearing type shall be defined on the motor data sheet.
13. Bearings shall have a maximum of 45^{o}C rise at rated horsepower (50 ^{o}C for 2-pole motors).
14. Bearings on frames 143T through 5010UZ shall be regreaseable with regreasing instructions labeled on the motors. The bearings found in frames 213T and larger shall have open bearings with cast iron inner bearing caps. If motor is to be operated by a variable frequency drive the manufacturer shall provide insulated bearings on both end of direct coupled motors. See motor data sheets for VFD motors.
15. The motor bearing housing shall have an extended automatic grease relief valve to effectively prevent bearings from being over-lubricated.
16. The motor nameplate shall have raised letters stamped on 304 stainless steel and be fastened to the motor frame with four stainless steel drive pins.
17. All motor hardware shall be English type and grade 5 zinc-dichromate plated.

18. The winding insulation system shall be Class H or better, non-hygroscopic, chemical, corrosion, fungus and humidity resistant. The complete insulation system will have a minimum resistance of 1.5 megohms after 168 hours of testing in a humidity chamber maintained at 100% relative humidity and 40º C ambient with both end bells removed. Motors used in adjustable speed drive applications shall have an insulation rating of 1860 vac peak with a 0.1 micro second rise time.
19. Motor leads shall be stranded copper, permanently identified on both ends and are brought out into the motor terminal box through a neoprene lead-positioning gasket with compression type terminal lugs. Each of the three leads shall be brought through a single hole into the conduit and termination box.
20. The conduit box shall be cast iron and threaded for rigid conduit connection. Conduit box shall be located at the F1 position of the motor unless otherwise noted on the motor data sheet. Conduit box volumes shall exceed the NEMA minimum standards by a minimum of 25% and boxes shall be able to rotate 90-degree increments. A bronze ground lug shall be provided in the conduit box.
21. A lifting eyebolt shall be provided for motor lifting (180 frame and larger). Eyebolt holes shall be threaded blind holes.
22. Motors shall be suitable for field configuration to any ceiling, wall, or floor mounting by rotating conduit box, end shield, and rotor – per application requirements (143T through 365T).
23. All motors shall meet the “NEMA Premium” efficiency requirements as outline by NEMA Table 12.12. Any deviation from this specification shall be received in writing from the project engineer. WP1 Rated.
24. Upper thrust bearing shall be rated for the existing pump and it’s down thrust.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. U.S. Motors Corporation
   2. Toshiba.

B. The CONTRACTOR shall assign to the designated equipment supplier the responsibility to select and supply suitable electric motors for the equipment. The choice of motor manufacturer shall be subject to review and acceptance by the OWNER. Such review will consider future availability of replacement parts and compatibility with driven equipment.

2.2 MOTORS 1/2 HORSEPOWER THROUGH 300 HORSEPOWER:

A. General
   1. The nominal motor horsepower shall be adequate for the driven machine without infringement upon the motor service factor at the installed altitude and specified ambient conditions.
   2. The motor horsepower shall be not more than the estimated maximum specified for each driven machine.

a. If the estimated maximum horsepower specified is not adequate to satisfy the foregoing restriction or any other requirements of these specifications, the motor with the next larger horsepower shall be supplied at no additional cost to the OWNER.

3. Some requirements of the Section may be excluded for motors which are part of valve operators, submersible pumps, or motors which are an integral part of standard manufactured equipment (i.e., non-NEMA mounting, common shaft with driven element), to the extent that such variation reflects a necessary condition of motor service or a requirement of the specified driven equipment.
4. Motor Voltage Ratings: The CONTRACTOR is required to review the Electrical Drawings and Specifications and to furnish all motors with voltage and phase as shown on the electrical drawings.

a. The CONTRACTOR shall notify the ENGINEER of any discrepancy between any motor sizes indicated by the Drawings and specified elsewhere, and any requirements of the driven equipment and the availability of motors from the manufacturers listed above.

5. Special Requirements: The CONTRACTOR shall refer to individual equipment specifications and the Drawings for special requirements such as motor part winding start, multi-speed windings, protective devices, auxiliary devices, etc.

B. Vertical Motors

1. Comply with the requirements for three phase motors except where the following requirements are more stringent.
    1. Enclosure:

a. All vertical motors installed outdoors shall have Weather Protected Type II (WPII) enclosures.
b. All vertical motors installed indoors shall have Weather Protected Type I (WP I) enclosures.

    2. All vertical motors shall have a Service Factor of 1.15.
    3. Motor Bearings:

a. Antifriction, oil lubricated, and filled initially with oil suitable for ambient temperatures to 40º C.

1) Suitable for intended application and have AFBMA B-10 rating life of 100,000 hours or more.
2) Bearing mounting shall be designed with easily accessible oil supply, flush, drain, oil level gauge, and relief fittings using extension tubes where necessary.

b. Furnished with re-lubricate ball, spherical, roller, or plate type thrust bearings. Lubrication shall be per manufacturer's recommendation for smooth operation and long life of the bearings.

2.3 COMPONENTS

A. Motor Enclosures:

    1. Open Drip Proof:

a. Stamped steel conduit boxes.
b. 1.15 service factor at 40º C ambient.

    2. Totally Enclosed Fan Cooled:

a. Cast iron conduit box.
b. 1.15 service factor at 40º C ambient
c. Tapped drain holes with Type 316 stainless steel plugs for frames 286T and smaller.
d. Automatic breather and drain devices for frames 324T and larger.

e. Upgraded insulation by minimum of 3 dips and bakes and sealer coat of epoxy or silicone.

3. Severe Duty:

a. Corrosion resistant type conforming to motors designated by manufacturer as:

1) Chemical Duty.
2) Mill and Chemical.
3) Custom Sever Duty.
4) Or similar applicable manufacturer's quality designation.

b. 1.15 service factor at 40º C ambient.
c. Tapped drain holes with Type 316 stainless steel plugs for frames 286T and smaller.
d. Automatic breather and drain devices for frames 324T and larger.
e. 2 cycles of vacuum epoxy impregnation of the motor windings.

2.4 ACCESSORIES

A. Conduit Boxes

1. Boxes on motors other than open drip-proof shall be gasketed.
2. Boxes shall be furnished with the size and number of openings as required for the conduits indicated on the Drawings.
3. Boxes shall be rotatable through 360 degrees in 90 degree increments.
4. Shall be furnished with an integral equipment ground lug installed and sized as required for the conductors indicated on the Drawings.

B. Lifting Devices: All motors weighing 265 lb (120 Kg) or more shall have suitable lifting devices for installation and removal.

C. Space Heaters:

1. Provide low power density 120VAC 60Hz single phase space heater with leads brought out to a separate terminal box.
2. Bring power leads for heaters into conduit box.

D. Nameplate:

1. All motors shall be fitted with a permanent, stainless steel nameplate indelibly stamped or engraved with:
   a. NEMA Standard motor data.
   b. Bearing description and lubrication instructions.
   c. Insulation class.
   d. Ambient temperature.
   e. Altitude rating.
   f. Power factor at full load.

2.5 CURRENT BALANCE

A. Current unbalance on polyphase motors shall not exceed the values tabulated below when motor is operating at any load within its service factor rating and is fed by a balanced voltage system:

1. Under 5 horsepower: 25 percent
2. 5 horsepower and above: 10 percent

2.6 OVER-TEMPERATURE PROTECTION

A. Requirements

1. Over temperature protection for motors rated 200 horsepower or greater shall consist of a minimum of six 100 OHM Platinum RTD's embedded in the motor windings, and one 100 OHM for each bearing. Wiring to an external junction box shall be provided. Thermal switch approved for this motor.

2.7 SHAFT CURRENT PROTECTION

A. All motors coupled with a variable frequency drive (VFD) shall include a shaft grounding system. Acceptable systems include AEGIS.

PART 3 - EXECUTION

3.1 TESTING

A. Each motor shall be given a routine commercial test as required by NEMA MG 1 to demonstrate that it is free from electrical or mechanical defects. Copies of routine test reports shall be submitted in the format specified by NEMA.

END OF SECTION

SECTION 26 09 13 - CONTROL DEVICES

PART 1 - GENERAL

1.1 SCOPE

A. This section sets forth the general specification and requirements for the control devices that shall be provided with control panels, motor starters, and other enclosures in order to assemble a complete and operable control, alarm, or indicating system.

B. The SUPPLIER shall coordinate the installation of items specified herein as required to ensure the complete and proper interfacing of all the components and systems.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, Special Conditions, alternates and Addenda, applicable drawings and the technical specification herein shall apply to work under this Section.

1.3 APPLICABLE REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1985; Incl. Rev. I and 2; ICS-6) Enclosures for Electrical Equipment

NEMA ICS 1 (1988) General Standards for Industrial Controls and Systems

UNDERWRITERS LABORATORIES, Inc. (UL)

UL 50 Enclosures for Electrical Equipment

UL 508 Industrial Control Equipment

1.4 SUBMITTALS

A. Provide complete submittal information for the control devices in accordance with Section 26 05 00.

B. Comply with the following requirements:

1. Submit certified dimensional drawings and manufacturer’s data sheets for each size and type of device specified herein to be utilized. Data sheets are to be highlighted to define the specific materials of construction and features specified herein along with detailed manufacturer’s model number.

2. Submit instruction bulletins for each type of control device. The instruction bulletins shall include installation instructions, wiring diagrams, power requirements, maintenance instructions, calibration instructions, and any other details of a specialized nature to the devices furnished.

C. Additional submittal requirements:

1. Circuit Breakers and/or fuses:

a. Provide a complete schedule showing load and rating of circuit breakers and/or fuses.

2. Control power transformers and/or power supplies:

a. Provide complete sizing calculations in accordance with the requirements identified herein.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturers have been indicated for various specified devices to establish the standard of quality and performance of the equipment to be supplied.

B. Devices of a given type shall be of the same model, class, or rating, have the same general appearance, and be from the same manufacturer.

2.2 GENERAL REQUIREMENTS

A. Analog measurements and control signals shall:

1. Be electrical as indicated herein, and shall vary in direct linear proportion to the measured variable, except as noted.

2. Electrical signals outside control panels shall be 4 to 20 mA DC, except as noted.

3. Signals within enclosures may be 1 to 5 VDC, or 0-10 VDC.

4. Dropping resistors shall be installed at all field side terminations in the control panels to ensure loop integrity.

B. Control panels provided with integral power supplies and control power transformers shall be configured to match the voltage and current requirements of the loads.

C. Each 120 VAC control loop or instrument shall have an individual circuit breaker or fuse within its respective control panel and clearly identified for function.

D. Each PLC output shall have its own individual fuse external of the I/O card, with blown fused indication.

1. Size external fuse to open before any I/O card mounted fuses.

E. Signal isolators, Signal Converters, and Power Supplies:

1. Signal isolators shall be furnished and installed in each measurement and control loop, wherever required:

a. To ensure adjacent component impedance match.

b. Where feedback paths may be generated.

c. To maintain loop integrity when the removal of a component of a loop is required.

2. Signal converters shall be included where required to resolve any signal level or signal type incompatibilities.

3. Power supplies shall be included, as required by the device manufacturers' load characteristics, to ensure sufficient power to each loop component.

2.3 CONTROL DEVICES

A. Signal Isolators and Converters.
   1. Signal isolators shall have complete isolation of input, output and power input.
      a. Signal input shall be 4-20 mA into 50 ohms, maximum.
      b. Signal output shall be 4-20 mA into 1000 ohms, minimum.
      c. Power input shall be 120 VAC, 60 Hz or 24 VDC.
      d. Span and zero shall be adjustable.
      e. Accuracy shall be ±1 percent of span.
      f. Units shall be surface or DIN rail mounted.
   2. Signal Converters
      a. Signal inputs of 1-5 V, 0-10 V, ect.
      b. Signal output shall be 4-20 mA into 1000 ohms, minimum.
      c. Power input shall be 120 VAC, 60 Hz or 24 VDC.
      d. Span and zero shall be adjustable.
      e. Accuracy shall be ±1 percent of span.
      f. Units shall be surface or DIN rail mounted.
   3. Acceptable manufacturers:
      a. Accromag.
      b. AGM Electronics Model TA-4000.
      c. Or approved equal.

B. Relays
   1. General Purpose Relays:
      a. General purpose relays shall be plug-in type.
      b. Contacts rated 10 amperes at 120 volts AC.
      c. With LED indication when engergized.
      d. Quantity and type of contacts shall be as shown on the Plans or as needed for system compatibility.
      e. Each relay shall be enclosed in a clear plastic heat and shock resistance dust cover.
      f. Sockets for relays shall have screw type terminals.
      g. Provide transient surge protection across the coil of each relay.
      h. Relays shall be:
         1) Potter and Brumfield Type KRP or KUP.
         2) IDEC.
         3) Square D Type K.
         4) Allen Bradley.

5) Or approved equal.

2. Slave and Interposing Relays:
   a. Additional slave relays shall be provided when the number or type of contacts shown exceeds the contact capacity of the specified relays and timers.
   b. Additional relays shall be provided when higher contact rating is required in order to interface with starter circuits or other equipment.
   c. Shall be provided to compensate for voltage drop due to long wire runs.
   d. The slave and interposing relays shall be as the general purpose relays.
   e. Provide transient surge protection across the coil of each relay.
3. Time Delay Relays
   a. Time delay relays shall be on-delay or off-delay type.
   b. Contacts shall be rated 10-amperes at 120 VAC.
   c. Units shall be including adjustable dial with graduated scale covering the time range in each case.
   d. Provide transient surge protection across the coil of each relay.
   e. As manufactured by Agastat, Series 7000 or equivalent Omron.

C. Manual Operators and Interface Devices - Unclassified Areas
1. General Requirements
   a. NEMA Type 13 Oil tight.
   b. With synthetic rubber gasket.
   c. Heavy duty.
   d. Industrial grade full size 1 – 13/64” diameter.
2. Pushbutton Units:
   a. Contacts rated:
      1) NEMA A600.
      2) 600 VAC maximum.
   b. Color Code:
      1) Red - Stop
      2) Green - Start
      3) Orange - Open
      4) Blue - Closed
   c. As manufactured by:
      1) Allen Bradley 800T.
      2) Square D Type K.

3) Cutler-Hammer 10250T Series.

d. Furnish one spare normally open and normally closed contact with each switch.

3. Selector Switches:

a. Contacts rated:

1) NEMA A600.

2) 600 VAC maximum.

b. As manufactured by:

1) Allen Bradley 800T.

2) Square D Type K.

3) Cutler-Hammer 10250T Series.

c. Furnish one spare normally open and normally closed contact with each switch.

4. Pilot Lights:

a. Transformer type LED pilot lights.

b. 120 VAC.

c. Push to Test type.

d. As manufactured by:

1) Allen Bradley.

2) Square D Type K.

3) Cutler-Hammer 10250T Series.

E. Terminal Blocks

1. Din rail mounted.

2. Terminal to be of the tubular screw type with pressure plate to minimize the possibility of breaking wire strands during tightening.

3. Recessed terminal hardware to minimize the possibility of contact with current carrying parts.

4. Molded of high dielectric material.

5. Minimum rating 600 VAC, 30 amp.

6. External connections to and from all control panel must be via terminal blocks, including power, control, alarm, instrumentation, monitoring, and solenoid circuits.

7. Individual terminals and terminal blocks shall be marked in a permanent manner with printed identification.

8. As manufactured by:

a. Entrelec M 4/6

b. Phoenix Contact UK 5 N

c. Or approved equal

F. Conductors within Control Panels

1. Single conductors shall be as follows:

a. Material: Soft annealed coated copper per ASTMB33 or B189.

b. Standard: ICEA S-19-81.

c. Stranded Wire - Class B.

d. Insulation and Coverings:

1) Thickness: Per ICEA.

2) Material:

a) No. 8 and Smaller: Type XHHW single conductor, copper power cable, moisture resistant, flame retardant thermoplastic insulation, 600 volt, 75 °C.

b) No. 6 and larger: Type XHHW-2 single conductor, copper power cable, heat and moisture resistant, flame retardant, thermoplastic insulation, 600 volt, 75°C.

e. No. 14 AWG minimum, shall be used for field control circuits, unless otherwise noted.

f. No. 16 AWG minimum, Type MTW shall be used for all PLC I/O connections within the panel; between I/O device and field wiring terminal blocks.

2. Instrumentation Cable (Shielded Twisted Pair STP):

a. Minimum conductor size 16 AWG.

b. Stranded and tinned copper conductors.

c. Polyethylene conductor insulated.

d. Foil aluminum-polyester shield – 100% shielding.

e. Minimum 18 AWG, stranded, tinned, copper drain wire.

f. PVC outer jacket.

g. UL Listed, TC rated.

h. 600 volt insulation level.

G. Wire markers:

1. Conductors within the control panel are to be permanently marked with wire numbers at each end.

2. Wire numbers are to correspond to the wire numbers indicated on the submittal drawings and are to correspond to the terminal block number to which they are attached in the control panel.

3. Markers shall be heat shrinkable tubing, imprinted type wire markers.

4. Manufacturers:

a. 3M.

b. Thomas & Betts.

c. Panduit.

H. Nameplates:

1. Nameplates: Engraved three-layer laminated plastic, white letters on black background.

2. Control components within the control panel shall have nameplates secured with stainless steel screws. Nameplates cannot be attached to the covers of the panel wireways.

3. The enclosure and components on the front cover or interior swing out panels shall be identified by nameplates.

a. Use standard manufacturer engraved nameplates for all pushbuttons, and selector switches only if color matches that specified for engraved nameplates. If not, then furnish nameplates to match colors as specified herein.

b. Use engraved plastic laminated nameplates for all other devices, displays, keypads, and annunciator LED's.

c. For NEMA 12, 4, and 4X enclosures, use an epoxy based adhesive to affix nameplates to enclosure cover.

4. A nameplate shall be provided for each signal transducer, signal converter, signal isolator, power supply, relay, terminal strips, and the like mounted inside the panel. The nameplate nomenclature shall match the component names identified in the submittal drawings.

5. Lettering, styles, abbreviations and sizes shall be in conformance with ISA-RP-60.6 (1984) with an intended viewing distance of 3 to 6 feet for external nameplates and 1 to 2 feet for internal nameplates.

I. Control Circuit Breakers:

1. Each 120 VAC control circuit, instrument, or loop shall be powered from an individual control circuit breaker.

2. Din rail mounted using the same DIN rail as used for the terminal blocks.

3. Manual ON-OFF Switch.

4. Rated 240 VAC.

5. Rated 2000 AIC.

6. Current ratings as needed load served.

7. Provide complete nameplate identifying each circuit.

8. As manufactured by:

a. ABB

b. Phoenix Contact

c. Entrelec

d. Square D

J. Fused Terminals:

1. Isolate all PLC Digital Outputs with fuses.
2. Isolate all PLC Digital Inputs with fuses.
3. Isolate all PLC Analog Inputs and Outputs with fuses.
4. Coordinate fuse size to be as recommended by the manufacturers. For PLCs, the fuse size to be below internal output protection of the PLC output module.
5. Fuses to be terminal block mounted.
6. Furnish nameplate identifying each fused terminal.
7. As manufactured by:
    a. Entrelec
    b. Phoenix Contact
    c. Or approved equal

K. Field / Remote Connections:

1. Field/remote connections shall be made at terminal blocks within the panel.
2. Furnish an individual terminal block space for each wire.
    a. Two wires on one terminal block will not be allowed.
3. Furnish an empty wire channel on the backpanel adjacent to the field/remote terminal block strip to be used to route the field/remote wires to the connection terminal blocks.
4. Provide spare terminal blocks as specified herein.

L. Control Voltages:

1. Control voltage shall be supplied via control circuit breakers in the panel.
2. Control power shall be sourced from the 120V power supplied to the panel, unless otherwise noted in the Plans.
3. AC control voltages other than that supplied shall be transformed via a control power transformer within the panel. DC control voltages shall be supplied by AC to DC power supplies, specified herein.

M. Control Power Transformers:

1. Low impedance type.
2. The control power transformers shall have fused over current protection on both the primary and secondary sides of the transformer.
3. Use actual coil power factors in calculating the VA rating of the transformer. Use a power factor of 35% if power factor of coils is unavailable.

4. Determine the continuous VA rating of the transformer based on maximum sealed VA load current from the coils of the starters, relays, and pilot lights. Maximum inrush current shall be calculated based on the maximum inrush of devices that can be energized at one time plus the load presented by the devices already energized, and the actual power factor of the loads. This maximum inrush current must not cause the secondary voltage of the transformer to fall below 85% of rated voltage when the primary voltage has been reduced to 90% of rated voltage. Based on these calculations then actual transformer size shall be the calculated value times 1.5.

N. Transient / Surge Protection

1. Data and Signal Line Protectors to be used on each and every analog input or output, and on each and every data and signal line external connection point:
    a. Provide electronic circuits and components from damaging surge voltage and currents.
    b. Provide protection of signal and data lines associated with computer, data, communications, instrumentation, broadcasting, and industrial control interfaces.
    c. Shall be used directly with EIA standard interfaces:
        1) RS-232
        2) RS-422
        3) RS-423
        4) RS-485
        5) 4-20 mA instrumentation loops.
    d. Repeatedly provide protection against surge voltages currents in excess of 10,000 Amps.
    e. DIN rail mounted.
    f. Cable shields shall be passed through and may be either grounded or not grounded at the protector.
    g. System:
        1) Heavy duty multi-staged protectors.
        2) Solid state stage intercepts the leading edge of the surge with sub-nanosecond response time.
        3) Within micro-seconds, a 3-pole common chambered gas tube capable of handling 20,000 ampere lightning current operates and crowbars the surge to ground.
        4) The protector remains in the crowbar state until the surge has passed and line voltages return to safe levels.
    h. Location:

1) Place at each end of a signal line, data line, or current loop.

2) In the case of daisy chain configuration, such as RS-485, protectors shall be placed at each node.

i. Electrical Characteristics:

1) Surge Life:

a) Greater than 1000 operations with 200 Amps, 10 x 100 µsec.

b) Greater than 10 operations with 10,000 Amps, 8 x 20 µsec.

2) Leakage current at rate line to ground voltage < 10 µAmps.

3) Signal/Data attenuation at maximum data rate 3 db with 600 terminations.

4) Operating temperature -40°C to +60°C.

j. As manufactured by:

1) Joslyn:

a) For differential signals, such as RS-422 or RS-485, and current loops – Model 1820.

b) For high frequency differential signals and current loops – Model 1821.

c) For line to ground protection, two separate circuits, and ground referenced signals (RS-232) and 4-20 mA loops where the return wire is grounded at the protector – Model 1810.

d) For high frequency line to ground protection, two separate circuits, and ground referenced signals (RS-232) and 4-20 mA loops where the return wire is grounded at the protector – Model 1811.

2. Protection from inductive spikes within the control panel.

a. Provide surge protection across all inductive coils for control relays, starters, solenoids, etc.

O. Power Supplies: Power supplies shall convert 120 VAC ±10% to 24 volt DC or other DC voltages as necessary.

1. Power supplies shall have an excess rated capacity of 40 percent or be rated 100 watt minimum.

2. The failure of a power supply shall be annunciated at the control panel and repeated to the SCADA system through a connection to PLC.

3. Output regulation shall be accurate within ±0.05% for a 10% line change or a 50% load change and shall include remote voltage sensing.

4. The power supply shall be rated for temperatures of 32 to 122 degrees F and shall be UL recognized.

5. Power supplies shall have fully isolated primary and secondary coils which shall be surrounded by an insulating enclosure which shall also provide mechanical isolation.

6. All power supplies shall be designed and configured as fully redundant systems so that the failure of one power supply will automatically transfer to the other power supply with no interruption in power.
    a. The power supply failure shall supply a dry contact for connection to a PLC input for an alarm indication.
7. As manufactured by:
    a. Power One W Series.
    b. Phoenix Contact Quint Series.
    c. IDEC Slim Line.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Conform to all application provisions of the NEMA and UL standards, NEC and local, state, and federal codes when fabricating the equipment.

B. Install each item in accordance with manufacturer's recommendations and in accordance with the Contract Documents. Locate devices, including accessories, where they shall be accessible from grade, except as shown otherwise.

C. Mount components in accordance with the installation details as prepared by the manufacturers.

D. Mount equipment so that each device is rigidly supported, level and plumb, and in such a manner as to provide accessibility; protection from damage; isolation from heat, shock, and vibration; and freedom from interference with other equipment within the panel.

E. Items, components, devices, and accessories shall be mounted and anchored using stainless-steel hardware, unless otherwise noted.

3.2 SPARES

A. Unused inputs and outputs from the PLC shall be wired to field terminal blocks and identified.

B. Furnish one spare normally open and one spare normally closed dry contact for each push-button, selector switch, relay, etc.

C. Furnish ten spare fuses for each type of fuse in the panel.

D. Furnish 15 spare terminal blocks or 20% whichever is greater.

E. Furnish five spare relays for each type used in the panel.

F. Spare contacts of relays, switches, etc., shall be internally wired to terminal blocks.

END OF SECTION

SECTION 26 16 00 - PANELS AND CONSOLES

PART 1 - GENERAL

1.1 SUMMARY

A. General: This section sets forth the general specifications and requirements for all the control panels and enclosures being provided under this contract.

1. Including but not limited to all:

a. All custom built and designed control panels.

2. The CONTRACTOR shall furnish, supply and install all custom panels for this project in accordance Contract documents.

3. This section also covers requirements for local control panels being supplied by the Equipment Manufacturers as part of the packaged equipment.

a. The CONTRACTOR shall design all interfaces between these control panels and the SCADA/PLC System.

4. This specification covers the requirements for the fabrication of instrument panel boards or enclosures, mounting, finishing, piping and wiring of instrument equipment.

B. Related Sections:

1. The Contract Documents are a single integrated document, and as such all Divisions and Section apply. It is the responsibility of the CONTRACTOR and its Sub-Contracts to review all sections to insure a complete and coordinated project.

1.2 PANEL FABRICATION

A. The following paragraphs describe general fabrication requirements for the instrument panels, enclosures, and subpanels:

1. All internal instrument and component device wiring shall be as normally furnished by the manufacturer. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, insulated for not less than 600 volts, with a moisture-resistant and flame-retardant covering rated for not less than 90 C.

2. Power distribution wiring on the line side of panel fuses shall be minimum 12 AWG. Secondary power distribution wiring and wiring for control circuits shall be minimum 14 AWG. Annunciator and indicating light circuits shall be minimum 16 AWG. Electronic analog circuits shall be 16 AWG twisted and shielded pairs rated not less than 300 volts. Analog circuits shall be separated from ac power circuits. Wiring for ac power distribution, dc power distribution, and control circuits shall have different colors and shall agree with the color coding legend on the system supplier's panel wiring diagrams.

3. The power entrance to each panel shall be provided with a surge protection device. Surge protectors shall be nominal 120 volts ac with a nominal clamping voltage of 200 volts. Surge protectors shall be a non-faulting and non-interrupting design with a response time of not more than 5 nanoseconds. Surge protectors shall be Transtector "ACP-I00BW", Power Integrity Corporation "ZTAS", or equal.
4. Terminal blocks for external connections shall be suitable for No. 12 AWG wire, and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated complete with marking strip, covers, and pressure connectors. Terminals shall be labeled to agree with identification shown on the Supplier's submittal drawings. A terminal shall be provided for each conductor of external circuits plus one ground for each shielded cable. All wiring shall be grouped or cabled and firmly supported to the panel. Not less than 8 inches of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. Not less than 25 percent spare terminals shall be provided. Each control loop or system shall be individually fused, and all fuses or circuit breakers shall be clearly labeled and located for easy maintenance.
5. The panel fabricator shall provide such additional circuits as may be indicated on the electrical schematic drawings.
6. Nameplates shall be provided on the face of the panel or on the individual device as required. Panel nameplates shall have approximate dimensions and legends as indicated on the drawings and shall be made of laminated phenolic material having engraved letters approximately 3/16 inch high extending through the black face into the white layer. Nameplates shall be secured firmly to the panel.
7. All panels shall be thoroughly cleaned, sanded, and given not less than one coat of rust-inhibiting primer both inside and out. The panel interior shall be given not less than one coat of white enamel or lacquer. All pits and blemishes in the exterior surface shall be filled. Exterior surfaces shall be smoothed and given not less than two coats of enamel, polyurethane, or lacquer finish. Color samples shall be submitted to the Engineer for color selection. One quart of finish color paint shall be furnished with the panels to cover future scratches.

B. FACTORY TEST

1. Panels shall be factory-tested electrically and pneumatically by the panel fabricator in the presence of the ENGINEER before shipment.

1.3 SUBMITTALS

A. Control Panel Engineering Submittals: Submit a two phase control panel engineering submittal for each and every control panel and enclosure being provided for this project.

1. Phase I shall be the Control Panel Hardware submittal which shall include but not be limited to:

a. Enclosure construction details and NEMA type.

b. Finish, including color chart for ENGINEER selection of color.

c. Layout.

d. Power circuits.

e. Signal and safety grounding circuits.

f. Fuses.

g. Circuit breakers.

h. Signal circuits.

i. Internally mounted instrumentation.

j. PLCs.

k. SCADA system components.

l. Face plate mounted instrumentation components.

m. Internal panel arrangements.

n. External panel arrangements.

o. Construction drawings drawn to scale which define and quantity.

1) The type and gage of fabrication steel to be used for panel fabrication.

2) The ASTM grade to be used for structural shapes and straps.

3) Panel door locks and hinge mechanisms.

4) Type bolts and bolt locations for section joining and anchoring.

5) Details on the utilization of “UNISTRUT” and proposed locations.

6) Stiffener materials and locations.

7) Electrical terminal box and outlet locations.

8) Electrical access locations.

9) Print pocket locations.

10) Writing board locations.

11) Lifting lug material and locations.

p. Physical arrangement drawing drawn to scale which define and quantity the physical groupings comprising:

1) Control panel sections.

2) Auxiliary panels.

3) Subpanels.

4) Racks.

5) Cutout locations with nameplate identifications shall be provided.

q. A bill of material which enumerates all devices associated with the control panel.

2. Phase II shall be the Control Panel Wiring Diagram submittal which shall include but not be limited to:

a. Schematic/Elementary diagrams shall depict all control devices and circuits and their functions.

b. Wiring/Connection diagrams shall locate and identify:

1) Electrical devices.

2) Terminals.

3) Interconnecting wiring.

4) These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all electrical and control devices.

c. Interconnection diagrams shall locate and identify all external connections between the control panel/control panel devices and associated equipment.

1) These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all panel ingress and egress points.

d. Control sequence diagrams shall be submitted to portray the contact positions or connections required to be made for each successive step of the control action.

3. All panel drawings shall be 22” x 34” reduced to and fully legible at 11” x 17”, and submitted at 11” x 17” format size, with all data sheets and manufacturer specification sheets being 8.5” x 11”.

4. The submittal shall be in conformance with NEMA Standard ICS-1-1.01, and each phase shall be submitted as a singular complete bound volume or multi-volume package and shall have the following contents.

a. A complete index shall appear in front of each bound volume.

1) All drawings and data sheets associated with a panel shall be grouped.

2) All panel tagging and nameplate nomenclature shall be consistent with the requirements of the Contract Documents.

b. Completed ISA-S20 data sheets for all instrumentation devices associated with each control panel supplemented with manufacturer specification sheets which verify the products conformance to the requirements of the Contract Documents.

c. A listing of spare parts in conformance with each equipment specification section.

1.4 QUALITY ASSURANCE

A. Environmental Suitability:

1. All indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designed in the Contract Documents.

2. Heating, cooling, and dehumidifying devices shall be provided in order to maintain all instrumentation devices to within a range equal to 20% above the minimum and 20% below the maximum of the rated environmental operating ranges.
3. Provide all power wiring for these devices.
4. Enclosures suitable for the environment shall be furnished.
5. All instrumentation in hazardous areas shall be suitable for use in the particular hazardous or classified location in which it is to be installed.

B. All control panels and assemblies shall be labeled and listed by a nationally recognized testing laboratory.
1. Underwriters Laboratory, Inc.
2. Or equal.

1.5 DELIVERY, STORAGE AND HANDLING

A. All panels are to be crated for shipment using a heavy framework and skids.
1. The panel sections shall further be cushioned satisfactorily to protect the finish of the instruments and panel during shipment.
2. All equipment which is shipped with the panel shall further have suitable shipping stops and cushioning material installed in a manner to protect instrument parts which could be damaged due to mechanical shock during shipment.

PART 2 - PRODUCTS

2.1 CONTROL PANELS

A. The following paragraphs describe specific requirements for the control panels:

B. CONSTRUCTION - NEMA 12 by Hoffman or equal in control room locations. NEMA 3R by Hoffman or equal outside.
1. NEMA 12
a. Seams continuously welded and ground smooth.
b. Door and body stiffeners as needed to make a rigid enclosure.
c. Heavy gauge continuous hinge.
d. Oil-resistant gasket attached to door with oil-resistant adhesive. Gasket to seal against roll lip on the enclosure opening.
e. Internal mounting panel held in place by collar studs welded to enclosure.
f. Lockable door latching and handle mechanism to allow easy access to interior of enclosure and keyboard.
g. Panel cut-outs for instruments, devices, and windows shall be cut, punched, or drilled and smoothly finished with rounded edges.
1) Reinforce around cut-outs with steel angles or flat bars.
2. Large panel cutouts such as for HMIs.

3. Pilot device groupings where the removed metal exceeds 50% of the available metal in an area bound by a 3” envelope around said pilot devices.

a. Finish.

1) Interior, smooth, polyester power coating.

2) Exterior polyester powder coating gray in color.

a) Panels that are in the same room as, motor control centers, switchboards, etc shall be of the same color as the motor control center or switchboards so that the control panel blends into the line up.

b. Manufacturer’s standard gauge steel.

c. Each door to have a three-point latching mechanism and padlocking handle with rollers on the ends of the latch rods.

d. With heavy duty lifting eyes.

e. With flange mounted disconnect.

f. Mounting panel

1) 10 gauge steel

2) With stiffeners

C. SIZE AND ARRANGEMENT - Panel dimensions and general instrument arrangement shall be as indicated on the drawings.

D. Interconnecting wiring and wiring to terminals for external connection shall be MTW or SIS 16 AWG, stranded copper wire, insulated for not less than 600 volts, with a moisture-resistant and flame-retardant covering rated for not less than 90 degrees Celsius except for electronic circuits and special instrument interconnect wiring which shall be in accordance with manufacturer requirements. Provide a switched fluorescent light at every four feet of panel length.

E. PANEL WIRING:

1. Power distribution wiring on line side of panel fuses minimum 12 AWG.

2. Secondary power distribution wiring and wiring for control circuits: Minimum number 14 AWG.

3. Annunciator and indicating light circuits: Minimum 14 AWG.

4. Electronic analog circuits within instrument and control panels: Minimum 16 AWG twisted and shielded pairs or triads rated not less than 16 volts.

5. Provide a 15 amp, 120 volt GFCI service outlet within each panel.

6. Wire Insulation Colors:

a. Conductors supplying 120-volts AC power on the line side of a disconnecting switch shall have a black insulation for the ungrounded conductor.

b. Grounded circuit conductors shall have white insulation.

c. Insulation for ungrounded 120-volt AC control circuit conductors shall be red.

d. All wires energized by a voltage source external to the control panels shall have yellow insulation.

e. Insulation for all DC conductors shall be blue.

7. Wire Marking:

a. Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on all shop drawings.

b. These numbers shall be marked on all conductors at every terminal in accordance with Section 26 05 09.

8. For case grounding, panels shall be furnished with a ¼-inch by 1-inch copper ground bus complete with solderless connectors for all equipment ground conductors.

a. Refer to Division 26 – Conduit Schedule for size and number of conductors.

9. Power Supply Wiring:

a. Each and every loop and instrument requiring 120 VAC shall be protected by individual DIN rail mounted circuit breakers.

1) The number of circuits depends on the circuit load as noted herein.

2) The circuit load shall not exceed 10 amp.

3) Different panel section or different process units must not use common branch circuits.

4) Furnish and install DIN rail mounted circuit breakers for all individual instruments.

a) Circuit breakers shall be mounted on the back of the panel.

b) Identified by a service name tag.

b. Each potentiometer type instrument, electronic transducer, controller or analyzer shall have an individual DIN rail mounted circuit breaker located within the control panel.

1) Circuit breakers shall have plastic tags indicating instrument tag numbers.

2) Individual plug and cord set power supply connections require DIN rail mounted circuit breakers ahead of the receptacle.

10. Furnish circuit breakers for the panel lights, and for the panel receptacle.

11. Alarm Wiring:

a. Install and wire all alarms including light cabinets, audible signal units, test and acknowledge switches and remote logic units as specified.

b. Interconnecting wiring to panel mounted initiating devices shall also be wired.

c. Where plug and cord sets are provided for component interconnection, harness and support the cables in neat and orderly fashion. Where separate wire is required, install No. 16 AWG with MTW or TFFN insulation between all components.

12. Signal Wiring:

a. Signal Wire – Non Computer Use

1) Signal wire shall be twisted pair or triads in conduit or troughs. Cable shall be constructed of No. 16 AWG with MTW or TFFN insulation between all components.

2) Color code for instrument signal wiring shall be as follows:

a) Positive (+) – Black

b) Negative (-) – White.

3) Multiconductor cables where specified shall consist of No. 18 AWG copper signal wires twisted in pairs, pairs, with 90°C, 600 V insulation.

a) A copper drain wire shall be provided for the bundle with a wrap of aluminum polyester shield. The overall bundle jacket shall be PVC.

4) Use for connections between field terminal blocks and the PLC wiring arms for analog inputs and outputs.

b. Signal Wire – Computer Use

1) Signal wires shall be similar to those for non-computer use but each pair shall be triplexed with a copper drain wire and aluminum polyester tape shall be applied over the triplexed group.

2) All cable shields, including thermocouple extension leads shall be terminated at a single point within the control panel.

3) Continuity of the shield is to be maintained throughout the cable runs.

c. Multi-conductor cables, wireways and conduit shall be sized to allow for 20 percent signal wire.

13. Wiring Installation:

a. All wires shall be run in plastic wireways.

b. Exception:

1) Field wiring.

2) Wiring run between mating blocks in adjacent sections.

3) Wiring runs from components on a swing-out panel to components on a part of the fixed structure.

a) Wiring run from components on a swing-out or front panel to other components on a fixed panel shall be made up in tied bundles.

b) These bundles shall be tied with nylon wire ties, and shall be secured to panels at both sides of the “hinge loop” so that conductors are not strained at the terminals.

4) Wiring run to front panel-mounted components.

c. Signal and low voltage wiring shall be run separately from power and 120 VAC control wiring.

1) 120 VAC circuits shall be run through grey colored plastic wireways.

2) 24 VDC circuits shall be run through white colored plastic wireways.

d. Wiring to rear terminals on panel-mount instruments shall be run in plastic wireways secured to horizontal brackets run above or below the instruments in about the same plane as the rear of the instruments.

e. Provide an empty wireway for all field wiring connections.

1) 120 VAC circuits shall be run through grey colored plastic wireways.

2) 24 VDC circuits shall be run through white colored plastic wireways.

f. Conformance to the above wiring installation requirements shall be reflected by details shown on the shop drawings for the ENGINEER’s review.

14. Grounding

a. Furnish equipment ground bus with lugs for connection of all equipment grounding wires.

F. ANALOG CIRCUITS AND AC POWER CIRCUITS: Separated.

G. INTERNAL PANEL WIRING COLORS:

a. AC Power Distribution: Red

b. DC Power and Control: Blue

c. Instrument: Black and white twisted shielded pair.

d. Other and in agreement with manufacturer's wiring diagrams as stated on manufactured drawing legend.

H. SURGE PROTECTION DEVICE FOR POWER ENTRANCES: Nominal 120 volts AC with a nominal clamping voltage of 200 volts; nonfaulting and noninterrupting design with a response time of not more than 5 nano-seconds. Utilize a branch panel TVSS unit as described in Section 26 35 53.

I. TERMINAL BLOCKS FOR EXTERNAL CONNECTIONS: Suitable for specified AWG wire, rated 30 amperes at not less than 600 volts (for incoming power circuits, and for field 1/0 terminals they shall be Phoenix contact or equal as shown on the drawings); with marking strip, covers, pressure connectors, and labeled terminals, each conductor of external circuits plus one ground terminal for each shielded cable. Provide minimum 25 percent spare terminals.

J. Group cables, and firmly support wiring to the panel. Provide minimum 8 inches clearance between terminal strips and the base of vertical panels for conduit and wiring space. Individually fuse each control loop or system, and clearly label and locate fuses or circuit breakers for maintenance.

K. Furnish and install equipment grounding conductor in accordance with NEC 250. Provide power ground lugs. Provide signal insulated and isolated ground lugs.

L. Nameplates on Internal and External Instruments and Devices: Materials approximate dimensions with legends as indicated on the Drawings made of laminated phenolic material having engraved letters approximately 3/16 inch high extending through the black face into the white layer; firmly secured to panels.

M. POWER SUPPLIES/FUSING

1. Design and arrange regulated 24 volt DC power supplies for instrument loops so that loss of I loop does not affect more than one instrument loop or system. Provide power supplies suitable for an input voltage variation of plus or minus 10 percent. Fuse or short circuit protects the supply output.

2. Selectively fuse the power distribution from multi-loop supplies so that a fault in one instrument loop will be isolated from the other loops being fed from the same supply. Label and locate fuses for easy access.

3. Output Voltage Regulation: As required by the instrument or control equipment being supplied.

4. Backup power supply units shall be provided to automatically supply the load upon failure of the primary supply. Design backup supply systems so that either the primary or backup supply can be removed, repaired, and returned to service without disrupting the instrument system operation.

5. Oversize the multi-loop supply systems for an additional 25 percent future load. Indicate failure of a multi-loop supply on the respective instrument panel or enclosure.

6. Furnish and install signal repeaters for instrument loops that exceed the load impedance of the power supplies. Indicating fuses: Neon bulb type for 120 VAC circuit and glass indicating fuse type for 24 VDC circuits.

N. SOURCE QUALITY CONTROL:

1. Functionally factory test instrument and control panel items electrically and pneumatically before shipment.

O. PANEL ACCESSORIES:

1. Manufacturers: Weidmuller SAKS; Entrelec; Phoenix Contact; Wago; or equal.
    a. Terminal Blocks: Nickel plated copper only; DIN rail; universal foot with the following as required for the application.
        1) Universal type
        2) Feed through
        3) Ground
        4) Neutral disconnect
        5) Intrinsically safe
        6) Explosion-proof
        7) Fuse
        8) Knife disconnect
        9) Ground fault indicator
        10) Bolt connecting
    b. Terminal Block Labeling: Each terminal and each conductor as previously specified with machine labels only.
        1) Manufacturers: Phoenix Contact; Entrelec; or equal.
            a) Signal Interface Modules:
                1. Analog isolating converter
                2. Ground loop isolations
                3. Signal amplification
                4. Signal level matching
                5. 24 VDC power supply (120 VAC input)
2. Disconnect Switches:
    a. Switches shall consist of a thermal magnetic circuit breaker with integral door operator – lockable
        1) Minimum 22 KAIC
        2) Not required for panels fed with 120 VAC or less. A nameplate must be furnished on the cover of the control panel identifying all sources of supply and foreign voltages within the control panel.
    b. The main disconnect shall disconnect all power sources within the control panel.

c. Sized in accordance with the NEC and total connected horsepower and associated locked rotor currents.

d. A disconnect shall be provided for each motor controller/starter within the control panel. This disconnecting means shall disconnect power and control power to each motor controller. Each disconnect shall be equipped with a dead front operator through either the cabinet door or a dead front panel.

PART 3 - EXECUTION

END OF SECTION

SECTION 26 20 00 - SERVICE AND DISTRIBUTION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. Provide all operations, methods, labor and equipment and provide and install all materials and incidentals necessary for the completion of the work as specified herein or included on the Drawings.

1.2 WORK INCLUDED

A. Electrical work required is indicated on the Drawings and specified herein and elsewhere includes, but is not necessarily limited to:
   1. Complete electrical distribution systems for power, control, and instrumentation as shown.
   2. Complete system of raceways, conductors, and equipment for all other auxiliary systems required. If noted, the equipment and wiring of these auxiliary systems will be furnished and installed under their respective sections; however, the conduit or raceway systems will be furnished and installed in accordance with Division 26 05 00.

B. The CONTRACTOR shall furnish and install all component parts of all the systems required for their safe and proper operation, whether or not specifically mentioned or noted on the Drawings, except those items or articles which are specifically noted as being supplied otherwise.

C. Perform all trenching and backfilling required in connection with the work which shall be in strict accordance with the provisions of Division 31 of these specifications.

D. Provide all required electrical conduits, conductors, and connections to items described in all other sections of these specifications.

1.3 APPLICABLE SECTIONS

A. The General Conditions, Supplementary Conditions, Special Conditions, Alternates and addenda, applicable drawings and the technical specifications herein shall apply.

B. Section 26 24 17 – Distribution Panelboards.

1.4 ELECTRICAL SERVICE

A. New underground electrical service(s) from the local transformer shall be at 480/277 volt, three phase, four wire, 60 hertz AC with current ratings as indicated on the Drawings. Conduit from utility pole to owners metering cabinet with pull rope.

B. The CONTRACTOR shall install service conduits and conductors from the OWNER metering cabinet to transformer and then service disconnect location to the service entrance section. The installation shall be in accordance with the utility company’s published requirements. See Drawings.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of the service entrance sections shall be in accordance with the manufacture's requirements.

3.2 INSTALLATION OF GROUNDING ELECTRODE SYSTEM

A. The service entrance section shall be bonded to the grounding electrode system (GES). The GES consists of, but not limited to, the metal underground water pipes, metal frame of the building or structure, concrete encased electrode (UREF), ground rings, rods, pipe, or plate electrodes, and other metal underground systems or structures as in compliance with the NEC. Provide bonding jumper same size as system ground to provide ground continuity from customer's side of metallic lines service entrance and street side of metallic mains. The neutral (grounded conductor) and grounding electrode system shall be connected together at the service disconnect only.

B. UFER ground connections to existing UFER Ground shall be exothermic welds or otherwise irreversible.

C. The equipment grounding system shall be such that all metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, portable equipment and other conductive items in close proximity with the electrical circuits operate continuously at ground potential and provide a low impedance path for the possible ground fault currents. The system shall comply with the National Electrical Code, modified as indicated on the Drawings or specifications.

D. The distributions system shall be provided with a separate equipment grounding conductor for each single or three-phase feeder, each branch circuit, each motor circuit, control or instrument raceways as indicated. The grounding conductor shall be installed in the common raceway with the related phase and/or neutral conductors. Flexible conduit equipment connections utilized in conjunction with branch circuits or feeders shall be provided with suitable bonding jumpers connected to listed grounding type fittings when required.

3.3 TESTING

A. General: Upon completion of this portion of the work, test all parts of the electrical system in the presence of the ENGINEER.

B. Test Requirements: All systems shall test free from short circuits and grounds, shall be free from mechanical and electrical defects, and shall show an insulation resistance between phase conductors and ground of not less than that required by the manufacturers.

3.4 FINAL INSPECTION

A. The CONTRACTOR shall be present at the final acceptance of the work by the OWNER.

B. The CONTRACTOR shall have pad and pencil to list all deficient items noted. Corrections and adjustments of deficient items shall be done after the inspection, not during.

C. See Section 26 05 00 for other requirements for final acceptance.

END OF SECTION

SECTION 26 22 00 - DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 SCOPE

A. This Section consists of dry type transformers and related items necessary to complete the work indicated within the Contract Documents.

1.2 REFERENCES

A. NEMA ST 1 – Specialty Transformers (Except General – Purpose Type).

B. NEMA ST 20 – Dry Type Transformers for General Applications.

C. NETA ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment (International Electrical Testing Association).

D. NFPA 70 – National Electrical Code.

E. UL – Underwriters Laboratories, Inc.

1.3 SUBMITTALS

A. In accordance with Section 26 05 00.

B. Product Data: provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type and rated temperature rise.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.1 DRY TYPE TRANSFORMERS

A. Transformers shall be premium high efficiency quiet type with copper windings, and shall be installed where indicated on the Drawings. The primary winding of the transformers shall have two 2-1/2 percent taps above, and below normal.

B. The transformers shall have a BIL of 10 KV with a temperature class of 185 degrees C for transformers up to 25 KVA, and a temperature class of 220 degrees C for larger transformers.

C. The sound level shall not exceed 44 dBa measured at 5 feet from the transformer after installation. Core and coil assemblies 30 KVA and larger, shall be mounted on rubber vibration isolators, designed to reduce harmonics generated noise.

D. The transformers shall be NEMA 3R outdoor rated with rodent screens.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set transformer plumb and level.

B. Use flexible conduit, 2 feet minimum length for connections to transformer case. Make conduit connections to side panel of enclosure.

C. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.

D. Mount floor-mounted transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

E. Mount trapeze-mounted transformers as indicated.

F. Provide grounding and bonding in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.2.

3.3 ADJUSTING

A. Adjusting installed work.

B. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION

SECTION 26 24 16 - BRANCH CIRCUIT PANELBOARD

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Lighting and Appliance Panelboard - Furnish and install lighting and appliance panelboard(s) as specified herein and where shown on the associated schedules drawings.

1.2 REFERENCES

The panelboard(s) and circuit breaker(s) referenced herein are designed and manufactured according to the latest revision of the following specifications.

A. NEMA PB 1 – Panelboards

B. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

C. NEMA AB 1 - Molded Case Circuit Breakers

D. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

E. UL 50 - Enclosures for Electrical Equipment

F. UL 67 – Panelboards

G. UL 98 - Enclosed and Dead-front Switches

H. UL 489 - Molded-Case Circuit Breakers and Circuit Breaker Enclosures

I. CSA Standard C22.2 No. 29-M1989 - Panelboards and Enclosed Panelboards

J. CSA Standard C22.2 No. 5-M91 - Molded Case Circuit Breakers

K. Federal Specification W-P-115C - Type I Class 1

L. Federal Specification W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit And Service.

M. NFPA 70 - National Electrical Code (NEC)

N. ASTM - American Society of Testing Materials

1.3 SUBMITTAL AND RECORD DOCUMENTATION

A. Approval documents shall include drawings. Drawings shall contain overall panelboard dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one line diagrams with applicable voltage systems.

1.4 QUALIFICATIONS

A. Company specializing in manufacturing of panelboard products with a minimum of fifty (50) years documented experience.

B. Panelboards shall be manufactured in accordance with standards listed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspect and report concealed damage to carrier within their required time period.

B. Handle carefully to avoid damage to panelboard internal components, enclosure, and finish.

C. Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

1.6 OPERATIONS AND MAINTENANCE MATERIALS

A. Manufacturer shall provide installation instructions and NEMA Standards Publication PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

B. Refer to Sections 26 05 00 and 26 05 05 for additional requirements.

1.7 WARRANTY

A. Manufacturer shall warrant specified equipment free from defects in materials and workmanship for the lesser of one (1) year from the date of installation or eighteen (18) months from the date of purchase.

1.8 RELATED WORK

A. Section 26 35 53 – Transient Voltage Surge Suppression

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D Company Type NF - Class 1670.

B. Cutler Hammer.

C. General Electric.

2.2 LIGHTING AND APPLIANCE PANELBOARD TYPE

A. Fabrication:

1. Interior

a. Continuous current ratings, as indicated on Drawings, not to exceed 600 amperes maximum for main breaker panelboards and not to exceed 800 amperes for main lug panelboards.

b. Minimum Short Circuit Rating: as indicated on the Drawings.

c. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors limited to bolt-on branch circuit breakers. The bussing shall be fully rated.

Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67. Bussing rated 100-400 amperes shall be plated copper. Bussing rated for 600 and 800 amperes shall be plated copper as standard construction. Bus bar plating shall run the entire length of the bus bar. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.

d. All current-carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.

e. A solidly bonded copper equipment ground bar shall be provided.

f. Split solid neutral shall be plated and located in the mains compartment up to 250 amperes so all incoming neutral cable may be of the same length.

g. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have pre-formed twistouts covering unused mounting space.

h. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, UL Listed label and short circuit current rating shall be displayed on the interior or in a booklet format.

i. Interiors shall be field convertible for top or bottom incoming feed. Main circuit breakers in 125A interiors shall be vertically mounted. Main circuit breakers over 125A shall be vertically mounted. Sub-feed circuit breakers shall be vertically mounted. Main lug interiors up to 400 amperes shall be field convertible to main breaker. Interior leveling provisions shall be provided for flush mounted applications.

j. Interior phase bus shall be pre-drilled to accommodate field installable options. (i.e., Sub-Feed Lugs, Sub-Feed Breakers, Thru-Feed Lugs)

k. Interiors shall accept 125 ampere breakers in group mounted branch construction.

2. Main Circuit Breaker

a. Shall be bolt-on type circuit breakers.

b. Main circuit breakers shall have an over center, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true RMS sensing and be factory calibrated to operate in a 40° C ambient environment. Thermal elements shall be ambient compensating above 40° C.

c. Two and three pole circuit breakers shall have common tripping of all poles. Circuit breakers frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the breaker that allows the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.

d. Circuit breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be UL Listed for reverse connection without restrictive line or load markings.

e. Circuit breaker escutcheon shall have international I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON or OFF position.

f. Lugs shall be UL Listed to accept solid or stranded copper conductors only. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16. Lug body shall be bolted in place; snap-in designs are not acceptable.

g. The circuit breakers shall be UL Listed for use with the following accessories: Shunt Trip, Under Voltage Trip, Ground Fault Shunt Trip, Auxiliary Switch, Alarm Switch, Mechanical Lug Kits, and Compression Lug Kits.

3. Branch Circuit Breakers

a. Shall be Square D type circuit breakers or approved equal. Circuit breakers shall be UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the panelboard schedules drawings.

b. Molded case branch circuit breakers shall have bolt-on type bus connectors.

c. Circuit breakers shall have an over center toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles.

d. There shall be two forms of visible trip indication. The circuit breaker handle shall reside in a position between ON and OFF. In addition, there shall be a red VISI-TRIP® indicator appearing in the clear window of the circuit breaker housing.

e. The exposed faceplates of all branch circuit breakers shall be flush with one another.

f. Lugs shall be UL Listed to accept solid or stranded copper

conductors only. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16.

g. Breakers shall be UL Listed for use with the following factory installed accessories: Shunt Trip, Auxiliary Switch, and Alarm Switch.

h. Breaker shall be UL Listed with the following ratings: (15-125A) Heating, Air Conditioning, and Refrigeration (HACR), (15-30A) High Intensity Discharge (HID), and (15-20A) Switch Duty (SWD)

4. Enclosures

a. Type 1 Boxes

1) Boxes shall be galvanized steel constructed in accordance with UL 50 requirements. Galvannealed steel will not be acceptable.

2) Boxes shall have removable end walls with knockouts located on one end. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.

3) Box width shall not exceed 26” wide.

b. Type 1 Fronts

1) Front shall meet strength and rigidity requirements per UL 50 standards. Shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.

2) Fronts shall be hinged 1-piece with door. Mounting shall be surface as indicated on associated drawings. All covers shall be hinged cover type.

3) Panelboards rated 250 amperes and below shall have MONO-FLAT fronts with concealed door hinges and trim screws. Front shall not be removable with the door locked. Panelboards rated above 250 amperes shall have vented fronts with concealed door hinges. Doors on front shall have rounded corners; edges shall be free of burrs.

4) Front shall have flat latch type lock with catch and spring loaded stainless steel door pull. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.

c. Type 4, and 12

1) Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized

steel.

2) All doors shall be hinged cover type. All doors shall be gasketed and equipped with a tumbler type vault lock and two (2) additional quarter turn fasteners on enclosures 59 inches or more in height. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.

3) Maximum enclosure dimensions shall not exceed 21” wide and 9.5” deep.

5. Surge Protective Device

a. Integral Surge Suppressor shall be provided for each branch circuit panelboard. See Section 26 35 53 for requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with manufacturer's written instructions, NEMA PB 1.1 and NEC standards.

3.2 FIELD QUALITY CONTROL

A. Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.

B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within 20% of each other. Maintain proper phasing for multi-wire branch circuits.

C. Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

3.3 INSTALLATION OF PANELS

A. Installation: Unless otherwise indicated on the drawings, install wall panels with the top of the trim 6'-0" above the finished floor. Panels located in equipment rooms and wire closets shall be surface mounted. Floor mounted panels shall be provided with a 4" concrete housekeeping pad. Floor mounted panels shall be anchored to floor at all four corners and to wall or structural member at top for seismic restraint.

B. Directories: Mount a typewritten directory behind glass or plastic on the inside of each panel door. On the directory, show the circuit number and complete description of all outlets with specific locations on each circuit. In addition, provide a typewritten label inside door showing source of power to panel to

feeder switch, panel designation and location within buildings.

END OF SECTION

SECTION 26 24 17 - DISTRIBUTION PANELBOARD

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Power Distribution Panelboard - Furnish and install distribution panelboard(s) as specified herein and where shown on the associated schedules and drawings.

1.2 REFERENCES

The panelboard(s) and circuit breaker(s) referenced herein are designed and manufactured according to the latest revision of the following specifications.

A. NEMA PB 1 – Panelboards

B. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

C. NEMA AB 1 - Molded Case Circuit Breakers

D. UL 50 - Enclosures for Electrical Equipment

E. UL 67 – Panelboards

F. UL 489 - Molded-Case Circuit Breakers and Circuit Breaker Enclosures

G. CSA Standard C22.2 No. 29-M1989 - Panelboards and Enclosed Panelboards

H. CSA Standard C22.2 No. 5-M91 - Molded Case Circuit Breakers

I. Federal Specification W-P-115C - Type I Class 1

J. Federal Specification W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit And Service.

K. Federal Specification W-C-865C - Fusible Switches

L. NFPA 70 - National Electrical Code (NEC)

M. ASTM - American Society of Testing Materials

1.3 SUBMITTAL AND RECORD DOCUMENTATION

A. Approval documents shall include drawings. Drawings shall contain overall panelboard dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one line diagrams with applicable voltage systems.

1.4 QUALIFICATIONS

A. Company specializing in manufacturing of panelboard products with a minimum of fifty (50) years documented experience.

B. Panelboards shall be manufactured in accordance with standards listed Article 1.2 - REFERENCES.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspect and report concealed damage to carrier within their required time period.

B. Handle carefully to avoid damage to panelboard internal components, enclosure, and finish.

C. Store in a clean, dry environment.

Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

1.6 OPERATIONS AND MAINTENANCE MATERIALS

A. Manufacturer shall provide installation instructions and NEMA Standards Publication PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

B. Refer to Sections 26 05 00 and 26 05 05 for additional requirements.

1.7 WARRANTY

A. Manufacturer shall warrant specified equipment free from defects in materials and workmanship for the lesser of one (1) year from the date of installation or eighteen (18) months from the date of purchase.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D Company.

B. Cutler Hammer.

C. Or Approved Equal. Siemens brand equipment is not approved.

2.2 POWER DISTRIBUTION PANELBOARDS

A. Circuit Breaker Distribution Panelboard

1. Interior

a. Shall be rated 600 Vac or 250 Vdc maximum. Continuous main current ratings as indicated on associated schedules and drawings not to exceed 1200 amperes maximum. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67.

b. Provide UL Listed short circuit current ratings (SCCR) as indicated on the associated drawings not to exceed the lowest interrupting capacity rating of any circuit breaker installed with a maximum of 200,000 RMS symmetrical amperes. Main lug and main breaker panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.

c. The panelboard interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.

d. The bussing shall be fully rated with sequentially phased branch

distribution. Panelboard bussing rated 100 through 600 amperes shall be plated copper. Bussing rated 800 amperes and above shall be plated copper. Bus bar plating shall run the entire length of the bus bar. The entire interleaved assembly shall be contained between two (2) U-shaped steel channels, permanently secured to a galvanized steel mounting pan by fasteners.

e. Interior trim shall be of dead-front construction to shield user from all energized parts. Main circuit breakers through 800 amperes shall be vertically mounted. Main circuit breaker and main lug interiors shall be field convertible for top or bottom incoming feed.

f. A solidly bonded copper equipment ground bar shall be provided.

g. Solid neutral shall be equipped with a full capacity bonding strap for service entrance applications. As scheduled, UL Listed panelboards with 200% rated solid neutrals shall have plated copper neutral bus for non-linear load applications. Gutter-mounted neutral will not be acceptable.

h. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, UL Listed label, and Short Circuit Current Rating shall be displayed on the interior or in a booklet format. Leveling provisions shall be provided for flush mounted applications.

2. Group mounted circuit breakers through 1200A

a. Circuit breaker(s) shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.

b. The interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.

c. Circuit breakers equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breakers shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breakers of different frame sizes shall be capable of being mounted across from each other.

d. Line-side circuit breaker connections are to be jaw type.

e. All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.

3. Electronic trip molded case 100% rated circuit breakers.

a. All electronic circuit breakers shall have the following time/current response adjustments: Long Time Pickup, Long Time Delay, Short Time Pickup, Short Time Delay, Ground Fault Pickup Ground Fault Delay and Instantaneous settings. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.

b. Circuit breaker trip system shall be a microprocessor-based true RMS sensing designed with sensing accuracy through the thirteenth (13^{th}) harmonic. Sensor ampere ratings shall be as indicated on the associated schedule and drawing.

c. Local visual trip indication for overload, short circuit and ground fault trip occurrences.

d. Long Time Pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.

e. Communications capabilities for remote monitoring of circuit breaker trip system, to include phase and ground fault currents, pre-trip alarm indication, switch settings, and trip history information shall be provided.

f. Circuit breaker shall be provided with Zone selective Interlocking (ZSI) communications capabilities on the short-time and ground fault functions compatible with all other electronic trip circuit breakers and external ground fault sensing systems as noted on schedules and drawings.

g. Furnish thermal magnetic molded case circuit breakers for 250A frames and below.

4. Electronic trip molded case standard function 80% rated circuit breakers.

a. All electronic circuit breakers shall have the following time/current response adjustments: Long Time Pickup, Long Time Delay, Short Time Pickup, Short Time Delay, Ground Fault Pickup Ground Fault Delay and Instantaneous settings. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.

b. Circuit breaker trip system shall be a microprocessor-based true RMS sensing designed with sensing accuracy through the thirteenth (13^{th}) harmonic. Sensor ampere ratings shall be as indicated on the associated schedule and drawing.

c. Local visual trip indication for overload, short circuit and ground fault trip occurrences

d. Long Time Pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.

e. Furnish thermal magnetic molded case circuit breakers for 250A frames and below.

5. Thermal magnetic molded case circuit breakers

a. Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.

b. Ampere ratings shall be as shown on the Drawings.

6. Enclosures

a. Type 1 Boxes

1) Boxes shall be galvanized steel constructed in accordance with UL 50 requirements. Zinc-coated galvannealed steel will not be acceptable.

2) Boxes shall have removable blank end walls and interior mounting studs. Interior support bracket shall be provided for ease of interior installation.

3) Maximum enclosure dimensions shall be 44” wide and 9.5” deep.

b. Type 1 Trim Fronts

1) Trim front steel shall meet strength and rigidity requirements per UL 50 standards. Shall have an ANSI 49 medium gray enamel electrodeposited over cleaned phosphatized steel.

2) Trim front shall be 4-piece with door available in surface mount. Trim front door shall have rounded corners and edges free of burrs. A clear plastic directory cardholder shall be mounted on the inside of the door.

3) Locks shall be cylindrical tumbler type with larger enclosures requiring sliding vault locks with 3-point latching. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock.

c. Type 4, and 12

1) Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.

2) All doors shall be gasketed and be equipped with a tumbler type vault lock and two (2) additional quarter turn fasteners. A clear plastic directory cardholder shall be mounted on the inside of door. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock.

3) Maximum enclosure dimensions shall not exceed 44” wide and 14.5” deep.

7. Surge Protection Devices: Provide surge suppression equipment (TVSS) for each panelboard and service entrance panelboards. See Section 26 35 53.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with manufacturer's written instructions, NEMA PB 1.1 and NEC standards.

3.2 FIELD QUALITY CONTROL

A. Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.

B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within 20% of each other. Maintain proper phasing for multi-wire branch circuits.

C. Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

END OF SECTION

SECTION 26 24 18 - DISTRIBUTION SWITCHGEAR

PART 1 - GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

1. Low Voltage Metal Enclosed Distribution Switchgear.
2. Circuit breakers shall be draw out type with electronic trip units as specified with trip ratings and features as shown on the Drawings or specified herein. Circuit breakers shall have interrupting, close and latch, and 30-cycle withstand ratings that meet the application requirements.
3. Standard NEMA circuit breakers are approved for this project.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following:

1. Section 26 05 00 - Electrical General Requirements.
2. Section 26 35 53 - Transient Voltage Surge Suppression.

1.3 STANDARDS

A. Equipment shall be designed, tested and manufactured according to the following:

1. ANSI C37.20.1 – Metal Enclosed Low Voltage Power Circuit Breaker Switchgear
2. ANSI C37.51 – Testing of Metal-Enclosed Low Voltage AC Power Circuit Breaker Switchgear.
3. NEMA SG-5 – Power Switchgear Assemblies
4. UL 1558 – Switchgear Assemblies

B. Main and Feeder Circuit Breakers shall be designed, tested and manufactured to the following:

1. ANSI C37.13 – Low Voltage AC Power Circuit Breakers Used In Equipment
2. ANSI C37.16 – Preferred Rating, Related Requirement And Application Recommendations For Low Voltage Power Circuit Breakers and AC Power Circuit Protectors.
3. ANSI C37.50 – Testing Low Voltage AC Power Circuit Breakers
4. NEMA SG-3 – Low Voltage Power Circuit Breakers
5. UL1066 – Low Voltage Power Circuit Breakers

1.4 SUBMITTALS

A. Submit under provisions of Section 26 05 00.

B. Shop Drawings: Indicate front and side views of enclosures with overall dimensions show; conduit entrance locations and requirements; nameplate legends; size and number of bus-bars per phase, neutral if present, and ground; and switchgear instrument details.

C. Product Data: Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.

D. Test Reports: Indicate results of factory production tests.

E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under standards. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 26 05 05.

B. Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years documented experience.

1.7 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 26 05 00.

B. Deliver in 48" inch maximum width shipping splits, individually wrapped for protection and mounted on shipping skids.

C. Accept switchgear on site. Inspect for damage.

D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Conform to NEMA PB 2 service conditions during and after installation of switchgear.

B. Switchboard lay-outs shall not exceed the space allocations detailed on the drawings.

1.10 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings.

B. Verify that all switchgear fit in building space provided prior to rough-in.

1.11 MAINTENANCE MATERIALS

A. Provide maintenance materials under provisions of Section 26 05 00.

B. Provide two of each key.

1.12 RATINGS

A. The ampacity of the Low Voltage Switchgear shall be as shown in the Drawings.

B. The short circuit current rating of the system shall as shown on the Drawings. All circuit interruption shall be accomplished by the circuit breaker and without the aid of limiter fuses. The Short time rating shall also be a function on the desired selectivity of the electrical system. Short time ratings shall be equal to interrupting ratings for systems delivering up to 42k amperes available fault current.

C. The assembly is designed for use on 60 Hz electrical systems up to 600 VAC. The assembly shall be properly braced to the ratings of the circuit breaker installed within the assembly.

D. Any items not specifically mentioned but which are obviously necessary for proper operations are implied in this specification.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D Power - Zone 4.

B. Cutler Hammer – Magnum DS.

C. Or Approved Equal. Siemens brand equipment is not approved.

2.2 STRUCTURE

A. General

1. Each steel section shall contain one or more individual circuit breakers, or instrumentations compartments, and a rear compartment for the buses and outgoing cable connections.
2. Rigid removable steel base channel shall be provided at the front and rear of each section.
3. The finish shall be medium gray ANSI #49.

B. Dimensions

1. Section widths should be 22, 30, or 36’ wide dependent on the size of the circuit breakers being installed.
2. The lineup shall provide adequate wire bending space for mains and feeders breakers using up to 750 kcmil wires.
3. Section depth shall be 54” minimum when using 800A feeders. Additional depth to the lineup shall be for the sole purpose of additional wire bending and conduit space.
4. Adequate conduit space hall be provided to allow all conductors to exit the structure at the same end.

C. Moving and Handling

1. The Lineup shall be divided into shipping splits not to exceed 64” wide and shall be capable of being lifted overhead or by a forklift.
2. Each shipping split shall be provided with removable lifting straps.
3. Removable Base Channels shall be provided with prying slots for ease of final positioning at the job-site.
4. For circuit breakers, an overhead or floor mounted lifter shall be provided to ease the installation or removal of circuit breakers in excess of 75 pounds.

2.3 BREAKER COMPARTMENT

A. Circuit Breakers

1. Each circuit breaker shall be mounted in its own barriered compartment.
2. Feeder circuit breakers rated 2000A or less shall be capable of being mounted in the uppermost compartment without de-rating.
3. Operational buttons on the circuit breaker as well as the trip unit and the display shall be accessible without opening the breaker compartment door.

4. Circuit breakers of like sizes and rated 1600A or less shall be interchangeable as standard. Circuit breakers of lower interrupting ratings shall be mechanically prohibited from being placed in the cell.
5. Prepared spaces shall be totally complete, include the racking mechanism, bussing, and secondary contacts as necessary, so that a circuit breaker of the correct frame size can be installed with no modifications required.
6. Circuit Breaker and prepared space compartments shall be “keyed” such that a breaker cannot be incorrectly installed with respect to Interrupting rating, Frame Size, or secondary connections.

B. Secondary Connections

1. All customer secondary control and communications connections shall be made from the front of the switchgear lineup.
2. A dedicated wiring area accessible from the front shall allow easy access to all control or communications terminations.
3. Control Connections shall be optional ring tongue terminals. All control wire shall be 14 gage SIS.
4. Dedicated conduit entry for control wires shall be provided at the top and bottom of each section, capable of landing up to 3 each 1 ½” conduits and accessible from the front.
5. All interconnections between sections at shipping splits shall use locking-pull apart terminal blocks.
6. All secondary and communication wiring shall be securely fastened to the switchgear without the use of adhesive backed wire anchors.

C. Instrumentation

1. Where additional space is required for instrumentation, CPT’s, metering, etc., a barriered instrumentation compartment shall be used.
2. The instrumentation compartment shall not inhibit the routing of control or communication wires.

2.4 BUSING AND CABLE COMPARTMENT

A. Busing

1. All vertical and horizontal distribution bussing shall be rated for the full ampacity of the lineup.
2. All bus joints consist of Grade 5 hardware and conical spring (e.g. Belleville) washers to withstand mechanical forces exerted during short circuits. All joints shall consist of a minimum of 2 bolts.
3. Busing shall be copper plated along its entire length.

4. Busing shall be braced to withstand the instantaneous interrupting rating of the main breaker(s) or 42kA minimum.
5. Optional barriers shall be available to separate the busing and cable compartment.

B. Cable Compartment

1. All incoming or outgoing power conductors shall be routed through this area.
2. Feeder Breakers shall have adequate wire bending space regardless of the interrupting rating.
3. Conduit area for each section shall be a minimum of 17” wide and provide adequate depth for all section conduits. Select depth based on the tables below:
4. Barriers separate the busing and cable compartments shall be provided.

2.5 LOW VOLTAGE POWER CIRCUIT BREAKERS

A. Circuit Breakers

1. The circuit breaker shall be Square D Masterpact NW Low Voltage Power Circuit Breaker, Cutler-Hammer Magnum DS, or equal, and listed to UL 1066.
2. Circuit breakers shall be suitable for the required instantaneous rating without the use of current limiting fuses.
3. All circuit breakers shall have field interchangeable electric accessories including shunt trip, spring release, electrical operator, auxiliary contacts, and Trip Unit.
4. All secondary connections shall be made directly to the front of the circuit breaker cradle.
5. Each circuit breaker shall have built in contact temperature and contact wear sensors.

B. Padlocking provisions shall be furnished to receive up to three padlocks when circuit breaker is in the disconnected position, positively preventing unauthorized closing of the circuit breaker contacts.

C. Provisions for up to two key locks shall be furnished allowing locking in the disconnected position. Provisions for locking in the connected, test and disconnected position by padlock or key lock shall be available as an option.

D. Located on the face of the circuit breaker shall be buttons, with optional lockable clear cover to open and close the circuit breaker and indicators to show the position of the circuit breaker contacts, status of the closing springs, and circuit breaker position in cell. An indicator shall show “charged-not OK to close” if closing springs are charged but circuit breaker is not ready to close. Circuit breaker racking system must have positive stops at the connected, test, disconnected and withdrawn positions.

E. Circuit breaker must be equipped with an interlock to discharge the stored energy spring before the circuit breaker can be withdrawn from its cell. Circuit breaker must provide a positive ground contact check between the circuit breaker and cell when the accessory cover is removed while the circuit breaker is in the connected, test or disconnected positions.

F. Circuit breaker shall provide long service life. The 3200 A circuit breaker frame and those of lower ratings must be certified to perform a minimum of 10,000 operations without maintenance. The 4000 A and 5000 A frames must be certified to 5,000 operations without maintenance.

G. Trip Units

1. Circuit breaker trip system shall be a MICROLOGIC, Digitrip, or equal electronic trip unit.
2. All trip units shall be removable to allow for field upgrades.
3. Trip Units shall incorporate “True RMS Sensing”, and have LED long-time pickup indications.
4. Trip unit functions shall consist of adjustable long-time pickup and delay, short-time pickup and delay, instantaneous neutral protection and ground-fault pickup and delay.
5. Adjustable long-time pickup (Ir) delay shall be available in an adjustable rating plug that is UL Listed as field-replaceable. Adjustable rating plug shall allow for nine long-time pickup settings from 0.4 to 1 times the sensor plug (In). Other adjustable rating plugs shall be available for more precise settings to match the application. Long-time delay settings shall be in nine bands from 0.5-24 seconds at six times Ir.
6. Short-time pickup shall allow for nine settings from 1.5 to 10 times Ir. Short-time delay shall be in nine bands from 0.1-0.4 I 2 t ON and 0-0.4 I 2 t OFF.
7. Instantaneous settings on the trip units with LSI protection shall be available in nine bands from 2 to 15 times In. The Instantaneous setting shall also have an OFF setting when short-time pick-up is provided.
8. All trip units shall have the capability for the adjustments to be set and read locally by rotating a switch.
9. Trip unit shall provide local trip indication and capability to indicate local and remote reason for trip, i.e., overload, short circuit or ground fault.
10. Ground fault protection shall be available for solidly grounded three-phase, three-wire or three-phase, four-wire systems. Trip unit shall be capable of the following types of ground-fault protection: residual, source ground return, and modified differential. Ground-faulting sensing systems may be changed in the field.
11. Ground fault settings for circuit breaker sensor sizes1200 A or below shall be in nine bands from 0.2 to 1.0 times In. The ground-faul settings for circuit breakers above 1200 A shall be available for four-wire systems.
12. Neutral current transformers shall be available for four-wire systems.
13. Trip units shall be available to provide additional protection by offering adjustable inverse definite minimum time lag (IDMTL). IDMTL provides optimized coordination by the adjustment of the slope of the long-time delay protection.
14. Trip units shall be available to provide real time metering. Metering functions include current, voltage, power and frequency.

H. Accessories

1. A test set shall be available to provide automatic function testing of the circuit breaker. No disassembly of circuit breaker shall be required.

2.6 METERING AND INSTRUMENTATION

A. Metering:

1. The metering capabilities of the Circuit Breaker Trip Units shall be networked together and be provided as a connection to the plant control system for monitoring.
2. CT's shall be appropriately sized for use.
3. On site set-up, commissioning, and system integration shall be included including all travel, lodging, and meal expenses.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine area to receive switchgear to provide adequate clearance for switchgear installation.

B. Check the concrete pads are level and free of irregularities.

C. Start work only after unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install switchgear in accordance with manufacturer's written guidelines, the NEC, and local codes.

3.3 FIELD QUALITY CONTROL

A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

B. Measure, using a Megger, the insulation resistance of each bus section phase-to-phase and phase-to-ground for one minute each, at minimum test voltage of 1000 Vdc; minimum acceptable value for insulation resistance is 1 megaohms. NOTE: Refer to manufacturer's literature for specific testing procedures.

C. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.

D. Physically test key interlock systems to check for proper functionality.

E. Test ground fault systems by operating push-to-test button.

3.4 ADJUSTING

A. Adjust all operating mechanisms for free mechanical movement per manufactures specifications.

B. Tighten bolted bus connections in accordance with manufacturer's instructions.

C. Adjust circuit breaker trip and time delay settings to values as instructed by the Architect/Engineer.

3.5 CLEANING

A. Touch up scratched or marred surfaces to match original finish.

END OF SECTION

SECTION 26 26 00 - TERMINAL BLOCKS

PART 1 - GENERAL

1.1 SCOPE OF WORK:

A. This section covers terminal blocks for control and other wiring.

1.2 SUBMITTALS:

A. Products shall be submitted in accordance with Section 26 05 00, and elsewhere in the Contract Documents, prior to installation.

1.3 MANUFACTURERS:

A. Terminal blocks shall be Entrelec, Phoenix Contact, Weidmuller, or equal.

B. Surge protection blocks shall be MTL Surge Technologies, Series SD, or equal.

C. Power distribution blocks shall be Ilsco Corporation, or equal.

PART 2 - PRODUCTS

2.1 TERMINAL BLOCKS:

A. Terminal blocks shall mount on standard DIN rail, and be of the size required for conductors therein. A minimum of 25 percent spares shall be provided in each terminal box. No more than 2 conductors shall be allowed per termination. Jumper bar assemblies shall be installed for interconnecting terminal blocks, distributing power and signal commons. Terminal blocks shall be U.L. rated for 600 Volts, and 30 Amps, minimum.

B. Grounding terminal blocks shall be provided for instrumentation cable shields. The terminal blocks shall have distinctive 2-color bodies, and shall be mounted to the DIN rail with metal screw down type clamps, providing a positive ground connection. One grounding terminal block shall be installed for every 2 instrument cables terminated. Grounding terminal blocks shall be U.L. rated for 600 Volts, and 20 Amps, minimum.

C. Terminal blocks shall be available in a variety of colors, including red, green, blue, gray, black, yellow, and orange.

D. DIN mount fuse holders shall have blown fuse indicators for EC and AC circuits. Fuse holders shall be of the compression clamp type. Fuse holders shall be U.L. listed, and rated for 600 Volts. Fuse sizes shall not exceed the U.L. current rating for the fuse holders.

E. DIN rail shall be prepunched, zinc bichromate plated steel. Symmetrical DIN rail shall be 35 mmX7.5mm, minimum.

F. Terminal blocks for 4 to 20 milliamp signals shall have knife disconnect switches, and accessible test points for testing and measurement of current loop signals, without the need for removing wire terminations.

2.2 SURGE PROTECTION BLOCKS (SPB):

A. Analog inputs and outputs shall be terminated at surge protection blocks (SPB). He SPBs shall be designed for a working voltage of 32 volts, and shall be fused.

B. SPBs shall provide full hybrid line to line protection, and shall have a GDT rating of 10,000 A (8/20us pulse waveform).

C. SPBs shall be UL94 V-2 listed.

2.3 POWER DISTRIBUTION BLOCKS (PDB):

A. PDBs shall be Electro-tin plated and manufactured from high strength 6061-T6 aluminum alloy.

B. PDBs shall be UL Recognized rated 90º and CSA Certified.

C. PDBs shall provide flexibility in using the connector as an in line splice or to reduce conductor size.

D. PDBs shall be rated for 600 Volts and dual rated for Copper and Aluminum Conductor.

E. PDBs shall have the sizes and ratings per NEC.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Each terminal block and fuse holder shall be identified with the circuit number, or conductor number, corresponding to the identification appearing on the shop Drawings for the equipment, or system.

B. Terminal block and fuse holder markers shall be computer printed plastic-type, with permanent markings.

C. End clamps and end sections shall be installed on each terminal block and fuse holder assembly.

D. Terminal blocks for DC voltages shall be blue, and AC voltages shall be gray.

END OF SECTION

SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment, appliances, and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

B. Fuses.

C. Spare Fuse Cabinet.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, Special Conditions, Alternates and Addenda, applicable drawings and the technical specifications including but not limited to the following:

1. Section 26 05 00 - Electrical General Requirements
2. Section 26 05 19 – Conductors and Cables

1.3 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Bussmann.

B. Other acceptable manufacturers: Gould Shawmut, Little Fuse.

C. All fuses shall be of one manufacturer. Fuses shall have a 200,000 ampere RMS symmetrical interrupting rating unless noted otherwise.

PART 2 - PRODUCTS

2.1 FUSE TYPES AND RATINGS

A. Fuses from 0 to 600 ampere for each circuit serving a single motor shall be UL Class RK5 dual-element Low Peak, LPN-RK (250 volt), LPS-RK (600 Volt).

B. All other fuses in the 0 to 600 ampere range shall be UL Class RK5, dual-element, time delay, low peak, LPN-RK (250 volt), LPS-RK (600 Volt).

C. Fuses larger than 600 ampere shall be UL Class L with time delay, Hi Cap, KRP-C.

D. High voltage fuses - see drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Spare fuses shall be furnished for all fuse types. Spares shall amount to 10% of

installed fuses with a minimum of one set of each fuse type and ampere rating. The set shall equal the number of poles in the appropriate switch.

B. Provide Spare Fuse Cabinet equal to Bussmann for storing spare fuses. Mount on wall in Equipment Room as directed by the ENGINEER.

END OF SECTION

SECTION 26 29 23 - PULSE WIDTH MODULATED VARIABLE FREQUENCY DRIVE

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provide all labor, materials, equipment and incidentals required and install, place in operation and field test variable frequency drive. With active front-end harmonics mitigation.

B. The adjustable frequency controller shall be a flux vector sine-wave, pulse width modulated (PWM) design. A modulation method which incorporates “gear changing” is not acceptable. The final responsibility of the completed drive system is that of the manufacturer. One manufacturer shall provide all drives systems under this contract. The drive systems shall be manufactured within the United State of America to alleviate concerns of future spare part availability and technical support. All drive systems shall be purchased and furnished by the CONTRACTOR.

1.2 QUALITY ASSURANCE STANDARDS

A. The entire VFD system as described herein shall be assembled and factory tested to assure a properly coordinated system.

B. Codes: Provide equipment is full accordance with the latest applicable rules, regulations, and standards of:

1. Local Laws and Ordinances.
2. State and Federal Laws.
3. National Electrical Code (NEC).
4. Underwriters Laboratories (UL).
5. American National Standards Institute (ANSI).
6. National Electrical Manufactures Association (NEMA).
7. Institute of Electrical and Electronic Engineers (IEEE).

C. The complete drive system shall be UL listed.

D. The manufacturer will have a minimum of 12 years experience in Integrated Bi-polar Transistor technology.

1.3 ACCEPTABLE EQUIPMENT MANUFACTURERS

A. Schneider Electric

B. Toshiba

1.4 SUBMITTALS

A. Submittals shall conform in all respect to this section.

B. Submittals shall be prepared specifically for this project by the VFD manufacturer. For this specific application submittal package will be due three weeks upon request.

C. Submittal information shall include, but not be limited to:

1. Equipment dimensions, including stub-up locations, shipping split and shipping weights.
2. Approval electrical drawings, termination drawings and component location diagrams.
3. Manufactures equipment specification.
4. Catalog cut sheets of major components.
5. Spare parts list, per Paragraph 3.03.
6. Certifications, including:
    a. Warranty, per section 1.04
    b. Efficiencies, per section 2.02. A.1.
    c. Harmonic distortion analysis study, per section 2.01E.

1.5 WARRANTY

A. All equipment furnished under this section shall be warranted for all parts and labor by the CONTRACTOR and the original equipment manufacturer for a period of not less than one (1) year from the date of startup.

B. The manufacturer shall meet the quality and program requirements of ISO 9001.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Any modification to the standard product is disallowed. Distributors and panel manufactures changes to the VFD products are specifically disallowed.

B. The VFD system shall consist of an active front-end harmonic filter unit, converter section, output inverter and control logic. All components shall be wired and tested together as a complete system. The labor and materials for field interconnection of the system are to be provided by the VFD manufacturer. Each drive shall be designed for stand alone operation. Multiple drive units shall not utilize shared components. The drive shall be housed in a free standing, front accessible, general purpose indoor enclosure rated NEMA 12, gasketed, with fans and filters. Cabinets shall be single or multi-bay, sheet steel with hinged doors. Doors will have concealed hinges with lockable through-the-door handle operator mechanism. Provisions shall be made for top or bottom entry/exit of incoming line power cables, outgoing load cables and control wiring. All VFD's shall include DC link reactors.

C. Each VFD shall have a molded case, circuit breaker type main power disconnect switch, with an external operating handle. The circuit breaker and the drive unit shall have a minimum short circuit rating of 42,000 amperes RMS symmetrical interrupting capacity and shall be labeled in accordance with UL Standard 489.

D. The following safety features shall be standard on all drives:

1. Provisions to padlock main disconnect handle in the “OFF” position.
2. Mechanical interlock to prevent opening cabinet door with disconnects in the “ON” position, or moving disconnect to the “ON” position while the unit door is open.
3. Auxiliary contact on main disconnects to isolate control when fed from external source.
4. Barriers and warning signs on terminals that are energized with the power disconnect “OFF”.

E. Any VFD over 60 horsepower shall meet all requirements as outlined in the latest edition of IEEE 519 for each individual and total harmonic voltage and current distortion and as indicated in this specification. As per Table 10.2 of IEEE 519-2014, individual or simultaneous operation of the VFD’s shall not add more than 3% total voltage harmonic distortion while operating at full load and speed from the utility source, or more than 5% while operating from a standby generator (if applicable).

1. The VFD manufacturer cannot predict or be responsible for pre-existing voltage distortion on the line or distribution from sources supplied by others. Maximum input voltage unbalance shall be .5% as defined in NEMA MG1 section 14.35.2.
2. As per Table 10.3 of IEEE 519-2014, maximum allowable total harmonic current demand distortion limits for each VFD operation at full load and speed shall not exceed 5% as calculated and measured at the point of common coupling Isc/Il>20).
3. The point of common coupling for all harmonic calculation and field measurement for both voltage and current distortion shall be defined as the main bus feeding each drive.
4. The short circuit current used for harmonic calculations shall be defined as the total full load current with all VFD’s operating multiplied by twenty. Example (5) 100 HP VFD’s Full load current = 5 x 126 amps = 630 amps. Short circuit current = 20x 630 amps = 12600 amps.
5. If harmonic filters are required to meet these requirements, the VFD manufacturer must provide as a minimum 5^{th}, 7^{th}, and 11^{th} harmonics filters and is responsible for the design and manufacturing of the filters. The vendor must supply cabling and installation for the filters. The filters are to be provided with a separate contactor such that the VFD can operate in the event of a filter failure. Failure of a filter shall not cause the entire drive system to shutdown.

F. Harmonic compliance shall be verified with onsite field measurement of both the voltage and current harmonic distortion on the main bus of the VFD termination without the VFD in operation. A recording of harmonic analysis displaying individual and total harmonic currents and voltage must be utilized.

G. VFD system shall maintain a 95 minimum true powerfactor throughout the entire speed range.

H. Displacement power factor shall be .95 percent or higher throughout the entire operating speed range, measured at drive input terminals.

I. For motors over 250HP, the drive shall include an RTD monitoring module which shall monitor 8 – 100 ohm platinum RTD's in the motor. The RTD module shall provide a trip and an alarm contact. The RTD alarm contact shall cause an alarm light to illuminate on the VFD front panel. The RTD Trip contact shall cause the VFD to trip, and send the trip status to the PLC. The alarm and trip contacts shall be settable and adjustable to variable trip and alarm settings. Motors 20HP to 250HP shall include a thermal switch for shutdown.

J. Variable Frequency Drive Ratings:

1. The minimum drive efficiency for NEMA 12 enclosed drive shall be 95.0 percent or better at motor base speed and rated torque. Losses shall include all control power and cooling system losses associated with the drive as well as the input phase shifting transformer.
2. Input Power rating shall be 400-460VAC, plus 10 percent, minus 10 percent, 3 phase, 60 Hz, plus 2, minus 2 Hertz.
3. The voltage ride through of the VFD shall be capable of sustaining continued operation with a 40% dip in normal line voltage. Output speed may decline only if current limit rating of VFD is exceeded.
4. Power loss ride through of the VFD shall be capable of a minimum of 3 cycles loss.
5. The output power shall be HP, 460 Volt, 3 Phase, 60 Hertz, per motor nameplate FLA at installed altitude plus service factor of 25%.
6. The operating ambient Temperature -10 to 40°C (14 to 104°F).
7. The storage temperature shall be -20 to 60°C (4 to 140°F).
8. The relative operating humidity shall be 0 to 95% Non-Condensing.
9. The site operating vibration condition shall be acceleration at 0.6 G maximum (10-55 Hz). Amplitude at 0.1mm maximum (50-100 Hz).
10. Drives shall be sized/de-rated to operate at full load at an elevation of 4700 ft.
11. Power unit rating bases shall be 100% rated current continuous and 120% for one minute at rated temperature.

2.2 CONSTRUCTION

A. The controller shall produce an adjustable AC voltage / frequency output. It shall have an output voltage regulation to maintain correct output V/Hz ratio despite incoming voltage variations.

B. The controller shall have a continuous output current rating of 100% of the motor nameplate rating as a minimum.

C. The converter section will incorporate three distinct diode bridges configured in a series connection. The series connection will provide continued balance of the bridges to insure the harmonic litigation remains consistent throughout the life of the drive. The variable frequency drive system shall also include a filter network and a transistorized inverter section. The drive manufacturer will also manufacture the Transistors used in the inverter section of the drive to reduce harmonics to flow back to the incoming power source.

D. The inverter output shall be generated by to be Insulated Gate Bipolar Transistors (IGBT's) with a PIV rating of 1200 volts minimum. The VFD shall not induce excessive power losses in the motor. The worst case RMS motor lines current measured at rated speed, torque and voltage shall not exceed 1.05 times the rated RMS motor current for a pure sin wave operation.

E. The controller (s) shall be suitable for operating standard NEMA Design-B induction squirrel-cage motor having a 1.15 service factor. The drive can be located up to 300 feet from the motor without requiring special cabling or a separate motor protection devices. Motor nameplate information shall be provided by the CONTRACTOR, prior to contract award to the VFD manufacture to properly size the inverter drive to be sized + 1 standard size in HP over that of the motor, and ALSO de-rated for altitude of the project location. In the future, is shall be possible to substitute any standard inverter rate motor (equivalent house power, voltage and RPM) in the field. Output filters shall be installed for motors over 300 foot from VFD.

F. The control logic section shall be fully digital and not require analog adjustment pots or fixed selector resistors. A power failure will not necessitate a reload of any drive parameter or configuration.

2.3 BASIC FEATURES

A. The door of each adjustable speed drive system shall include an operator interface station and key pad with a manual speed device. The interface shall be LED and have a minimum of 4 – digit, 7 – segment display. Each drive shall have operator interface devices as called out in the drawings.

B. For safety the drive will require manual restart for customer programmable faults. The fault displays shall include over current, over voltage, heat sink overheat, load side short circuit, load-side ground fault, inverter overload, stator over-current during start-up, load-side over current during start-up, EEPROM error, RAM error, ROM error, communication error, (Dynamic braking resistor over current), Under voltage, low current, over torque, lose of phase, and motor overload.

C. The door mounted key pad interface shall be capable of controlling the VFD and setting the drive parameters. The key pad shall have the following programming features:

1. The digital display must present all diagnostic messages and parameters values in English engineering units when accessed.

2. The digital interface keypad shall allow the operator to enter exact numerical settings in engineering units. A plain English user menu (rather than codes) shall be provided in software in nonvolatile memory as a guide to parameter setting and reset table in the field through the key pad. The drive set up parameters must be able to be transferred to new boards to reprogram spare boards.
3. The VFD shall have the capabilities of communicating via network via modbus TC/IP to the PLC. All status shall be communication to the PLC including 3 phase voltage, 3 phase current, speed, status alarms, errors, etc.
4. Programmable output relay contacts and inputs shall be rated for 250 VAC, 2 Amps. A separate 24 VDC power supply (50 mA) shall be available to control exterior control devices. Programmable analog output signals shall be available to meet system requirements. Programmable analog input speed signals shall be available to accept a speed command.
5. The principle output frequency shall be programmable from 0-400 Hz and acceleration / deceleration from .1 to 6000 seconds. The PWM carrier frequency shall be adjustable from .5 to 15 kHz and shall be self adjusting.
6. The VFD shall have internal to the drive a proportional gain; integral gain anti-hunting gain, lag time constant and PID error limit adjustments. This shall be programmable through the key pad.

2.4 ENCLOSURE

A. All VFD components shall be factory mounted and wired on a dead front, grounded indoor NEMA Type 12, gasketed enclosure. It shall be suitable for mounting on a concrete house keeping pad. The steel enclosure shall have a minimum of two-layer of primer and one-layer of industrial finished Sherwin Williams Precision enamel paint or equal.

B. A forced air cooling system will automatically start and stop as necessary to extend the life of the fan.

C. VFD systems shall be stand alone system with an integral through the door mounted disconnect switch operator.

D. The dimensions of the VFD enclosure shall be maximum 36” wide, 24” + 8” depth, 90” height.

2.5 PROTECTIVE FEATURES AND CIRCUITS

A. The VFD shall have the following additional protective features that will protect against damage to the motor, load conductor, contactors or solid state soft starts and the VFD internal devices and electronics.

B. Three phase short circuit on the VFD output terminals.

C. Losses of input power due to opening VFD input disconnect device or loss of utility power during VFD operation.

D. A loss of one (1) phase of the input power shall cause the drive to trip off protecting the drive systems electronics.

E. The VFD will run without connection to the motor load but have low current trip.

F. The VFD shall sense an output short circuit that may occur during operation.

G. The key pad display shall provide a minimum of the last 50 system faults.

H. There shall be stall protection on an overload condition with inverse time overcurrent trip. Current limits shall be adjustable from 10 to 215% of the drive current.

2.6 PARAMETER SETTINGS

A. The following system configuring setting shall be provided and field adjustable, without exception, through the keypad/display unit. Except for motor nameplate data, all parameters must be adjustable while the processor is on-line and the drive is running.

1. Motor Nameplate Data.
2. Motor Full Load Amps.
3. Motor Frequency.
4. Number of poles.
5. Full Load RPM's.
6. Motor Voltage.
7. Operating current limits. – Min/Max.
8. VFD Configuration Parameters.
9. Independent accel/decel rates.
10. Min./Max. speed (Frequency
11. Forward or Reverse operation.
12. Catch a spinning load selection.
13. Preset Speed capabilities.
14. Volts per Hertz ratio.
15. No load / Full Load boost.
16. Over current trip selection.
17. Frequency jump selection.
18. Programmable meter output signals (Hz. Speed, RPM, Voltage, Torque, PID feed back, input/output power, and DC bus voltage.

B. Automatic Control

1. 4-20 mA input control signal.
2. PID internal or external set point capabilities.
3. Programmable preset speed operational run conditions.

4. Automatic load reduction during overload condition or soft stall.
5. Programmable loss of signal control: Stop, maintain speed or default to preset speed or set point.

C. All drive setting adjustable and operation parameters shall be restored in a parameter log which allows minimum and maximum points as well as the present set values. This parameter log shall be accessible via a RS-232 or RS485 serial port or other communications method as well as on the keypad or internal to the drive.

D. The drive shall have the following inputs/output features that will provide control and monitoring of the VFD. The analog outputs shall be isolated as required by this specification.
1. Three programmable analog outputs.
2. Two programmable analog inputs. The 4-20mA analog input speed reference signal will be galvanically isolated. Calibration adjustments shall be provided by the keypad.
3. 4-groups of 8 pattern runs or 32 pattern runs shall be available.
4. Three programmable digital output (form C, dry contact relays)
5. One potential pot input (three wire control) +10 V, wiper and common, if specified in drawing.
6. System control program providing built–in drive control or application specific configuration capabilities.
7. Input / output function shall match those indicated in the drawings.
8. Minimum / maximum dry contact output.

2.7 DIAGNOSTIC FEATURES AND FAULT HANDLING

A. The VFD shall include a comprehensive microprocessor based digital diagnostic system that monitors its own control functions and displays faults and operating conditions.

B. A “Fault Log” shall be accessible through the keypad digital illustrations in English. The display shall be capable of illustrating 50 past faults. Optional output shall be through the serial port link. All drive possible fault conditions will be accessible through the fault log.

2.8 DRIVE OPTIONS

A. For drives located more then 300 feet from motor, the drive shall be modified to include a factory or SI wired output line reactor.

B. Information included elsewhere:
1. Drive feed location – See Drawings.
2. Drive overall dimensions allowed – See Drawings.
3. Additional control information – See Drawings.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. The drives will be completely assembled, wired, and tested in the United States of America. The following tests will be performed:

1. The manufacturer shall use the ISO-9001 standards in the purchase, engineering, manufacturing and testing of the VFD system.

2. Upon completion of manufacture and assembly, the drives shall be subjected to a complete factory test to demonstrate compliance with specified features and characteristics of the specification. The purchaser at his option shall be able to witness factory testing of his unit, with factory coordination.

3. The testing procedure shall be the manufacturer's standard procedure (except for loss of phase) to assure maintenance free service. The buyer shall be given a 5 day notice prior to the start of factory testing for the buyer's representative to witness the testing.

4. All equipment, devices, instrumentation, and personnel required to perform the factory tests shall be supplied by the manufacturer. Upon satisfactory completion of the test, the seller shall upon request submit two (2) certified copies of the test report to the buyer. Component failure during testing will require repeating any test associated with the failure or modified components to demonstrate proper operation.

5. A loss of each phase testing shall be conducted at the factory to guaranty the safe and orderly shutdown of the drive under load. These tests shall conclude that the drive will not fail its electronic circuits or causes sever over heating of the bridges. These tests shall not limit the life of the drive system. There are no exceptions to this test. This test shall be performed and test reports provided to the ENGINEER prior to installation of the drive system package.

3.2 STARTUP AND FIELD TESTING

A. The VFD manufacturer shall provide the services of a factory trained technician for startup assistance, programming and testing. Verification of the VFD input harmonics voltage and current distortion limits specified must be verified as part of the start-up and acceptance. If harmonics distortion requirements are not met, it is the responsibility of the VFD supplier to meet these specifications at the manufacturer's expense. Meg-ohm testing will be done to the load conductors and motor to verify condition of the equipment prior to startup. The VFD manufactures shall certify the VFD and motor system as compatible. UL508 technicians shall not be allowed to perform startup procedures.

B. A 10% payment retention will be released upon factory field test verification of harmonic specifications requirements and final test report and acceptance.

C. Spare Parts

1. The following spare parts shall be furnished. The net price per item shall be provided with the request for proposal. Each spare part shall be package and identified by part number and type for long term customer storage.

a. Three of each type of fuse rated 480 Volts or less. Manufacturer's recommended + 1 of each fuse.

b. Two of each type of converter power semi-conductor. Manufacturer's recommended + 1 of each fuse.

c. Two of each type of inverter power semi-conductor. Manufacturer's recommended + 1 of each fuse.

d. One of each type of control board, gate firing board and communication board. Manufacturer's recommended + 1 of each fuse.

e. One key pad assembly. Manufacturer's recommended + 1 of each fuse.

f. OR Replacement VFD for items b. through e. Manufacturer's recommended + 1 of each fuse.

g. Five of each type of panel lamp. Manufacturer's recommended + 1 of each fuse.

h. Three of each size MOV's. Manufacturer's recommended + 1 of each fuse.

END OF SECTION

SECTION 263553 - SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.01 SCOPE

The Contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the contract drawings. To maximize performance and reliability and to obtain the lowest possible let-through voltages, the ac surge protection shall be integrated into electrical distribution equipment such as switchgear, switchboards, panelboards, busway (integrated within bus plug), or motor control centers. Refer to related sections for surge requirements in:

1.02 RELATED SECTIONS

1. Section 262418 – Switchboards – Low Voltage
2. Section 262417 – Distribution Panelboards – Low Voltage
3. Section 262416 – Branch Circuit Panelboards - Low Voltage (Commercial Metering)

1.03 REFERENCES

1. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable standards
   - A. ANSI/UL 1449 4th Edition or later
   - B. ANSI/UL 1283 5th Edition or later (type 2 applications)
   - C. IEEE C62.41.1
   - D. IEEE C62.41.2
     - a. IEEE C62.43-2005
   - E. IEEE C62.45-2002
   - F. IEEE C62.48-2005
   - G. IEEE C62.62-2010
   - H. UL 96A
   - I. NFPA 780

1.04 SUBMITTALS – FOR REVIEW/APPROVAL

1. The following information shall be submitted to the Engineer:
   - A. Provide verification that the SPD complies with the required ANSI/UL 1449 4th Edition or later listing by Underwriters Laboratories (UL). Compliance may be in the form of a file number that can be verified on UL's website www.ul.org, the website should contain the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (In).
2. Where applicable the following additional information shall be submitted to the engineer:

A. Descriptive bulletins

B. Product sheets

1.05 SUBMITTALS – FOR CONSTRUCTION

1. The following information shall be submitted for record purposes:

   A. Final as-built drawings and information for items listed in Section 1.04 and shall incorporate all changes made during the manufacturing process

1.06 QUALIFICATIONS

1. The manufacturer of the electrical distribution equipment shall be the manufacturer of the SPD within the electrical distribution equipment.
2. For the equipment specified herein, the manufacturer shall be ISO 14001 and ISO 9001 or 9002 certified.
3. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of twenty-five (25) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
4. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2011/65/EU and have a visible label showing compliance.
5. The SPD shall be UL 1449 current edition listed, 20 kA nominal discharge current, Type 1 or Type 2 for use in UL 96A systems.

1.07 DELIVERY, STORAGE AND HANDLING

Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of manufacturer's instructions shall be included with the equipment at time of shipment.

1.08 OPERATION AND MAINTENANCE MANUALS

Operation and maintenance manuals shall be provided with each SPD shipped.

PART 2 - GENERAL

2.01 MANUFACTURERS

1. Eaton

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

2.02 VOLTAGE SURGE SUPPRESSION – GENERAL

2. Electrical Requirements

A. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.

B. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 115% of the nominal system operating voltage.

C. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards. End of life mode to be open circuit. Unit with end of life short-circuit mode are not acceptable.

D. Unit shall operate without the need for an external overcurrent protection device, and be listed by UL as such. Unit must not require external overcurrent protective device or replaceable internal overcurrent protective devices for the UL Listing.

E. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

	Protection Modes			
Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●
High Leg Delta	●	●	●	●

A. Nominal Discharge Current (I_n) – All SPDs applied to the distribution system shall have a 20kA I_n rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an I_n less than 20kA shall be rejected.

B. ANSI/UL 1449 4th Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 4th Edition VPR for the device shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	3000

2. SPD Design

F. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable single-mode modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs

requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

G. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.

H. Electrical Noise Filter – Each Type 2 unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.
   a. Type 2 units with filtering shall conform to UL 1283 5th Edition
   b. Type 1 units shall not contain filtering or have a UL 1283 5th Edition Listing.

I. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.

J. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:
   a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
      i. For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
      ii. For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes
      iii. The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.

   a. Remote Status Monitor (optional) – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.
   b. Audible Alarm and Silence Button (optional) – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also

be an audible alarm silence button used to silence the audible alarm after it has been activated.

c. Surge Counter (optional) – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.

   i. The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.

B. Thermal MOV Protection

   The unit shall contain thermally protected MOVs. These self-protected MOVs shall have a thermal protection element integrated with the MOV and a mechanical disconnect with arc quenching capabilities in order to achieve overcurrent protection of the MOV. The thermal protection assembly shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly. The use of plug in single-mode modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

K. Safety Requirements

The SPD shall minimize potential arc flash hazards by containing no single-mode plug in user serviceable / replaceable parts and shall not require periodic maintenance. SPDs containing items such as replaceable single-mode plug in modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

a. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.

2.03 SYSTEM APPLICATION

3. The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

4. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

2.04 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

3. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.
   A. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
   B. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
   C. The panelboard shall be capable of re-energizing upon removal of the SPD.
   D. The SPD shall be integral to the panelboard and connected directly to the bus. Alternately, an integral SPD can be connected to a circuit breaker for disconnecting purposes if a disconnect is required.
   E. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.
   F. The SPD shall be of the same manufacturer as the panelboard.
   G. The complete panelboard including the SPD shall be UL67 listed.

2.05 SWITCHGEAR, SWITCHBOARD, MCC AND BUSWAY REQUIREMENTS

   H. The SPD application covered under this section is for switchgear, switchboard, MCC, and busway locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
   I. The SPD shall be of the same manufacturer as the switchgear, switchboard, MCC, or busway
   J. The SPD shall be factory installed integral to the switchgear, switchboard, MCC, and/or bus plug at the assembly plant by the original equipment manufacturer
   K. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.

L. The SPD shall be connected through a disconnect (30A circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.

M. The SPD shall be integral to switchgear, switchboard, MCC, and/or bus plug as a factory standardized design.

N. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.06 SERVICE ENTRANCE REQUIREMENTS

O. Service entrance located SPDs shall be tested and designed for applications within ANSI/IEEE C62.41 Category C environments.EXECUTION

2.07 EXAMINATION

2.08 FACTORY TESTING

5. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of NEMA, IEEE, and UL standards.

2.09 INSTALLATION

4. The installation of the SPD shall be factory installed integral to the distribution equipment. The Contractor shall install all distribution equipment per the manufacturer's recommendations, applicable electrical codes and the contract drawings.

2.10 WARRANTY

6. The manufacturer shall provide a ten (10) year warranty (15 year warranty with registration) that covers replacement of the complete unit from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local electrical code.

END OF SECTION

SECTION 26 80 10 - HVAC SYSTEMS CONTROL

PART 1 - GENERAL

1.1 SCOPE

Furnish all labor, materials, equipment, appliances and perform all operations in connection with, and complete in strict accordance with, this section of specifications and the applicable drawings and subject to the terms and conditions of the contract for the following work:

A. Electrical work associated with the systems including, but not necessarily limited to:

1. All electrical installation including power distribution and special systems, is included in the scope of the general contract. Of specific concern are the control systems related to mechanical equipment. Responsibility for the control work is divided between the project electrician (Division 26) and his controls sub-contractor.
2. All electrical work shall be in accordance with Division 26.
3. Division 26 shall provide all power to and throughout the building, to include motor control centers, breaker panels, and all other systems designated to Division 26, and specified herein. Division 26 shall install all conduit systems.
4. Division 26 shall run and connect all wiring and devices which power or control motors and other mechanical or control devices. Where control devices are located in power circuit, the controls contractor shall interrupt the circuit in the mechanical equipment junction box, wire through the control device and back to the junction box.
5. Breakers and disconnects, auxiliary contacts, standard pilot lights and magnetic starters are the responsibility of Division 26 and shall be as specified herein.
6. Auxiliary relays, low voltage transformers, control panel switches and devices, thermostats, pressure switches, electric operated valves, etc., are the responsibility of Division 26.
7. All wiring shall terminate at labeled terminal strips.

1.2 APPLICABLE SECTIONS

The General Conditions, Supplementary General Conditions, alternates and Addenda, applicable drawings and the technical specification including but not limited to the following;

A. Section 26 05 00 - Electrical General Requirements.

B. Section 26 05 19 – Conductors and Cables.

1.3 SUBMITTALS

A. Reference Section 26 05 00

B. The controls contractor shall provide shop drawings for control system circuits.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Terminal Blocks: DIN rail mounted, modular type, single layer, non-fused. Entreloc or approved equal.

B. Twisted, Shielded Pair Conductors for Control Wiring: Conductors shall be copper with 100 % shielding, plenum rated. Beldon type 89418 or approved equal. Cables shall be run in conduit.

C. Conductors: All control conductors shall be #14 AWG XHHN-2 minimum.

D. Labeling: All control conductors shall be labeled with a number corresponding to the mechanical control system drawings. All labeling shall be heat-shrink ink printed type by Panduit Pan-Quick LS3 system or equal.

PART 3 - EXECUTION

3.1 GROUNDING

A. Labeling: All control conductors shall be numerically labeled corresponding to the mechanical control systems record drawings.

B. Grounding Lugs: Ground all shielded pair shields at one end only to avoid ground loops. At terminal block connections, the shield shall be continuous from one conductor to another and shall be isolated from the local ground plane.

C. Conductors: All conductors shall be run in conduit unless specifically noted otherwise. The minimum size of conduit shall be 3/4" unless specifically noted otherwise.

END OF SECTION

SECTION 281000 - ACCESS CONTROL

1.1 SUMMARY

A. Section Includes:

1. Access control system.

B. Products Furnished and Installed under This Section:
1. Electric strike(s). (ES)
2. Request to Exit (REX)
3. Card Reader (CR)

1.2 ACTION SUBMITTALS

A. Shop Drawings:

1. Project general notes.
2. Head-end hardware, equipment, and device locations.
3. Block diagram and cable/conduit routing illustrating end-to-end system wiring.
4. End-to-end system communications details.
5. Secondary power calculations

B. Field Quality-Control Submittals:

1. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Installation and programming instructions for operating system software, including all applicable software add-ons.
2. Installation and programming instructions for antivirus and security protection software.
3. Manufacturer's recommended setup and testing procedure for operating system software and applicable software add-ons.
4. Troubleshooting instructions for operating system software and applicable software add-ons.
5. Troubleshooting instructions for antivirus and security protection software.

6. Installation instructions for access control system servers.
7. Installation instructions for access control system DGPs.
8. Installation instructions for access control system input/output interface.
9. Installation instructions for access control system door controllers.
10. Installation instructions for access control system workstation.
11. Installation instructions for access control system power supplies and battery chargers.
12. Installation instructions for access control system printers.
13. Manufacturer's recommended testing and inspection procedure for operation of access control system servers, panels, input/output interfaces, door controllers, and workstations.
14. Manufacturer's recommended testing and inspection procedure for operation of access control system power supplies and battery chargers.
15. Manufacturer's recommended testing and inspection procedure for operation of access control system printers.
16. Installation instructions for integrated credential readers and entry management devices.
17. Printing, programming, and handling instructions for access control credentials.
18. Installation instructions for electrified locking devices and accessories.
19. Installation instructions for egress management devices.
20. Manufacturer's recommended tests and inspections for integrated credential readers and entry management devices.
21. Manufacturer's recommended tests and inspections for electrified locking devices and accessories.
22. Manufacturer's recommended tests and inspections for egress management devices.
23. Manufacturer's recommended testing and inspection procedure for end-to-end operation of access control system software, hardware, and integrated hardware devices.

B. Warranty documentation.

1.5 WARRANTY FOR ACCESS CONTROL SYSTEM

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed access control system performs in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: Three years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 ACCEPTABLE EQUIPMENT FOR ACCESS CONTROL

A. 1 x DSX-1040 Power Distribution Panel

B. 1 x DSX-1042 Intelligent 2 Door Package

C. 1 x DSX-1042 Intelligent Controller per 1-2 additional doors

D. HID Proximity ProxPro II 5455 125 kHz Wall Switch Proximity Reader per 1 door
   1. URL: https://www.hidglobal.com/products/5455

E. If door has crash bar hardware:
   1. h.e.s.|AssaAbloy 9800 Series Surface Mounted Electric Strike per 1 door
      a. URL: https://www.hesinnovations.com/en/products/electric-strikes/9800-series

   OR
   2. h.e.s.|AssaAbloy 9400 Series Surface Mounted Electric Strike per 1 door
      a. URL: https://www.hesinnovations.com/en/products/electric-strikes/9400-series

F. If door has standard door handle and door jamb hardware:
   1. h.e.s.|AssaAbloy 8000 Series Electric Strike per 1 door
      a. URL: https://www.hesinnovations.com/en/products/electric-strikes/8000-series

G. If door opens outward from building:
   1. Alarm Controls|AssaAbloy 1200S, 1200L, 1200LB Single Magnetic Lock per 1 door
      a. URL: https://www.alarmcontrols.com/en/products/magnetic-locks/1200s-1200l-1200lb/
   2. Securitron|AssaAbloy PB2 Push Buttons (or equivalent) per 1 door
      a. URL: https://www.securitron.com/en/products/push-buttons---egress-devices/pb2
   3. Securitron|AssaAbloy XMS Exit Motion Sensor per 1 door
      a. URL: https://www.securitron.com/en/products/push-buttons---egress-devices/xms

PART 3 - EXECUTION

3.1 INSTALLATION OF ACCESS CONTROL SYSTEM

A. Acceptable Installing Companies
   1. Peak Alarm of Salt Lake City, UT
   2. Mountain Alarm of Orem, UT

B. Description: Access control system provides a means of regulating or controlling physical entry into an area, or access to or use of a device by electrical, electronic, and/or mechanical means. Typical access control system includes a card reader at a controlled door, which reads a user credential and sends the collected data to a centrally located DGP over the cabling infrastructure. DGP may hold a user database onboard or may communicate with a user database over the network. If user is authorized for access at a controlled door, DGP signals the electronic lock at the door to unlock. If user credential is not authorized according to user database, the door remains locked and access is denied. In addition to card readers and electronic locks, access control systems may include various other connected devices programmed for a desired function.

C. Performance Criteria:

1. Regulatory Requirements:

a. Components listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Comply with NFPA 1, NFPA 730, NFPA 731, and ICC IBC.
c. Certification: Provide certificate, authorized under UL Certification Service, that access control system installation complies with installation requirements of UL CCN ALOV.

2. Listing Criteria: UL CCN ALOV and UL CCN ALVY; including UL 294.
3. Consult Architect for resolution of conflicting requirements.

D. Selection of Access Control System Components:

1. Source Limitations: Obtain components for access control system from sources approved by manufacturer warranting performance of entire system.

E. Special Techniques:

1. Comply with manufacturer's published instructions.
2. Mounting Heights: Mount field devices in accessible locations in accordance with United States Access Board ADA-ABA Accessibility Guidelines standards.
3. Wiring Methods:

a. Cable Type: Cat 6 Cable
b. Analog Maximum Cable Length: 1000ft
c. Digital Maximum Cable Length: 300ft

F. Interfaces with Other Work / Systems Integration:

1. Coordinate installation of new access control system components with OWNER'S existing System

3.2 FIELD QUALITY CONTROL OF ACCESS CONTROL SYSTEM COMPONENTS

A. Field tests and inspections must be witnessed by OWNER.

B. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections for access control system components.
2. Perform industry standard tests and inspections for power supplies, batteries, and other standby power provisions.
3. Engage factory-authorized service representative to test end-to-end system connection and functionality.
4. Verify monitoring of access control system status and diagnostics information.

C. Nonconforming Work:

1. Access control equipment will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Collect, assemble, and submit test and inspection reports.

3.3 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.

3.4 PROTECTION

A. After installation, protect access control system components from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 281000

SECTION 282300
VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The video surveillance equipment will be provided and installed by the OWNER.
B. The conduits, and single-gang box near the video camera installation will be by the CONTRACTOR.
C. The Cat 6 Cable terminated with RJ-45 Connectors will be provided and installed by the CONTRACTOR from the single-gang box to the location of the network switch. Leave 2-4ft slack in each cable run to accommodate the whip to the camera.

A. END OF SECTION 282300

SECTION 31 05 19
GEOSYNTHETICS

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers the manufacturing and installation of geosynthetics.

1.2 RELATED WORK

A. Related work specified in other sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 31 22 00 Site Grading
3. Section 31 23 15 Excavation and Backfill for Buried Pipelines
4. Section 33 46 16 Sub-Drainage System
5. Section 33 16 00 Underground Water Storage Reservoir

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text to by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. B16.1/ASTM D 751	Standard Test Methods for Coated Fabrics
2. ASTM D 1777	Standard Test Method for Thickness of Textile Materials
3. ASTM D 3786	Standard Test Method for Bursting Strength of Textile Fabrics - Diaphragm Bursting Strength Tester Method
4. ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
5. ASTM D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
6. ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
7. ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
8. ASTM D 5034	Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)
9. ASTM D 5035	Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
10. ASTM D 5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Quality Control Certificates shall be provided at a minimum frequency of one (1) per every hundred thousand (100,000) square feet of geosynthetics produced consecutively,

and which is supplied to the project. These certificates shall be supplied only for the individual rolls of geosynthetics sampled and tested by the Manufacturer or his representative. An individual Quality Control Certificate shall be provided for each roll of geosynthetics provided to the project, which was not produced consecutively within the hundred thousand (100,000) square foot lot. Quality Control Certificates shall be submitted two (2) weeks prior to installation of geosynthetics and shall state that the geosynthetics meets the requirements of these specifications for:

1. Mass per Unit Area
2. Grab Tensile Strength
3. Mullen Burst Strength
4. Equivalent Opening Size

C. Geosynthetics shall not be accepted and/or incorporated into the project without the approved quality control documentation.

D. Certification stating that all geosynthetics is furnished by one manufacturer shall be submitted two (2) weeks prior to installation.

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage and handling of the geosynthetics shall be the responsibility of CONTRACTOR.

B. During shipment, handling and storage, the geosynthetics shall be protected from ultraviolet light exposure, precipitation, or other inundation, mud, dirt, dust, puncture, cutting or any other damage or deleterious conditions. To that effect, geosynthetics rolls shall be shipped and stored in relatively opaque and watertight wrappings. An opaque tarp shall be placed over all rolls where the outer wraps are removed or damaged and where the geotextile is exposed. CONTRACTOR shall be responsible for the replacement of damaged or unacceptable materials at no cost to OWNER.

C. Storage of Materials: A storage area shall be provided on site by OWNER. The storage of geosynthetic materials shall be the responsibility of CONTRACTOR until the completed installation is accepted by ENGINEER.

D. Damaged Geosynthetics: Damaged geosynthetic materials shall be repaired, if possible, in accordance with these specifications, or shall be replaced at no additional cost to OWNER.

1.6 MEASUREMENT AND PAYMENT

A. Geosynthetics shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS

2.1 GEOSYNTHETICS (FILTER FABRIC)

A. The geosynthetics shall be 10-ounce (or heavier) non-woven filter fabric.

B. Geosynthetics shall be provided in rolls.

C. Each roll of geosynthetics shall be externally labeled or tagged to provide product identification sufficient for field determination as well as inventory and quality control purposes. Each roll shall be labeled with the name of manufacturer, roll number, physical dimensions (length and width) and the material type. Any roll of geosynthetics from which the labeling has been removed or has become illegible, shall not be used, but shall be removed from the site and replaced at the expense of CONTRACTOR.

D. The geosynthetics shall be sampled, tested, and certified by the manufacturer for the following properties:

MATERIAL PROPERTIES FOR NON-WOVEN GEOTEXTILE FILTER FABRIC		
Property	Specification	ASTM Test Method
Mass per Unit Area (min)	10.0 oz./S.Y.	D-5261
Grab Tensile Strength (min)	250 lbs.	D-4632
Elongation at Break	50 %	D-4632
Tear Strength (min)	100 lbs	D-4533
Apparent Opening Size (maximum U.S. Sieve size)	100 mesh	D-4751

E. Filter Fabric shall be **Mirafi 1100N by TenCate, 250NW by U.S. Fabrics**, or approved equal.

2.2 GEOSYNTHETIC (DRAINAGE COMPOSITE)

A. Geosynthetic drainage composite materials shall be provided in rolls. The system shall have a polypropylene dimpled core bonded to a non-woven filter fabric.

B. Each roll of geosynthetic material shall be externally labeled or tagged to provide product identification sufficient for field determination as well as inventory and quality control purposes. Each roll shall be labeled with the name of manufacturer, roll number, physical dimensions (length and width) and the material type. Any roll of geosynthetic material from which the labeling has been removed or has become illegible, shall not be used, but shall be removed from the site and replaced at the expense of CONTRACTOR.

C. The geosynthetic materials shall be sampled, tested, and certified by the manufacturer for the following properties:

MATERIAL PROPERTIES PREFABRICATED DRAINAGE COMPOSITE		
Property	Specification	ASTM Test Method
Mass per Unit Area (min)	15.8 oz./S.Y.	D-5261
Grab Tensile Strength of Geotextile (min)	100 lbs.	D-4632
Puncture of Geotextile	30 lbs	D-4833
AOS of Geotextile (min)	70	D-4751
Thickness	0.40 inch	D-1777
Compressive Strength of Core	15,000 psf	D-1621
Flow (gal/min/ft)	17.5	D-4716 @ 4000 psf and i=1

D. Prefabricated Drainage Composite shall be **J-DRain 420 by JDR Enterprises, Inc., Delta-Drain 6000 by Cosella-Dorken**, or approved equal.

PART 3 EXECUTION

3.1 DEPLOYMENT

A. Prior to deployment, CONTRACTOR shall inspect each roll of geosynthetics to verify that the roll has a valid Quality Control Certificate and that has been previously approved by ENGINEER.

B. Adjacent rolls shall be joined by overlapping the edges a minimum of twelve (12) inches.

C. The overlap shall be glued, sewn or otherwise fastened or secured at intervals no greater than two feet along a line through the midpoint of the overlap. Additional fasteners shall be installed as necessary to prevent slippage of the geosynthetics regardless of location.

D. CONTRACTOR shall visually inspect the geosynthetics during deployment for holes, tears or improperly formed geosynthetics. Defective areas shall be repaired or removed and replaced by CONTRACTOR at no additional cost to OWNER.

E. Smoking shall not be permitted on the geosynthetics.

F. CONTRACTOR shall be responsible to provide adequate loading (e.g., sand bags or similar items that will not damage the underlying geosynthetic) to prevent movement of the geosynthetics. Any damage to the geosynthetics shall be repaired at CONTRACTOR's expense.

G. The geosynthetics shall not be exposed to the sun and elements for more than 72 hours unless the filter fabric has ultraviolet inhibitors. Fabric with ultraviolet inhibitors shall not be exposed for a period in excess of the manufacturer's recommendations, in which case manufacturer shall provide prior to product delivery.

H. Any damage to the geosynthetics during installation or any fabric that has been exposed to the sun or elements for longer than the 72 hours, or as specified by the manufacturer, shall be replaced by CONTRACTOR at no additional cost to OWNER.

I. CONTRACTOR shall be responsible to observe placement of geosynthetics. CONTRACTOR shall provide a daily inventory of all geosynthetics deployed to ENGINEER.

3.2 REPAIRS

A. Any holes, tears or defective areas in the geosynthetics shall be repaired by patching with same type of geosynthetics. The patch shall extend a minimum of twelve (12) inches in all directions beyond the area to be repaired. The patch shall be secured in place by gluing, sewing, or securing the fabric as per these specifications.

- END OF SECTION -

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SECTION 31 11 00
CLEARING, GRUBBING, AND STRIPPING

PART 1 GENERAL

1.1 SUMMARY

A. This Work shall consist of removing and disposing of all trees; shrubs; brush; stumps; windfalls; roots; and other vegetation, including dead and decayed matter; and debris that exist within the designated construction limits, borrow areas, and soil stockpile areas and which are not specifically designated to remain.

1.2 DEFINITIONS

A. Clearing: Clearing operations shall consist of cutting, removing and disposing of trees, shrubs, bushes, windfalls and other vegetation within the construction limits, borrow areas, and soil stockpile areas. All brush shall be cut off within six inches of the ground surface.

B. Grubbing: Grubbing operations shall consist of removing and disposing of stumps, roots, debris deleterious materials, and other remains (such as organic and metallic materials) which if left in place would interfere with proper performance or completion of the contemplated work, would impair its subsequent use or form obstructions therein. Organic material from clearing or grubbing operations shall not be incorporated in fill or backfill.

C. Stripping: Stripping operations shall consist of removing all soil material containing sod, grass, or other vegetation and topsoil to a minimum depth of six (6) inches from all areas that will receive fill or over all trenches in field or yard areas.

1.3 MEASUREMENT AND PAYMENT

A. Measurement and payment for clearing, grubbing and stripping shall not be paid as a unit item, but considered as included in the contract unit or lump sum prices for the various items of the contract to which it relates.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 CLEARING

A. All trees, stumps, shrubs, bushes, windfalls and other vegetation (except such trees and vegetation as may be indicated or directed by ENGINEER to be left standing) shall be cut off to within six inches of the ground surface and shall be removed from the construction limits. Trees and vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by such means as the circumstances require.

3.2 GRUBBING

A. All stumps, roots, debris, deleterious and other organic or metallic materials not suitable for foundations shall be removed completely from the construction limits, borrow areas

and soil stockpile areas. Unless otherwise permitted by ENGINEER, stumps shall be removed completely. If any stumps are permitted to remain, they shall be cut off not more than six inches above the ground.

3.3 STRIPPING

A. Soil material containing sod, grass, or other vegetation and topsoil shall be removed to a minimum depth of six (6) inches from all areas to receive fill from the area within lines 5 feet outside all foundation walls, over all trenches, and from beneath pavement and curb and gutter areas. Place and compact stripped material at east 2:1 slope of pump station property, see plans, or in other locations acceptable to ENGINEER. Topsoil shall be placed over areas which may be landscaped in future (outside of paved areas).

3.4 DISPOSAL

A. Open burning of combustible materials will be not allowed.

B. All trees, timber, stumps, roots, debris, shrubs, bushes, and other vegetation removed during the clearing and grubbing operations shall be removed from the project site and disposed of by CONTRACTOR subject to specific regulations imposed by laws and ordinances and in a manner that will not create a public nuisance nor result in unsightly conditions. CONTRACTOR shall assume full responsibility for acceptable disposition of the material as well as for any damages resulting from his disposal operations.

- END OF SECTION -

SECTION 31 22 00
SITE GRADING

PART 1 GENERAL

1.1 SUMMARY

A. This Work consists of site grading and related activities.

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 45 00 Quality Control and Materials Testing
2. Section 01 50 00 Temporary Construction Utilities & Environmental Controls
3. Section 31 23 15 Excavation and Backfill for Buried Pipelines
4. Section 31 23 23 Excavation and Backfill for Structures
5. Section 32 11 23 Untreated Base Course

1.3 REFERENCES

A. The latest edition of the following publications form a part of these Specifications to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM D 1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3)
2. ASTM D 2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

1.4 MEASUREMENT AND PAYMENT

A. Site grading shall not be paid as a separate item but shall be paid as part of the items to which it relates.

PART 2 PRODUCTS

2.1 EMBANKMENT MATERIAL

A. Embankment materials are defined as those complying with ASTM D2487, the Unified Soil Classification System (USCS) of CL, ML, SM, SC, SP or combinations of these materials.

B. Embankment material shall be free from frozen lumps, rocks larger than 6 inches in the larger dimension, roots, trash, lumber, or organic material. Suitability of material for embankment in accordance with these criteria will be as determined by ENGINEER.

C. Use of natives as embankment material in fills. Outside the perimeter of those fills which must be structural fill material (ie outside the 1:1 sloped fill lines which support pump station footings and floor), fills may be native excavated earth (per goetech report) if it meets fill compaction requirements.

1. Using native (onsite excavated earth) materials below AC paving and concrete. The geotech report indicates if native excavated earth (ie native clay) is too wet or too dry it may be impractical to achieve the required 96% minimum compaction required below asphalt paving, sidewalks and curb & gutter. NOTE: Minimum compation is based on the average of the two Proctor tests required in Section 31 23 23, paragraph 2.1. Remove and replace any non-compliant fills with compliant fills.
2. Using natives in fills outside of areas covered with asphalt or concrete. If native materials meet a 90% compaction requirement, they may be used in the shallow fills which are outside of areas covered with asphalt and concrete. These areas are shown on grading plans covered with open graded rock.

D. It is anticipated that CONTRACTOR will be required to furnish additional quantities of embankment fill material from off-site sources to supplement material available from on-site excavations. However, if required, CONTRACTOR shall not borrow materials from adjacent private or public lands without providing to OWNER written verification of such approval from the appropriate landowner or agency. CONTRACTOR shall be responsible for all costs associated with providing additional quantities of embankment fill as may be required to complete the work described herein and as shown on the Contract Drawings.

PART 3 EXECUTION

3.1 GENERAL

A. Grading shall produce uniform grades or slopes between spot elevations or contours shown.

B. Areas of construction activity shall be left in condition of uniform grade, blending into pre-existing contours and concealing, as much as possible, evidence of construction activity by back dragging or raking to conceal tire marks. Revegetation shall not be performed until the subgrade is acceptable to OWNER.

C. Unless otherwise directed by OWNER, all excess excavated materials shall be removed from the site and disposed of by CONTRACTOR. CONTRACTOR shall restore stockpile area to pre-existing condition.

3.2 SITE PREPARATION

A. Prior to placement of embankment fill, loose or disturbed soil shall be removed and replaced with compacted structural fill, or disturbed soil shall be properly compacted.

B. Prior to placement of embankment fill, the top 6-inches, or as noted on the Contract Drawings, of the subgrade shall be scarified and compacted to 95% minimum Modified Proctor density as determined by ASTM D1557.

C. Embankment shall include the placement of materials to raise the existing grade to the established elevations indicated and the construction of driving surfaces.

D. Embankment material shall be placed in no more than 8-inch loose lifts for heavy equipment, and 4-inch loose lifts for hand operated equipment.

E. All embankment fill material shall be placed and compacted to 96% minimum Modified Proctor Density as determined by ASTM D1557. Embankment under roadways, to a minimum depth of four feet, shall be compacted to 96% minimum as determined by ASTM D1557.

F. Where the moisture content is not suitable and/or sufficient compaction has not been obtained, the fill shall be reconditioned to an approved moisture content and recompacted to the minimum required compaction, unless recommended otherwise by the Soils Testing Agency, prior to placing any additional fill material.

G. Unless otherwise specified, CONTRACTOR shall be responsible for arranging for the placing and compacting of approved fill material in accordance with these Specifications. If the Soils Testing Agency should determine that CONTRACTOR is failing to meet the minimum requirements, CONTRACTOR shall stop operations and make adjustments as necessary to produce a satisfactorily compacted fill at no additional cost to OWNER.

3.3 GRADING

A. The final grade of all completed areas shall be between plus and minus one-tenth (± 0.1) of a foot from the grade designated on the Contract Drawings.

- END OF SECTION -

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SECTION 31 22 16
FINE GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Perform fine grading work required to prepare site for landscape finish grading and soil preparation as described in Contract Documents.
   2. Furnishing of conditioner to stockpiled topsoil.

B. Related Sections:
   1. Section 32 91 13: Finish grading and soil preparation for landscaping.

1.2 REFERENCES

A. American Society For Testing And Materials:
   1. ASTM D 1557-02, 'Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.'

1.3 QUALITY ASSURANCE

A. Pre-Installation Conference: Participate in pre-installation conference.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not commence work of this Section until site grading tolerances are met.

3.2 PREPARATION

A. Protection: Protect utilities and site elements from damage.

B. Surface Preparation:
   1. Before placing topsoil, dig out weeds from planting areas by their roots and remove from site. Remove rocks larger than 1 inch in size and foreign matter such as building rubble, wire, cans, sticks, concrete, etc.
   2. Remove imported paving base material present in planting areas down to natural sub-grade or other material acceptable to Architect.
   3. Limit use of heavy equipment to areas no closer than 6 feet from tank or other permanent structures.

3.3 PERFORMANCE

A. Interface with Other Work: Do not commence work of this Section until site grading tolerances are met.

B. Site Tolerances:
   1. Maximum variation from required grades shall be 1/10 of one foot.
   2. To allow for final finish grades of planting areas, sub-grade elevations in landscape areas, before placing topsoil are:
      a. Upland Grass Seed Areas: 5 inches below top of walk or curb.

C. Do not expose or damage existing shrub or tree roots designated to remain.

D. Distribute approved imported topsoil as required. Remove organic material, rocks and clods greater than 1 inch in any dimension, and other objectionable materials.

E. Slope grade away from structure for 12 feet minimum from walls at slope of 1/2 inch in 12 inches minimum unless otherwise noted. Direct surface drainage in manner indicated on Drawings by molding surface to facilitate natural run-off of water. Fill low spots and pockets with specified fill material and grade to drain properly.

END OF SECTION

SECTION 31 23 15
EXCAVATION AND BACKFILL FOR BURIED PIPELINES

PART 1 GENERAL

1.1 SUMMARY

A. This item shall consist of excavating all pipeline trenches to the lines and grades indicated on the Contract Drawings or as directed by ENGINEER in the field, and the backfilling of all pipeline trenches. Excavation shall include the removal of all materials of whatever nature encountered to the depths shown on the Contract Drawings, or as modified in the Field by ENGINEER.

1.2 RELATED SECTIONS

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 01 45 00 Quality Control & Materials Testing
3. Section 01 50 00 Temporary Construction Utilities and Environmental Controls
4. Section 31 23 19 Dewatering
5. Section 33 05 05 Ductile Iron Pipe
6. Section 33 05 11 HDPE Pressure Pipe
7. Section 33 92 10 Steel Pipe, Specials, and Fittings

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referred. The publications are referred to in the text by basic designation only.

B. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

1. M 145 Standard Specification for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
2. T 27 Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates
3. T 88 Standard Method of Test for Particle Size Analysis of Soils
4. T 96 Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
5. T 180 Standard Method of Test for Moisture Density Relations of Soils Using a 10 lb. (4.54 kg) Rammer and an 18 in (457 mm) Drop
6. T 191 Standard Method of Test for Density of Soil In Place by the Sand Cone Method
7. T 205 Density of Soil In-Place by the Rubber-Balloon Method
8. T 238 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
9. T 239 Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
10. T 310 Standard Specification for In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. C 131 Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
2. C 136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
3. D 422 Standard Test Method for Particle Size Analysis of Soils
4. D 698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft3)
5. D 1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone method
6. D 1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft3)
7. D 2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity -Flow Applications
8. D 2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
9. D 6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.4 DEFINITIONS

A. Degree of Compaction: Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557.

B. Pipe Zone: That zone in an Excavation which supports, surrounds, and extends to 12 inches above the top of the pipe barrel. Specifically, 4 inches below the bottom (where rock, hard pan, boulders, etc. are encountered), 12 inches above the top of the pipe, and 1 foot laterally beyond both sides of the pipe, unless noted otherwise on the Drawings.

C. Trench Zone Backfill: That zone in an Excavation which begins 12 inches above the top of the pipe barrel and extends to the natural surface level or the finished grade indicated on the Plans.

D. Unyielding Material: Unyielding material shall consist of rock and gravelly soils with stones greater than 12 inches in any dimension or as defined by the pipe manufacturer, whichever is smaller.

E. Unstable Material: Unstable material shall consist of materials too wet to allow backfill compaction or to properly support the utility pipe, conduit, or appurtenant structures.

F. Rock: Solid mineral material which cannot be removed with equipment reasonably expected to be used in the Work without cutting, drilling or blasting. Minimum equipment size, in good running order, shall be similar to a **Komatsu 300, Caterpillar 320 or 330**, or equal.

1.5 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 - Submittal Procedures:

1. Copies of Field Density Test reports shall be submitted to ENGINEER or RPR at the beginning of each workday for the previous day's testing of subgrades, embankments and backfill Materials.
2. Copies of all Laboratory Test Reports shall be submitted to ENGINEER or RPR within 24 hours of the completion of the test.
3. Submit gradations and proctors for Pipe Zone Material and Trench Zone Backfill.
4. Excavation Protection Plan: Describe sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations to support plan.

1.6 SITE CONDITIONS

A. Unsuitable Weather Limitations: CONTRACTOR shall not place, spread, or roll any fill material during unsuitable weather conditions. CONTRACTOR shall not resume operations until moisture content of material is satisfactory.

B. Weather Softened Subgrade: CONTRACTOR shall remove and replace at no additional cost to OWNER soft subgrade materials resulting from adverse weather conditions.

C. Protection of Graded Areas: CONTRACTOR shall protect all graded areas from traffic and erosion and shall keep these areas free of trash and debris. Work required to repair and reestablish grades in settled, eroded, and rutted areas shall be completed to specified tolerances at CONTRACTOR's expense.

D. Reconditioning Compacted Areas: All areas compacted to required specifications that become disturbed by subsequent construction operations or weather conditions shall be scarified, moisture conditioned, and re-compacted to the required density prior to further construction.

E. Grading: the final compacted surface of base course shall not vary more than 1/4 inch above or below design grade.

PART 2 PRODUCTS

2.1 MATERIALS

A. Stabilization Material: Stabilization material shall consist of hard, durable particles of stone or gravel, screened or crushed to the required size and gradation. The material shall be free from vegetation matter, lumps or balls of clay, or other deleterious matter and shall conform to the following gradation when tested in accordance with AASHTO T 27 or ASTM C 136.

1. Coarse material shall be crushed or washed and fine material shall be wasted to meet the grading requirements set forth below. Note that if stabilization material is required, an 8 oz. non-woven filter fabric shall be placed between the stabilization material and the pipe zone material.

2. Coarse aggregate, retained on the No. 4 sieve, shall have a percentage of wear not greater than 40 percent when tested by the Los Angeles Test, AASHTO T-96 or ASTM C 131.

Sieve Size (Square Opening)	Percent By Weight Passing Screen
2-inch	100
1-1/2 inch	10 - 50
3/4-inch	0 - 25
No. 4	0 - 10
No. 200	0 - 3

B. Pipe Zone Material: All material in the pipe zone shall be clean and free from alkali, salt, petroleum products, vegetative matter or other deleterious matter, slag, cinders, ashes and rubbish or other material that in the opinion of the ENGINEER may be objectionable or deleterious. "Squeegee" or any other flowable material shall not be permitted. Pipe zone material shall conform to the following:

1. Storm Drain – Gravel, 100 percent crushed mineral aggregate per the following gradation:

U.S. Standard Sieve Size (Square Opening)	Percent By Weight Passing Screen
1 1/2 - inch	100
1 - inch	95-100
1/2 - inch	25-60
No. 4	0-10
No. 200	0-5

2. Waterline – Sand per the following gradation:

U.S. Standard Sieve Size (Square Opening)	Percent By Weight Passing Screen
1/2 - inch	100
No. 10	30-60
No. 40	0-30
No. 200	0-15

3. Waterline – Controlled Low-Strength Material (Flowable Fill):

a. Flowable Fill shall be per APWA Section 03 31 05 – Controlled Low Strength Material. Contractor shall submit a CLSM material – which is sand-cement-flyash slurry mix that has between 50 to 150 psi strength at 28 days. Submit any proposed admixtures.

C. Select Trench Backfill: When pipes are below structures (and below 1:1 sloped planes supporting footings), Trench Zone Backfill must be Structural Fill Material.

D. Native Trench Backfill: Do not use native earth for trench backfill.

E. Imported Granular Trench Backfill: Use non-plastic imported granular trench backfill meeting soils classifications A-1, A-2 or A-3 (A-1-a for Granular Borrow material) of AASHTO M 145 with max particle size under 6 inches and meet a 96% compaction requirement.

PART 3 EXECUTION

3.1 EXCAVATION

A. Excavation shall be performed to the lines and grades indicated. All excavated materials not intended for reuse shall be removed from the site and disposed of by the Contractor.

B. Rock Removal

1. CONTRACTOR shall cut away Rock at excavation bottom to form level bearing.
2. All shaled layers shall be removed to provide sound and unshattered base for foundations.
3. CONTRACTOR shall remove and legally dispose of excess excavated material and debris off-site unless indicated otherwise.

4. CONTRACTOR shall correct unauthorized Rock removal at no additional cost to OWNER.

3.2 SAFETY

A. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable State safety requirements and the latest requirements of OSHA Safety and Health Standards for Construction (29 CFR 1926). CONTRACTOR is responsible for assessing safety needs to meet such requirements, arranging for proper equipment and/or construction methods, and maintaining such equipment, methods and construction practices so as to fully comply with all safety requirements.

B. CONTRACTOR is responsible for assessing needs related to confined space entry, as defined by OSHA. CONTRACTOR shall meet all such requirements, arranging for proper equipment and/or construction methods, and maintaining such equipment, methods and construction practices so as to fully comply with all confined space safety requirements.

3.3 DEWATERING

A. Water removal shall be in accordance with Section 31 23 19 - Dewatering.

3.4 TRENCH WIDTH

A. The bottom of the trench shall have a minimum width equal to the outside diameter of the pipe plus 24-inches or as detailed on the Contract Drawings.

B. The width of the trench shall be ample to permit the pipe to be laid and jointed properly, and the backfill to be placed and compacted as specified. Trenches shall be of such extra width, when required, as will permit the convenient placing of timber supports, sheeting, and bracing, and the handling of special units as necessary.

3.5 TRENCH PREPARATION

A. Each trench shall be excavated so that the pipe can be laid to the alignment and grade as required. The trench wall shall be so braced that the workmen may work safely and efficiently. All trenches shall be drained so the pipe laying may take place in dewatered conditions.

B. Bottom Preparation

1. Where rock, hard pan, boulders or other material which might damage the pipe are encountered, the bottom of the trench shall be over excavated 4 inches below the required grade and replaced with Stabilization Material. Otherwise, the bottom of the trench shall be over excavated 6 inches or 1/12 the outside diameter of the pipe, whichever is greater, below the required grade and replaced with Pipe Zone Backfill.
2. The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Bell holes shall be excavated to the necessary size at each joint or coupling to eliminate point bearing. Stones of 1-inch or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.

C. Removal of Unstable Material

1. Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed by ENGINEER and replaced to the proper grade with Stabilization Material. When removal of unstable material is required due to the fault or neglect of CONTRACTOR in his performance of the work, the resulting material shall be excavated and replaced by CONTRACTOR without additional cost to OWNER.

D. The trench bottom (at the level of the base of the pipe) shall be given a final trim using a string line, laser, or another method approved by ENGINEER for establishing grade, such that each pipe section when first laid will be continually in contact with the ground along the extreme bottom of the pipe. Bell holes shall be provided at each joint to permit the jointing to be made properly. The trench grade shall permit the pipe spigot to be accurately centered in the preceding laid pipe joint, without lifting the pipe above the grade, and without exceeding the permissible joint deflection.

3.6 SHEETING AND SHORING

A. Sheet, shore, and brace excavations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.

B. Support trenches excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.

C. Design sheeting and shoring to be removed at completion of excavation work.

D. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.

E. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

3.7 LAYING AND JOINING PIPE

A. Laying pipe: Provide proper facilities for lowering pipe sections into place. Dropping pipe will not be permitted. Place each section true to line and gradient in close and true contact with adjacent sections.

B. Joining pipe:

1. Use methods of joining conduit sections ensuring ends are fully entered and inner surfaces are flush and even. The equipment used to force the joints together must be adequate to overcome the gasket pressure involved. Pipe shall be installed in accordance with these specifications and the manufacturers written specifications.
2. Just prior to joining the pipes, both spigot and bell ends shall be thoroughly cleaned to remove all foreign substances which may have adhered to the bell and spigot surfaces. All dust and dirt shall be removed with a clean rag. An approved lubricant (recommended by the manufacturer), that is not injurious to the gasket, shall be applied in accordance with the manufacturer's recommendations.
3. In the event any foreign material becomes embedded in the lubricant, or the lubricant becomes contaminated by water or other substances before the joint is started, the area affected shall be re-cleaned and new lubricant applied.
4. The pipe being joined shall be carefully moved into position, line and grade checked, and, as the spigot end is started into the bell of the section previously laid, the gasket shall be checked to insure uniform entry into the bell at all points. Align the spigot to the bell and insert the spigot into the bell until it contacts the gasket uniformly. Apply firm steady pressure either by hand or by bar and block assembly, until the spigot easily slips through the gasket. Care must be taken to ensure that the spigot is not over-inserted and that previously assembled pipe joints are not disturbed.

3.8 PIPELINE TRENCH BACKFILLING AND COMPACTION

A. Pipe Zone:

1. Pipe Zone Backfill shall be placed in layers not exceeding 6 inches loose thickness for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines, unless otherwise approved or specified. The backfill shall be brought up evenly on both sides of the pipe for the full length of the

pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe. Each layer shall be compacted to at least 95 percent of the maximum Modified Proctor density (ASTM D-1557), unless otherwise specified.

2. Replacement of Unyielding Material: Unyielding material removed from the bottom of the trench shall be replaced with Stabilization Material placed in layers not exceeding 6 inches loose thickness.
3. Replacement of Unstable Material: Unstable material removed from the bottom of the trench or excavation shall be replaced with Stabilization Material placed in layers not exceeding 6 inches loose thickness.
4. Where the pipe grade exceeds 30%, cohesive material shall be used in lieu of pipe bedding. The cohesive material shall be moistened to within 2% of optimum moisture and compacted as noted.
5. The relative density of the compacted cohesionless material shall not be less than 60% as determined by the Bureau of Reclamation Relative Density of Cohesionless Soil Test (Designation E-12) of the "Earth Manual."

B. Trench Backfill: Trenches shall be backfilled to the grade shown with Trench Zone Backfill material as specified.

1. Trench backfill in asphalted road shall consist of backfilling the trench from above the pipe zone up to underneath the noted recommended depth for untreated base course and asphalt or concrete of finished grade with Trench Backfill material compacted to 95 percent of maximum density (ASTM D-1557). Backfill shall be placed in layers not exceeding 6-inches loose thickness for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines, unless otherwise approved or specified.
2. Trench backfill in unimproved or landscaped areas shall consist of backfilling the trench from above the pipe zone to 8-inches below finished grade with Trench Backfill material compacted to 95 percent of maximum density (ASTM D-1557). Backfill from 8-inches below finished grade to finished grade shall consist of topsoil replacement in addition to replacement of all landscaped materials. Trench backfill shall be placed in layers not exceeding 8 inches loose thickness.
3. It shall be the responsibility of CONTRACTOR to be assured that the Trench Backfill material is capable of being compacted to the degree specified. It shall be CONTRACTOR’s responsibility to remove and dispose of all excess excavated material.

C. Final Backfill:

1. Unimproved and Landscaped Areas: The top 8-inches of the trench shall be filled with topsoil. Topsoil may be native material stripped prior to excavation of the trench. Backfill shall be deposited in layers of a maximum of 12-inch loose thickness and compacted to a minimum of 85 percent maximum density (ASTM D-1557). Compaction by water flooding or jetting will not be permitted. This requirement shall also apply to all other areas not specifically designated above.
2. Roadways shall be completed with the type and thickness of materials (i.e., Untreated Road Base and Asphalt) as indicated or shown on the Contract Drawings

3.9 SPECIAL REQUIREMENTS

A. Special requirements for both excavation and backfill relating to the specific utilities from above the pipe zone to the natural surface level or the finished grade indicated on the Plans shall be placed and compacted as follows:

1. Where existing underground pipes or conduits larger than 3 inches in diameter and all sizes of sewer lines or sewer laterals cross the trench above the new work, the backfill from the bottom of the trench to 1 foot above the top of the intersecting pipe or conduit shall be pipe zone material compacted to 95 percent of maximum density (ASTM D-1557). The pipe zone material shall extend 2 feet on either side of the intersecting pipe or conduit to ensure that the material will remain in place while other backfill is placed.

B. The maximum trench length open at any given time shall not exceed 200 feet unless approved by ENGINEER and must be backfilled in a timely manner.

3.10 MAINTENANCE OF BACKFILL

A. All backfill shall be maintained in satisfactory condition, and all places showing signs of settlement shall be filled and maintained during the life of the Contract and for a period of one year following the day of final acceptance of all work performed under the Contract. When CONTRACTOR is notified by ENGINEER or OWNER that any backfill is hazardous, CONTRACTOR shall correct such hazardous condition at once. Any utility, road and/or parking surfacing damaged by such settlement shall be repaired by CONTRACTOR to the satisfaction of OWNER and ENGINEER. In addition, CONTRACTOR shall be responsible for the cost to OWNER of all claims for damage filed with the Court, actions brought against the said OWNER for, and on account of, such damage.

3.11 FINISH GRADING AND CLEANUP

A. CONTRACTOR shall grade the trench line to a smooth grade to affect a neat and workmanlike appearance of the trench line.

B. All tools, equipment and temporary structures shall be removed. All excess dirt and rubbish shall be removed from the site by CONTRACTOR.

C. CONTRACTOR shall restore the site to at least as good as original condition, including but not limited to final trench grade and restoration of affected public and private facilities whether in the public right-of-way or on private property. Any exception to this requirement must be in writing from ENGINEER for the job specific conditions.

3.12 COMPACTION TESTS

A. It shall be the responsibility of CONTRACTOR to accomplish the specified compaction for backfill, fill, and other earthwork. It shall be the responsibility of CONTRACTOR to control his operations by performing any additional tests necessary to verify and confirm that CONTRACTOR has complied, and is complying at all times, with the requirements of these Specifications concerning compaction, control, and testing.

1. Testing of Backfill Materials

a. Characteristics of backfill materials shall be determined in accordance with the requirements of Section 01 45 00 - Quality Control & Materials Testing.
b. The CONTRACTOR shall demonstrate the adequacy of compaction equipment and procedures before exceeding any of the following amounts of earthwork quantities:
   i) 50 linear feet of trench backfill.
c. Until the specified degree of compaction on the previously specified amounts of earthwork is achieved, no additional earthwork of the same kind shall be performed.
d. After satisfactory conclusion of the initial compaction demonstration and at any time during construction, earthwork which does not comply with the specified degree of compaction shall not exceed the previously specified quantities.
e. Compliance tests may be made by ENGINEER to verify that compaction is meeting the requirements previously specified at no cost to CONTRACTOR.
f. ENGINEER may require retesting of backfill that has settled from water penetration in the trench. CONTRACTOR shall remove the overburden above the level at which ENGI¬NEER wishes to test and shall backfill and recompact the excavation after the test is complete at no additional cost to the OWNER.
g. If compaction fails to meet the specified requirements, CONTRACTOR shall remove and replace the backfill at proper density or shall bring the density up to specified level by other means acceptable to ENGINEER. Subsequent tests required to confirm and verify that the reconstructed backfill has been brought up to specified density shall be paid by CONTRACTOR. CONTRACTOR's confirmation tests shall be performed in a manner acceptable to ENGINEER

2. Field Density Tests

a. Field density tests shall be made in accordance with ASTM D 1557.

- END OF SECTION –

SECTION 31 23 19
DEWATERING

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section provides specifications for dewatering systems and appurtenances to be used during construction as required to remove water and continuously maintain groundwater at a level at least 1-foot below the bottom of the excavation.

B. CONTRACTOR shall obtain all necessary permits for disposal of water removed from the excavation.

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures

1.3 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Before dewatering is commenced, CONTRACTOR shall provide information to ENGINEER outlining the method, installation and details of the proposed dewatering system. CONTRACTOR shall provide ENGINEER with plans setting forth details of the proposed dewatering systems. The dewatering system plans shall be of sufficient detail to indicate sizes of pumps, piping, appurtenances, the ultimate disposal point for water, and to indicate the overall completeness and effectiveness of the proposed system.

C. CONTRACTOR shall certify to OWNER that the design and implementation of the proposed dewatering system is sufficient to complete the Work.

D. Submit a plan to monitoring settlement of adjacent structures.

1.4 QUALITY CONTROL

A. CONTRACTOR shall be responsible to control the rate and effect of dewatering to avoid all settlement and subsidence.

B. Where critical structures exist immediately adjacent to areas of proposed dewatering, reference points shall be established and observed at frequent intervals to detect any settlement which may develop. CONTRACTOR is responsible for protecting adjacent structures from settlement. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of CONTRACTOR.

PART 2 PRODUCTS

2.1 MATERIALS

A. CONTRACTOR shall be responsible for selection of dewatering means, methods and materials.

B. Standby pumping equipment shall be maintained on the Site.

PART 3 EXECUTION

3.1 DESIGN AND IMPLEMENTATION

A. CONTRACTOR shall be responsible for complete design and implementation of the dewatering system.

B. CONTRACTOR shall be responsible for the design and implementation of any modifications that may be required to the initial design of the dewatering system (at no additional cost to OWNER) to provide a dewatering system that operates adequately to complete the Work.

C. CONTRACTOR shall furnish, install, operate and maintain all machinery, appliances, and equipment to maintain all excavations free from water during construction.

D. CONTRACTOR shall dispose of water so as to not cause damage to public or private property, or to cause a nuisance or menace to the public or violate the law.

E. CONTRACTOR shall be responsible to obtain groundwater discharge permits, if required.

F. CONTRACTOR shall install and operate the dewatering system so as to not cause damage or endanger adjacent structures or property.

G. The control of groundwater shall be such that softening of the bottom of excavations, or formation of "quick" conditions or "boils," does not occur. Dewatering systems shall be designed and operated so as to prevent removal and migration of the natural soils.

H. CONTRACTOR shall have sufficient stand-by equipment at the project site at all times to continuously maintain the dewatering program until Work necessitating dewatering is complete.

I. CONTRACTOR shall have on hand equipment and machinery in good working condition for emergencies and shall have personnel available for operation of such equipment and machinery.

J. CONTRACTOR shall control surface water to prevent entry into excavations.

- END OF SECTION -

SECTION 31 23 23
EXCAVATION AND BACKFILL FOR STRUCTURES

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers excavating, backfilling, and compacting of disturbed areas for structures and roadways as directed by ENGINEER.

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 01 45 00 Quality Control and Materials Testing
3. Section 01 45 23 Testing Agency Services
4. Section 01 50 00 Temporary Construction Utilities and Environmental Controls
5. Section 31 11 00 Clearing, Grubbing and Stripping
6. Section 31 23 15 Excavation and Backfill for Buried Pipelines
7. Section 31 23 19 Dewatering

1.3 REFERENCES

A. The latest edition of the following publications form a part of this specification to the extent referred. The publications are referred to in the text by basic designation only.

B. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

1. M 145 Standard Specification for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
2. T 27 Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates
3. T 88 Standard Method of Test for Particle Size Analysis of Soils
4. T 180 Standard Method of Test for Moisture Density Relations of Soils Using a 10 lb. (4.54 kg) Rammer and an 18 in (457 mm) Drop
5. T 191 Standard Method of Test for Density of Soil In Place by the Sand Cone Method
6. T 310 Standard Specification for In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. D 422 Standard Test Method for Particle Size Analysis of Soils
2. D 698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft3)
3. D 1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone method
4. D 1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft3)
5. D 2487 Standard Practice for Classification of Soils for Engineering Purposes

(Unified Soil Classification System)

6. D 6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

D. The latest Edition of the Utah Department of Transportation Standard Specification for Road and Bridge Construction.

E. The latest Edition of the American Public Works Association (APWA) and Associated General Contractors of America Standard Plans and Standard Specifications.

1.4 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 Submittal Procedures:

1. Submit gradations and proctors for structural fill materials and each backfill material used.

PART 2 PRODUCTS

2.1 WALL BACKFILL MATERIAL

A. Wall backfill material shall consist of native or import fill material meeting soils classifications A-1, A-2 or A-3 of AASHTO M 145, with a maximum particle size no greater than 6 inches in any dimension and shall be capable of meeting the compaction requirements.

1. Wall backfill material shall be free from frozen lumps, rocks larger than 6 inches in the largest dimension, roots, trash, lumber and organic material.

2.2 STRUCTURAL FILL

A. Structural fill material shall be imported, non-expansive, granular soil with less than 35 percent passing the No. 200 sieve, with a liquid limit less than 30, and free from rocks larger than 4 inches in the largest dimension, frozen lumps, roots, trash, lumber and organic material.

B. Overexcavate below footings and compact 12-inches of structural fill below footings. See plans.

2.3 FLOOR SLAB FILL (UPPER 4 INCHES)

A. Material shall be non-expansive granular soil (sand or gravel) with less than 5 percent passing the No. 200 sieve, and free from rocks larger than 2 inches in the largest dimension, frozen lumps, roots, trash, lumber and organic material.

2.4 3/4" WASHED ROCK (DRAIN ROCK)

A. 3/4" Washed Rock shall consist of hard, durable particles of stone or gravel, screened or crushed, to the required size and gradation. The material shall be free from vegetation matter, lumps or balls of clay, or other deleterious matter and shall conform to the following gradation when tested in accordance with AASHTO T 27 or ASTM C 136.

Sieve Size (Square Opening)	Percent By Weight Passing Screen
3/4-inch	100
3/8 inch	78-92
No. 4	0 - 50
No. 8	0 - 5
No. 200	0 - 3

PART 3 EXECUTION

3.1 EXCAVATION

A. Excavation shall be performed to the lines and grades indicated. Excavated material not required or not satisfactory for backfill shall be removed from the site.

B. Excavations shall be braced and supported as needed to prevent the ground adjacent to the excavation from sliding or settling. Slides shall be promptly removed and corrected by CONTRACTOR.

3.2 PREPARATION

A. Compact subgrade to density requirements for subsequent backfill materials.

B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with granular fill and compact to density equal to or greater than requirements for subsequent fill material.

C. Scarify subgrade surface to depth of 6 inches.

D. Pump Station Building subgrade shall be prepared by removing approximately 13 feet native earth (collapsible clays) down to a stable gravel layer (which layer is field determined by geotechnical engineer), and then constructing a structural fill to support the pump station as shown in the plans and described in the specifications.

E. Subgrade below asphalt pavement shall be prepared by removing native earth to subgrade, compacting native subgrade to 96% relative compaction, before placing base and asphalt.

F. Geotechnical Engineer shall observe the subgrade conditions after the +/-13 foot over-excavation (ie gravel layer is exposed in bottom of excavation,) and verify native clays have be adequately remove before CONTRACTOR may start backfilling with Structural Fill.

3.3 DEWATERING

A. Water removal shall be in accordance with Section 31 23 19 - Dewatering.

3.4 BACKFILL

A. Backfill material shall not be placed against concrete structures that have not been properly cured. No backfill material shall be placed until concrete has cured for a

minimum of 7 days or until the compressible strength is 3,400 psi, whichever is greater.

B. Backfill material shall be placed in no more than 6-inch loose lifts for compaction by hand operated machine compactors, and 8 inches loose lifts for other than hand operated machines.

C. Structural fill placed beneath foundations, footings or the floor slab shall be placed and compacted to at least 96% of maximum dry density at a moisture content within 2 percent of optimum moisture content in accordance with ASTM D 1557.

D. Backfill material shall be placed and compacted to at least 95 percent of maximum dry density at a moisture content within 2 percent of optimum moisture content in accordance with ASTM D-1557.

E. Where the moisture content is not suitable and/or sufficient compaction has not been obtained, the fill shall be reconditioned to an approved moisture content and re-compacted to the minimum required compaction prior to placing any additional fill material.

F. CONTRACTOR shall be responsible for arranging for the placing and compacting of approved fill material in accordance with these Specifications. If it is determined that CONTRACTOR is failing to meet the minimum requirements, CONTRACTOR shall stop operations and make adjustments as necessary to produce a satisfactorily compacted fill at no additional cost to OWNER.

G. Sufficient personnel, equipment, sumps or other means should be provided to maintain the site in an acceptable dry condition for the duration of this contract.

H. Excavations shall be so braced and supported as needed to prevent the ground, adjacent to the excavation, from sliding or settling. Localized slides or settlements shall be promptly removed and corrected by CONTRACTOR.

3.5 FINISHED GRADE

A. The finished subgrade and grade of the fill shall not vary more than 0.05 feet from the established grades and cross sections shown on the Contract Drawings.

3.6 COMPACTION TESTS

A. Compaction testing shall be the provided and paid for in accordance with Section 01 45 00 – Quality Control and Materials Testing.

B. It shall be the responsibility of CONTRACTOR to accomplish the specified compaction for backfill, structural fill, Untreated Base Course and other earthwork. It shall be the responsibility of CONTRACTOR to control his operations by performing any additional tests necessary to verify and confirm that CONTRACTOR has complied, and is complying at all times, with the requirements of these Specifications concerning compaction, control, and testing.

1. Testing of Backfill Materials

    a. Characteristics of backfill materials shall be determined in accordance with the requirements of Section 01 45 00.
    b. Contractor shall demonstrate the adequacy of compaction equipment and procedures before exceeding any of the following amounts of earthwork quantities:

        1) One (1) test per 1.0 feet of backfill thickness placed per structure.

    c. Until the specified degree of compaction on the previously specified amounts of earthwork is achieved, no additional earthwork of the same kind shall be performed.
    d. After satisfactory conclusion of the initial compaction demonstration and at any time during construction, earthwork which does not comply with the specified degree of compaction shall not exceed the previously specified quantities.
    e. Quality Control tests may be made by ENGINEER to verify that compaction is meeting the requirements previously specified at no cost to CONTRACTOR. If ENGINEER requires retesting of backfill, CONTRACTOR shall remove the overburden above the level at which ENGINEER wishes to test and shall backfill and recompact the excavation after the test is complete at no additional cost to OWNER.
    f. If compaction fails to meet the specified requirements, CONTRACTOR shall remove and replace the backfill at proper density or shall bring the density up to specified level by other means acceptable to ENGINEER. Subsequent tests required to confirm and verify that the reconstructed backfill has been brought up to specified density shall be paid in accordance with Section 01 45 23 – Testing Agency Services. The confirmation tests shall be performed in a manner acceptable to ENGINEER. Frequency of confirmation tests for remedial work shall be double that amount specified for initial confirmation tests.

2. Field Density Tests

    a. Tests shall be performed in sufficient numbers to meet the requirements of Section 01 45 00 and to ensure that the specified density is being obtained.

C. Field density tests shall be made in accordance with ASTM D1557 and ASTM D6938.

- END OF SECTION –

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SECTION 32 11 23
ROAD BASE - UNTREATED BASE COURSE

PART 1 GENERAL

1.1 DESCRIPTION

A. This Work consists of the placement of Sub-Base and Untreated Base Course (UBC) material at designated roadways and all driving surfaces as indicated on the Drawings.

1.2 RELATED SECTIONS

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 01 45 00 Quality Control and Materials Testing

1.3 REFERENCES

A. The latest edition of the following publication forms a part of this Specification to the extent referenced. The publication is referred to in the text by basic designation only.

B. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

1. AASHTO T 88 Standard Method of Test for Particle Size Analysis of Soils
2. AASHTO T 180 Standard Method of Test for Moisture Density Relations of Soils Using a 10 lb. (4.54 kg) Rammer and an 18 in (457 mm) Drop
3. AASHTO T 191 Standard Method of Test for Density of Soil In-Place by the Sand Cone Method
4. AASHTO T 310 Standard Specification for In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods. (Shallow Depth)

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM D 422 Standard Method for Particle Size Analysis of Soils
2. ASTM D 698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3)
3. ASTM D 1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone method
4. ASTM D 1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lnf/ft3)
5. ASTM D 2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
6. ASTM D 6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

D. The latest edition of the Utah Department of Transportation Standard Specification for Road and Bridge Construction (UDOT).

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Untreated Base Course (State approved 1-1/2" gradation, APWA Grade 1 or Grade 3/4).

1.5 MEASUREMENT AND PAYMENT

A. Road Base shall not be measured or paid as a separate item, but shall be included as part of the various items to which it relates.

PART 2 PRODUCTS

2.1 MATERIALS

A. Untreated Base Course: Untreated Base Course Materials shall meet the APWA Specifications for Grade 1 or Grade 3/4 as shown in Table 32 11 23-1 and shall meet A-1-a soil classification (ASHTO M145 or ASTM D3282). Recycled concrete will not be allowed.

TABLE 32 11 23-1

SIEVE SIZE	MASTER GRADING BAND LIMITS (PERCENT PASSING)	GRADE 1 GRADATION (PERCENT PASSING)	GRADE 3/4 GRADATION (PERCENT PASSING)
1 1/2 inch	100	-	-
1 inch	90-100	100	-
3/4 inch	70-85	-	100
1/2 inch	65-80	79 - 91	-
3/8 inch	55-75	-	78 -92
No. 4	40-65	49 - 61	55 - 67
No. 16	25-40	27 - 35	28 - 38
No. 200	7-11	7 - 11	7 - 11

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

A. Prior to placement of untreated base course materials, the foundation area to receive untreated base course materials shall be scarified to a minimum depth of 8-inches and recompacted to 95% minimum laboratory density as determined by ASTM D1557.

3.2 UNTREATED BASE COURSE MATERIAL PLACEMENT

A. No Untreated Base Course material shall be placed on sub-grade materials until the sub-grade has been checked and accepted by ENGINEER.

B. Road base material placed on driving surfaces shall be compacted to a minimum density of 96% in accordance with ASTM D1557 to provide a uniform graded smooth surface.

C. Untreated Base Course material shall be placed to a minimum thickness eight (8) inches or as shown on the Contract Drawings.

3.3 FIELD QUALITY CONTROL

A. CONTRACTOR shall be responsible for directing proper placement of all road base materials. CONTRACTOR shall be responsible for the stability of the road base materials during placement and shall replace any portions which have become displaced due to careless or negligent work on the part of CONTRACTOR, or to damage resulting from natural causes, such as storms.

B. Whenever the work areas to receive Sub-Base and/or Untreated Base Course material are covered with snow, the snow must be removed prior to placing the road base and/or Untreated Base Course and deposited outside the immediate construction areas at CONTRACTOR's expense.

- END OF SECTION -

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SECTION 32 12 16
HOT-MIX ASPHALT CONCRETE PAVING

PART 1 GENERAL

1.1 SUMMARY

A. This section addresses the requirements for installing hot-mix asphalt concrete, as outlined in Section 33 05 25 – Pavement Restoration of the APWA Specifications, and as modified herein.

1.2 RELATED SECTIONS

A. Related work specified in other sections includes but is not limited to:

1.	Section 01 33 00	Submittal Procedures
2.	Section 01 45 00	Quality Control and Materials Testing
3.	Section 01 50 00	Temporary Facilities and Environmental Controls
4.	Section 32 11 23	Road Base - Untreated Base Course
5.	Section 32 11 24	Pulverized Pavement Base Course (APWA)
6.	Section 32 12 05	Bituminous Concrete (APWA)
7.	Section 32 12 13.13	Tack Coat (APWA)
8.	Section 32 12 16.13	Plant-Mix Bituminous Paving (APWA)
9.	Section 32 17 23	Pavement Marking (APWA)
10.	Section 33 05 25	Pavement Restoration (APWA)

1.3 REFERENCES

A. The American Public Works Association General Conditions and Standard Specifications for Construction, latest edition

B. The latest edition of the following publication forms a part of this specification to the extent referenced. The publication is referred to in the text by basic designation only.

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1.	ASTM D 2041	Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
2.	ASTM D 2950	Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Method
3.	ASTM D 3665	Standard Practice for Random Sampling of Construction Materials

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Laboratory mix design for proposed hot-mix asphalt concrete paving.

C. Means and methods for removal, reprocessing, and placement of existing asphalt surfaces as base course material.

D. Laboratory mix design for proposed tack coat application.

E. Quality assurance tests for asphalt and aggregate material sources.

F. Copies of batch delivery tickets shall be submitted during progress of the work, and shall show the following information:

1. Name of production facility
2. Serial number of ticket
3. Date and truck number
4. Name of CONTRACTOR
5. Job name and location
6. Weight of asphalt concrete
7. Loading temperature
8. Signature or initial of plant representative
9. Type and grade of asphalt cement
10. Type and grade of aggregate
11. Applicable mix design method
12. Separate weights of aggregate and asphalt

G. Submit type and number of rollers required for compacting asphalt concrete

1.5 SITE CONDITIONS

A. Pave only when air and roadbed temperatures in the shade are greater than 40 deg. F and rising. The temperature restrictions may be waived only upon written authorization from ENGINEER.

B. Do not pave during rain or unsuitable weather or when surface is wet.

1.6 ACCEPTANCE

A. Acceptance of hot-mix asphalt concrete paving is based upon minimum density, minimum thickness, smoothness, and surface appearance. Smoothness and surface appearance shall be as defined by Section 32 12 16.13 of the APWA Specifications.

PART 2 PRODUCTS

2.1 BITUMINOUS PAVEMENT

A. The bituminous material shall be PG 64-22, DM-1/2, 50 blow per APWA Section 32 12 05 unless noted otherwise. Maximum allowable reclaimed asphalt pavement (RAP) is 15% and shall be free from detrimental quantities of deleterious materials.

B. Sampling and testing shall be the responsibility of CONTRACTOR, and shall be performed as required in Section 01 45 00 - Quality Control and Materials Testing.

2.2 TACK COAT

A. Tack coat material shall be Grade SS-1 and conform to all requirements of Section 32 12 13.13 - Tack Coat (APWA).

PART 3 EXECUTION

3.1 PREPARATION

A. Preparation shall conform to all requirements of Section 32 12 16.13 and Section 33 05 25 of the APWA specifications.

B. CONTRACTOR shall map and mark all existing surface utilities within the line of work, and shall lower fixtures if pavement machine is not capable of passing over structure.

C. All asphalt and concrete surfaces within the line of work are to be removed and disposed of properly by CONTRACTOR. CONTRACTOR may, upon written authorization of OWNER, use processed asphalt materials as base course material. Excess materials shall be removed and disposed by CONTRACTOR.

D. Existing asphalt pavements and drive approach extensions to be removed shall be cut by a wheel cutter or other device capable of making a neat, reasonably straight and smooth cut without damaging adjacent pavement and/or concrete that is not to be removed. The cutting device operation shall be subject to the approval of ENGINEER.

E. Any existing base, surfacing, or pavement shall be thoroughly cleaned immediately prior to receiving the plant-mixed surfacing. Where existing pavement is being widened or extended, it shall be cut to a straight vertical face prior to the paving operations and treated with asphalt paint binder.

3.2 BASE COURSE

A. Base course material shall be placed in accordance with Section 32 11 23 of these specifications.

B. Base course surfaces shall be maintained in an acceptable condition for both moisture and density, as defined by Section 32 11 23 - Road Base – Untreated Base Course, until the overlying hot-mix asphalt cement materials have been placed, at no additional expense to OWNER.

C. Processed asphalt materials may be used as base course provided that the resulting gradation for the 1" or 3/4” and -200 sieves comply with the requirements of Section 32 11 23 - Road Base. Processed asphalt materials may also be used if they meet the requirements of APWA Section 32 11 24 – Pulverized Pavement Base Course with the addition of stabilizers and if approved by the OWNER. Processed asphalt which has been contaminated with clay or silt materials will not be accepted.

3.3 PLACEMENT OF TACK COAT

A. Apply tack coat to all existing asphalt concrete surfaces preparatory to placing asphalt concrete pavement in accordance with Section 32 12 13.13 – Tack Coat of the APWA specifications.

3.4 PLACEMENT OF HOT-MIX ASPHALT CONCRETE

A. For all excavations within twenty-four (24) inches of any structure, concrete, or edge of existing pavement surface; CONTRACTOR shall remove and replace existing pavement surface to the concrete, structure, or edge of existing pavement surface.

B. Where a longitudinal trench is partly in pavement, the pavement shall be replaced to the original pavement edge, on a straight line, parallel to the center line of the roadway.

C. Where no part of a longitudinal trench is in the pavement, surfacing replacement will only be required where existing surfacing materials have been removed.

D. Spreading shall be as nearly continuous as possible. The mixture shall be spread and struck off in such a manner that the finished surface shall result in a uniform smooth surface. The longitudinal joints in succeeding courses shall be offset at least 6 inches transversely to avoid a vertical joint through more than one course.

E. All cold transverse joints shall be paper-patched or saw-cut to a clean vertical edge before paving resumes.

F. Placement shall also allow for line, grade, elevations, and thickness specified herein and as shown on the drawings.

G. When asphalt concrete is laid against vertical surfaces such as gutters, the face of the vertical surface shall be roughened for proper bonding, cleaned, and then painted with a light coating of asphalt cement or emulsified asphalt.

H. At terminations of new surface course, the asphalt concrete shall be feathered into the existing surface over such a distance as may be required to produce a smooth riding transition. Base course and single course construction shall be joined by vertical butt joints finished and rolled to a smooth surface.

I. Asphaltic concrete shall not be placed when frozen materials are present in the base or sub-base.

J. Asphaltic concrete shall not be placed during adverse conditions, i.e., rain or when a roadway surface is wet.

K. Asphaltic concrete shall be placed between April 15 and October 15. Asphalt concrete shall not be placed after October 15 and before April 15 of the following year unless roadway surface temperatures are 40° F and rising in the shade. Approval to place the asphalt concrete after October 15 and before April 15 of the following year requires written approval from the OWNER.

L. Roadways not completed prior to October 15, and not meeting the requirements of this section, shall be repaired by placing a temporary 2-inch thick asphalt (or other ENGINEER approved surface) course over all exposed, earthen surfaces. These temporary surfaces shall be completely removed and repaired in accordance with these specifications at no additional expense to OWNER.

M. Asphalt rolling shall be in accordance with Section 32 12 16.13 of the APWA specifications. CONTRACTOR shall establish and document a rolling pattern for obtaining densities. The test strip shall be no shorter than 300 feet. Establishment of rolling patterns are for the purpose of establishing minimum rolling patterns, and shall not release CONTRACTOR of meeting all requirements of these specifications and drawings. After the mixture has been spread, the surface shall be rolled in longitudinal direction commencing at the outside edge or lower side and proceeding to the higher side. Each pass of the roller shall overlap the preceding pass at least one-half the width

of the roller. Rolling shall continue until 95% of the laboratory density as determined in accordance with ASTM Designation D1559 for the asphalt mixture being used has been obtained. Density tests shall be done following the procedures of ASTM D2950. Complete compaction before temperature drops to 180° F. Rolling operations shall be conducted in such a manner that shoving or distortion will not develop beneath the roller.

N. The target density for asphalt placement shall be 94 percent of laboratory density plus or minus two (2) percent. If an individual test result falls below 92 percent of maximum density, the material represented by that test will be considered defective, and shall be removed and replaced by CONTRACTOR at no additional cost to OWNER.

O. The minimum acceptable thickness of asphalt for completed roadways shall be 3 inches, as verified by core samples. Areas found to contain less than the minimum thickness shall be removed and replaced at no additional expense to OWNER.

P. Allowable tolerance shall be 1/4 inch vertical deviation from design elevation in 10 feet. Match existing adjacent surface slopes.

Q. The completed finish shall be as specified in Section 32 12 16.13 of the APWA specifications. The surface of the pavement, after compaction, shall be uniform and true to the established grade. When tested with a ten-foot straight edge placed on the surface of the pavement, at any point, the surface shall not deviate more than one-eighth of an inch from the lower edge of the straight edge. All high and low spots shall be remedied immediately by removing the wearing course material over the affected areas and replacing it with fresh, hot wearing course and surface finish material and immediately compacting it to conform with the surrounding area.

R. CONTRACTOR shall adjust the height of all street fixtures to match final grade. If required, concrete collars shall be placed around all surface street fixtures (i.e. manholes, valve boxes, monuments, etc.).

S. CONTRACTOR shall complete all concrete collars within 2 weeks of completion of paving each roadway section.

T. CONTRACTOR shall restripe streets, as required, in accordance with Section 32 17 23 - Pavement Markings of the APWA specifications.

U. A 2% minimum cross-slope and 4% maximum cross-slope is required. Any slopes higher or lower than the required range must be approved by the City Engineer or designee.

3.5 REPAIR

A. Remove bumps and depressions exceeding 1/4 inch vertical deviation in 10 feet.

B. Repair options include mill and inlay, or grinding. Feather edges on bituminous concrete repairs are not allowed. Apply a cationic or anionic tack emulsion to make miller surfaces water resistant.

3.6 SITE SAFETY AND TRAFFIC CONTROL

A. Site safety and traffic control shall be the responsibility of CONTRACTOR.

B. CONTRACTOR shall verify full compliance with all applicable local, county, state and/or federal regulations, and shall comply with Section 01 55 26 Traffic Control.

- END OF SECTION -

SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.1 SUMMARY

A. This section covers the furnishing of labor, materials and appurtenances necessary for installation of the black PVC coated chain link fence system defined herein. The manufacturer shall provide a total fence system including all components, panels, posts, gates, and hardware required.

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 03 30 00 Cast-in-Place Concrete

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specifications to the extent referenced. The publications are referred to in the text to by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
2. ASTM F 552 Standard Terminology Relating to Chain Link Fencing
3. ASTM F 567 Standard Practice for Installation of Chain Link Fence
4. ASTM F 626 Standard Specification for Fence Fittings
5. ASTM F 668 Standard Specification for Polyvinyl (PVC), Polyolefin and Other Polymer-Coated Steel Chain Link Fence Fabric
6. ASTM F 900 Standard Specification for Industrial and Commercial Swing Gates
7. ASTM F 934 Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials
8. ASTM F1083 Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
9. ASTM F1664 Standard Specification for Poly (Vinyl Chloride) (PVC) and Other Conforming Organic Polymer-Coated Steel Tension Wire Used with Chain-Link Fence
10. ASTM F1665 Standard Specification for Poly (Vinyl Chloride) (PVC) and Other Conforming Organic Polymer-Coated Steel Barbed Wire Used with Chain-Link Fence

1.4 MEASUREMENT AND PAYMENT

A. Full compensation for chain link fences and gates shall be considered at the contract unit bid prices for each lineal foot of chain link fences and gates installed and accepted.

1.5 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop drawings: Site plan showing layout of fence location with dimensions, location of gates and opening size, cleared area, elevation of fence, gates, footings and details of attachments.

C. Certifications: Manufacturers material certifications in compliance with the current ASTM specifications.

D. Domestic certifications: Material certifications, Made in U.S.A., Buy American Act or Buy America when required.

E. Material samples: When required, provide representative samples of chain link fabric, framework and fittings.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Upon receipt at the job site, all materials shall be checked to ensure that no damage occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism and theft.

1.7 QUALITY ASSURANCE

A. Manufacturer: Company headquartered in the United States having U.S. manufacturing facility/facilities specializing in manufacturing chain link fence products with at least 5 years' experience.

B. Fence contractor: Company with demonstrated successful experience installing similar projects and products in accordance with ASTM F567 and have at least 5 years' experience.

C. Tolerances: Current published edition of ASTM specifications tolerances apply. ASTM specification tolerances supersede any conflicting tolerance.

1.8 WARRANTY

A. All structural fence components (i.e. rails, pickets, and posts) shall be warranted within specified limitations, by the manufacturer for a period of 20 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Wheatland Tube Co.,

B. Master Halco, Inc.,

C. Southwestern Wire, Inc.,

D. Or approved equal

2.2 GENERAL

A. Dimensions indicated herein for roll-formed pipe and H-sections are outside dimensions, excluding coatings.

B. Fence fabric height shall be 6 feet unless otherwise indicated.

C. Fencing materials shall be galvanized and PVC coated after fabrication.

D. The color of the fencing fabric, poles, and fittings shall be **black**.

E. Fencing shall be topped with 3 lines of barbed wire on single, 45 degree supporting arms, sloped outward. Fence height with barbed wire shall be over 6.6 feet.

2.3 STEEL FABRIC

A. Fence fabric shall be 9 gauge steel wire, 2-inch mesh, with top selvages knuckled and bottom selvages twisted and barbed.

B. Fabric shall be hot-dip galvanized and PVC coated according to ASTM F668, Class 2a or Class 2b. The weight of the zinc shall meet the requirements of STM F 668, Table 4.

2.4 FRAMING AND ACCESSORIES

A. **Round steel pipe and rail:** Schedule 40 standard weight pipe, in accordance with ASTM F1083, 1.8 oz/ ft² hot dip galvanized zinc exterior and 1.8 oz/ft² hot dip galvanized zinc interior coating. Intermediate Strength Grade: Minimum yield strength 50,000 psi.

1. Line post shall be 2-3/8” outside diameter, 1.8 oz/ft² zinc coating.
2. End, Corner, Pull post 2-7/8” outside diameter, 1.8 oz/ft² zinc coating.
3. Top, brace, bottom and intermediate rails, 1.660” outside diameter, 1.8 oz/ft² zinc coating.

B. **Polymer Coated Pipe:** Polymer coated pipe shall have a PVC coating fused and adhered to the exterior zinc coating of the galvanized pipe in accordance with ASTM F1043. The minimum thickness of the PVC coating shall be 10-mils (0.254 mm). The color shall match fabric **black** per ASTM F934.

C. **Tension Wire:** Tension wire shall be located at the bottom of the fabric and shall consist of 7 gauge wire complying with ASTM F 1664. Wire gauge specified is the core wire gauge. The color shall match the coating of the chain link fabric and shall be Class 2a or Class 2b. Tension wire shall be interlaced with the fabric or attached to the fabric with wire ties at a spacing of no more than 18 inches apart.

D. **Barbed Wire Support Arms:** Support arms shall be manufacturer’s standard fabrication with finish to match fence framework. Support arms shall be single 45 degree arm type and shall be capable of withstanding 250 pounds of downward pull.

E. **Barbed Wire:** Polymer coated steel barbed wire shall comply with ASTM F 1665, double 14 gauge twisted strand wire, with 4 point 14 gauge round barbs spaced 5 inches on center. Match coating of the chain link fabric.

F. **Tension and Brace Bands:** Galvanized pressed steel complying with ASTM F626, minimum steel thickness of 12 gauge (0.105 in.), minimum width of 3/4 inch and minimum zinc coating of 1.20 oz/ft². Secure bands with 5/16 inch galvanized steel carriage bolts.

G. **Terminal Post Caps, Line Post Loop Tops, Rail and Brace Ends, Boulevard Clamps, Rail Sleeves:** In compliance to ASTM F626, pressed steel galvanized after fabrication having a minimum zinc coating of 1.20 oz/ft².

H. **Truss Rod Assembly:** In compliance with ASTM F626, 3/8-inch diameter steel truss rod with a pressed steel tightener, minimum zinc coating of 1.2 oz/ft², assembly capable of withstanding a tension of 2,000 lbs.

I. **Tension Bars:** Tension bars shall conform to ASTM F626 and shall be galvanized steel one-piece length 2-inch less than the fabric height. Minimum zinc coating 1.2 oz. /ft². Bars for 2 inch mesh shall have a minimum cross section of 3/16 inch by 3/4-inch.

J. **Polymer Coated Color Fittings:** In compliance with ASTM F626, PVC coating minimum thickness 0.006-inch fused and adhered to the zinc coated fittings. Match color to fence system.

K. **Tie Wire and Hog Rings**: Galvanized minimum zinc coating 1.20 oz/ft², 9-gauge (0.148") steel wire in compliance with ASTM F626. Tie wire and hog rings shall be polymer coated and match the color of the fence system.

2.5 SWING GATES

A. **Swing Gates:** Galvanized steel pipe welded fabrication in compliance with ASTM F900. Gate frame members 1.900-inch outside diameter, ASTM F 1083 schedule 40 galvanized steel pipe. Frame members spaced no greater than 8 ft. apart vertically and horizontally. Welded joints protected by applying zinc-rich paint in accordance with ASTM Practice A 780. Positive locking gate latch, pressed steel galvanized after fabrication. Galvanized malleable iron or heavy gauge pressed steel post and frame hinges. Provide lockable drop bar and gate holdbacks with double gates. Match gate fabric to that of the fence system. Gateposts per ASTM F1083 schedule 40 galvanized steel pipe. The gatepost diameter from table 2.5.B. Gate frames and gate posts shall be PVC coated and match the color of the fence system.

B. Gateposts: Schedule 40 pipe in compliance with ASTM F1083.

Gate fabric height up to and including 6 ft.		
Gate leaf width	**Post Outside Diameter**	**Weight**
up to 4 ft.	2.375 in.	3.65 lb/ft
over 4 ft. to 10 ft.	2.875 in.	5.79 lb/ft
over 10 ft. to 18 ft.	4.000 in.	9.11 lb/ft
Gate fabric height over 6 ft. to 12 ft.		
Gate leaf width		
up to 6 ft.	2.875 in.	5.79 lb/ft
over 6 ft. to 12 ft.	4.000 in.	9.11 lb/ft
over 12 ft. to 18 ft.	6.625 in.	18.97 lb/ft
over 18 ft. to 24 ft.	8.625 in.	28.58 lb/ft

2.6 CONCRETE

A. Concrete for post footings shall have a 28-day compressive strength of 2,500 psi in accordance with Section 03 30 00 – Cast-in-Place Concrete.

PART 3 EXECUTION

3.1 FRAMEWORK INSTALLATION

A. Posts: Posts shall be set plumb in concrete footings in accordance with ASTM F567. Minimum footing depth, 24 inch plus an additional 3 inch depth for each 1 ft. increase in the fence height over 4 ft. or as indicated on the contract drawings whichever is greater. The minimum footing diameter shall be four times the largest cross section of the post up to a 4.00” dimension and three times the largest cross section of post greater than a 4.00” dimension or as indicated on the contract drawings, whichever is greater. Top of concrete footing to be at grade and crowned to shed water away from the post. Line posts installed at intervals not exceeding 10 ft. on center.

B. Top rail: When specified, install 21 ft. lengths of rail continuous thru the line post or barb arm loop top. Splice rail using top rail sleeves minimum 6 inches long. Rail shall be secured to the terminal post by a brace band and rail end. Bottom rail or intermediate rail shall be field cut and secured to the line posts using boulevard clamps or brace band with rail end. Fences 12 feet high or higher require mid rail.

C. Terminal posts: End, corner, pull and gate posts shall be braced and trussed for fence 6 ft. and higher and for fences 5 ft. in height not having a top rail. The horizontal brace rail and diagonal truss rod shall be installed in accordance with ASTM F567.

D. Tension wire: Shall be installed 4 inches up from the bottom of the fabric. Fences without top rail shall have a tension wire installed 4 inches down from the top of the fabric. Tension wire to be stretched taut, independently and prior to the fabric, between the terminal posts and secured to the terminal post using a brace band. Secure the tension wire to each line post with a tie wire. Install the top tension wire through the barb arm loop for fences having barbed wire and no top rail.

3.2 CHAIN LINK FABRIC INSTALLATION

A. Chain Link Fabric: Install fabric to outside of the framework. Attach fabric to the terminal post by threading the tension bar through the fabric; secure the tension bar to the terminal post with tension bands and 5/16 inch carriage bolts spaced no greater than 12 inches on center. Chain link fabric shall be stretched taut free of sag. Fabric to be secured to the line post with tie wires spaced no greater than 12 inches on center and to horizontal rail spaced no greater than18 inches on center. Secure fabric to the tension wire with hog rings spaced no greater than 18 inches on center.

1. Tie wire shall be wrapped 360 degrees around the post or rail and the two ends twisted together three full turns. Excess wire shall be cut off and bent over to prevent injury. The installed fabric shall have a ground clearance on no more than 2 inches.

3.3 BARBED WIRE INSTALLATION

A. Barbed Wire: Stretched taut between terminal posts and secured in the slots provided on the line post barb arms. Attach each strand of barbed wire to the terminal post using a brace band.

3.4 GATE INSTALLATION

A. Swing Gates: Installation of swing gates and gateposts in compliance with ASTM F 567. Direction of swing shall be inward. Gates shall be plumb in the closed position having a bottom clearance of 3 inch, grade permitting. Hinge and latch offset opening space shall be no greater than 3 inches in the closed position. Double gate drop bar receivers shall be set in a concrete footing minimum 6 inch diameter 24 inch deep. Gate leaf holdbacks shall be installed for all double gates.

3.5 GROUNDING

A. Fences crossed by powerlines of 600 volts or more shall be grounded at or near the point of crossing and at distances not exceeding 150-feet on each side of the crossing.

B. Ground conductor shall consist of No. 8 AWG solid copper wire. Grounding electrodes shall be 3/4-inch by 10-foot long copper-clad steel rod. Electrodes shall be driven into the earth so that the top of the electrode is at least 6 inches below grade. Where driving is impractical, electrodes shall be buried a minimum of 12-inches deep and radially from the fence. Top of electrode shall be not less than 2 feet or more than 8 feet from the fence.

C. Ground conductor shall be clamped to the fence and electrodes with bronze grounding clamps so as to create electrical continuity between the fence posts, fence fabric, and ground rods. After installation, the total resistance of fence to ground shall not be less than 25 ohms. PVC coated shall be ground down prior to installing clamps. Repair coating around clamp per the manufacturer’s recommendations.

D. Fence grounding is not the responsibility of the fence installer or manufacturer. A licensed electrical contractor shall install grounding when required.

3.6 CLEAN UP

A. Clean Up: The area of the fence line shall be left neat and free of any debris caused by the installation of the fence.

- END OF SECTION -

SECTION 33 05 03
COPPER PIPE

PART 1 GENERAL

1.1 SUMMARY

A. CONTRACTOR shall furnish and install all copper pipes, fittings, couplings, supports, joint materials and appurtenances as shown and specified, and as required for a complete and workable piping system.

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 22 10 10 Plumbing Piping and Specialties
3. Section 33 12 00 Mechanical Appurtenances
4. Section 33 13 00 Pipeline Testing and Disinfection

1.3 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for this section. Full compensation for Copper Pipe shall be considered as included in the contract unit or lump sum bid prices for the various items of the contract to which Copper Pipe relates.

1.4 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publication is referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM B88 Standard Specification for Seamless Copper Water Tube

C. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C 800 Standard for Underground Service Line Valves and Fittings

D. INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

E. INTERNATIONAL PLUMBING CODE (IPC)

F. INTERNATIONAL MECHANICAL CODE (IMC)

1.5 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit catalog information on all fittings and valves shown on the Contract Drawings, referencing each item by number as shown on the Contract Drawings. Information shall indicate manufacturer specification compliance and dimensional data.

1.6 QUALITY ASSURANCE

A. Reject any pipe which does not conform to Contract Documents or is cracked, chipped, crushed, dented, kinked, or otherwise unacceptable.

PART 2 PRODUCTS

2.1 PIPE

A. The type and class of the pipe and fittings shall be as indicated on the Contract Drawings and shall be Type K copper for buried services lines and Type L copper for interior piping.

B. Type K and Type L copper pipe shall have smooth surfaces free from bumps. Type K shall also be flexible enough to be coiled. All piping shall have the capacity to function at design working pressures.

C. Copper pipe to be buried or encased in concrete shall be polyethylene coated or installed in a polyethylene sleeve. Polyethylene coated pipe shall have a coating thickness of 0.025 inches and shall be **Mueller Industries Streamline Plastic Coated Pipe**, or approved equal. Polyethylene sleeve shall be a minimum 6 mil thick and shall be **Northtown Polywrap C**, or approved equal. Color shall be blue for cold water, red for hot water, or purple for reclaimed water. Seal seam joints and around fittings with **Polyken #930**, or approved equal, adhesive tape.

2.2 CONNECTIONS AND FITTINGS

A. Connections shall be flared or compression type for service lines. All other connections for above ground and in interior to structures shall be hot 95-5 lead free soldered joints.

B. Connections for dissimilar piping shall include dielectric insulation unions.

C. Fittings shall conform to AWWA C-800 standards and shall be capable of operating at 150 psi

2.3 COPPER PIPE SUPPORT CLAMPS

A. See Section 05 45 00 Mechanical Metal Supports.

PART 3 EXECUTION

3.1 INSTALLATION

A. Pipe shall be installed per manufacturers' instructions and per the requirements of the INTERNATIONAL PLUMBING CODE (IPC) and INTERNATIONAL MECHANICAL CODE (IMC). In case of a conflict between the two installation requirements the more stringent requirement shall apply.

B. The pipe shall be plugged at the end of each work day or period of suspension.

3.2 PRELIMINARY CLEANING AND FLUSHING

A. CONTRACTOR shall flush the pipeline as the work progresses by a means in accordance with good practice to insure that any foreign materials do not remain in any of the piping.

3.3 TESTING OF PIPING

A. Source of Water: CONTRACTOR shall assume all responsibility to obtain the necessary water supplies for pressure testing of the pipeline.

B. Testing Procedure:

1. Pipe shall be tested in accordance with the INTERNATIONAL PLUMBING CODE, Section 312 - Tests and Inspections.
2. In the case of pipelines that fail to pass the leakage test, CONTRACTOR shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall repeat the pipeline testing until the pipeline passes the leakage test, all at no additional cost to OWNER.
3. ENGINEER shall be notified at least 48 hours before the pipeline is to be tested so that ENGINEER may be present during the test.

3.4 DISINFECTION

A. For all potable water systems and where otherwise required all pipelines shall be disinfected in accordance with Section 33 13 00 – Pipeline Testing and Disinfection and approved before being allowed to be connected into a culinary system. Sewer pipelines do not require disinfection.

B. Source of Water: CONTRACTOR shall assume all responsibility to obtain the necessary water supplies for disinfection of the water line system.

- END OF SECTION –

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SECTION 33 05 05
DUCTILE IRON PIPE

PART 1 GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall furnish and install all pipe, fittings, closure pieces, supports, bolts, nuts, gaskets, jointing material, polyethylene wrap, marker tape, tracer wire, and appurtenances as shown and specified, and as required for a complete and workable piping system.

1.2 RELATED WORK

A. Related work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 01 50 30 Protection of Existing Utilities
3. Section 09 90 00 Painting and Finishes
4. Section 31 23 15 Excavation and Backfill for Pipelines
5. Section 33 12 00 Mechanical Appurtenances
6. Section 33 13 00 Pipeline Testing and Disinfection

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publication is referred to in the text by basic designation only.

B. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1. ASTM D 2041 Cast-Iron Pipe Flanges and Flanged Fittings Class 25, 125, and 250

C. AMERICAN STANDARDS FOR TESTING AND MATERIAL (ASTM)

1. ASTM A 193 Standard Specification for Alloy-Steel and Stainless-Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
2. ASTM A 194 Standard Specification for Carbon Steel, Alloy Steel, and Stainless-Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
3. ASTM A 283 Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
4. ASTM A 536 Standard Specification for Ductile Iron Castings

D. American Society of Mechanical Engineers (ASME)

1. ASME B1.1 Unified Inch Screw Threads, (UN And UNR Thread Form)
2. ASME B18.2.1 Square, Hex, Heavy Hex, And Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, And Lag Screws (Inch Series)
3. ASME B18.2.2 Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, And Coupling Nuts (Inch Series)

E. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C 104 Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
2. AWWA C 105 Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems
3. AWWA C 110 Standards for Ductile-Iron and Gray-Iron Fittings, 3-inch Through 48-inch, for Water
4. AWWA C 111 Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
5. AWWA C 115 Standard for Flanged Ductile-Iron Pipe with Ductile Iron or Gray-Iron Threaded Flanges
6. AWWA C 150 Standard for the Thickness Design of Ductile-Iron Pipe
7. AWWA C 151 Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water
8. AWWA C 153 Standard for Ductile-Iron Compact Fittings, 3-inch Through 64-inch for Water
9. AWWA C 219 Standard for Bolted, Sleeve-Type Couplings for Plain-End Pipe
10. AWWA C 600 Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances
11. AWWA C 606 Standard for Grooved and Shouldered Joints
12. AWWA C 651 Standard for Disinfecting Water Mains
13. AWWA M 11 Steel Pipe – A Guide for Design and Installation

1.4 SUBMITTALS

A. Submit catalog information on all pipe, fittings, valves, couplings, gaskets, tapes, bolts and nuts, wraps, safety tapes, and tracer wires as shown on the Drawings. Information shall indicate manufacture specification compliance and dimensional data.

B. Submit shop drawings on all fabricated piping and pipe supports.

C. Submit bolting patterns, procedures, and bolting equipment data, and calculations for target torque calculations.

D. Certified affidavit of compliance for pipe and fittings or other materials furnished under this Section and as specified in the referenced standards.

1.5 QUALITY ASSURANCE

A. Except as modified herein, materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.

PART 2 PRODUCTS

2.1 DUCTILE IRON PIPE

A. Ductile iron pipe shall conform to the requirements of the AWWA C151 and AWWA C150 and pipe must be certified for potable water use by the National Sanitation Foundation (NSF/ANSI 61) and must bear the logo "NSF-pw" or "NSF-61" indicating such certification. Pipe shall be rated to 350 psi. The pipe shall be provided with rubber gaskets, specials, and fittings as required. Nominal pipe laying lengths shall be 20-feet.

B. Buried Ductile Iron Pipe shall be encased with 8 mil (minimum), Group 2, Class C black polyethylene, conforming to the requirements of AWWA C105. All seams in the polyethylene encasement shall be taped with a minimum 12 mil adhesive tape, **Polyken #900**, **3M Scotchrap 51,** or approved equal, to completely seal the seam.

2.2 FITTINGS

A. MJ and Push-on fittings shall conform to the (AWWA C110 or C153), be NSF certified to ANSI/NSF 61 and shall be for a minimum rated working pressure of 250 psi.

B. Flanges shall conform to AWWA C110 AWWA C111, and ANSI B16.1, Class 125 and shall have either raised or plain faces, and shall have a minimum working pressure rating of 250 psi. For pipe sizes 24-inch and smaller, flanged joints may be rated for a maximum of 350 psi with the use of specially designed gaskets.

C. All buried fittings shall be completely coated with food grade grease, **Chevron FM Grease**, or approved equal, and shall be completely encased with 8 mil (minimum), Group 2, Class C polyethylene, conforming to AWWA C105 and color to match the pipe wrap. All seams in the polyethylene encasement shall be taped with a minimum 12 mil adhesive tape, **Polyken #900**, **3M Scotchrap 51,** or approved equal, to completely seal the seam.

2.3 DUCTILE IRON PIPE JOINTS

A. Ductile iron pipe and fittings shall be furnished with mechanical joints, push-on joints, flanged joints, or restrained joints as required.

1. Mechanical and push-on joints shall conform to the requirements of AWWA C111.
2. Flanged joints shall conform to the requirements of AWWA C115.
3. Restrained joints shall conform to the requirements of AWWA C151. Restrained joints shall **be Flex-Ring, Field Flex-Ring, or Lok-Ring by American Ductile Iron Pipe, Field Lok, TR-Flex by U.S. Pipe**, or approved equal.
4. Joint restraining devices that impart point loads and/or wedging action on the pipe wall as a means of joint restraint shall not be allowed unless there are no other options available. CONTRACTOR may propose such devices by providing a formal substitution request indicating the locations the devices are to be used and that the devices is rated at least for the class of pipe being supplied. The devices shall be **MegaLug Model 1100 by EBAA Iron**, or approved equal.

2.4 MECHANICAL-TYPE COUPLINGS (GROOVED)

A. Mechanical-type couplings shall be provided where indicated on the Drawings and shall conform to the requirements of AWWA C606. Mechanical type couplings shall be designed for a water working pressure not less than the design pressure of the pipe on which they are to be installed. Mechanical-type couplings shall be **Victaulic Style 31 (flexible or rigid)**, or approved equal.

B. Gaskets shall be the flush seal type.

C. Mechanical-type couplings for equipment connections shall be provided with rigid grooved couplings or flexible type coupling with harness, unless thrust restraint is provided by other means.

D. Grooved fittings, couplings and valves shall be furnished from the same manufacturer as the coupling. Grooving tools shall be from the same manufacturer as the grooved components.

2.5 SOLID SLEEVE-TYPE COUPLINGS

A. Solid sleeve-type couplings shall be provided where shown on the Drawings. Coupling shall be of ductile iron and shall be of the size to fit the pipe and fittings shown. Coupling shall be pressure rated 250 psi and comply with AWWA C110. Restraints shall be provided where indicated on the Drawings.

2.6 BOLTED SLEEVE-TYPE COUPLINGS

A. Sleeve-type couplings shall be provided where shown on the Drawings. Couplings shall be of ductile iron, without pipe stop, and shall be of sizes to fit the pipe and fittings shown. Coating shall be fusion bonded epoxy. Couplings shall be pressure rated for 250 psi and comply with AWWA C219. Couplings shall be **Style 501 or FC1 by EJ Prescott, Style 501 by Romac**, or approved equal.

2.7 RESTRAINED BOLTED SLEEVE-TYPE COUPLINGS

A. Restrained bolted sleeve-type couplings shall be provided where shown on the Drawings. Couplings shall be of ductile iron or ASTM A283 Grade C steel, without pipe stop, and shall be of sizes to fit the pipe and fittings shown. Coating shall be fusion bond epoxy. Couplings shall be the rated for 250 psi and comply with AWWA C219. Sleeve length shall be 7 inches for pipe diameters 4-inch through 12-inch and 10 inches for pipe diameters 14-inch and larger. Restraint gland shall be ductile iron meeting the requirements of ASTM A 536. Couplings shall be **Series 470 by Smith-Blair, Style 400RG by Romac, Series 3800 by EBAA Iron, Inc.**, or approved equal.

2.8 FLANGE COUPLING ADAPTER (DISMANTLING JOINT)

A. Provide flanged coupling adapters (dismantling joint) were shown on the Drawings. CONTRACTOR will not be allowed to substitute any other type of flanged coupling adapter unless approved by ENGINEER. The coupling shall be rated as indicated on the Drawings.

B. Flanged coupling adapter bodies shall be fabricated from steel, ASTM A512 or A 513 or Ductile Iron ASTM A536, without pipe stop. The body shall not be less than 1/4-inch thick or at least the same wall thickness as the pipe to which the coupling is connected. If the strength of the body material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe. The follower ring shall be fabricated from steel, ASTM A576 or A36.

C. For flanged coupling adapters installed in piping systems rated for positive pressure, the coupling shall be restrained with harness bolts or tie rods. Other means of restraining the coupling such as set screws will not be accepted. Harnesses shall be designed in accordance with AWWA Manual 11, or as indicated. Harness sets shall be designed for the maximum test pressure of the pipe in which they are installed.

D. Gaskets shall be composed of a rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions.

E. Flanged coupling adapters (dismantling joints) shall be **Model 975 by Smith-Blair, Model 309 by JCM, Model DJ400 by Romac**, or approved equal.

2.9 GASKETS

A. Except as otherwise provided, gaskets for flanged joints shall be 1/8-inch thick rubber fabric. Class 250 or less flange gaskets shall be **Flange-Tyte by U.S. Pipe**, higher pressure joint gaskets shall be **Garlock BLUE-GARD Style 3000**, or approved equal. Wherever blind flanges are shown, the gaskets shall consist of 1/8-inch thick cloth-inserted rubber sheet which shall cover the entire inside surface of the blind flange and shall be cemented to the surface of the blind flange.

B. All buried fittings using steel bolts shall be coated with no-oxide wax and wrapped with polyethylene or as otherwise approved by ENGINEER.

2.10 BOLTS AND NUTS

A. Bolts and nuts shall be rated for the system working pressure with a minimum safety factor of three. Bolts and nuts buried, submerged, and inside vaults shall be zinc coated steel (wax tape coated). Bolts and nuts above grade, exposed or inside structures, shall be Type 304 stainless steel. Bolts and nuts in exposed to wastewater or in corrosive environments shall be Type 304 stainless steel.

B. All flange bolt lengths shall be selected by CONTRACTOR such that three full threads, as a minimum, protrude from the hex nut and washer after assembly.

C. Flange bolts shall have ASME B1.1, Class 2A threads, and be manufactured of ASTM A 193, Grade B7 steel. Bolts shall conform to ASME B18.2.1.

D. Flange nuts shall have Class 2A fit, and be manufactured of ASTM A 194, Grade 2H steel, having square or hex heavy dimensions in accordance with ASME B18.2.2.

E. Connection T-bolts for mechanical joint (MJ) fittings shall be Cor-Ten high strength, low alloy steel conforming to AWWA C111.

2.11 CEMENT MORTAR LINING

A. Ductile iron pipe and fittings shall be lined with cement mortar in accordance with the requirements of the AWWA C104 except that the lining thickness shall be not less than 1/8 of an inch. The pipe interior surfaces shall be smooth and free from factures, excessive crazing, and roughness.

2.12 THRUST BLOCKS AND RESTRAINED JOINTS

A. Provide thrust restraint by use of thrust blocks or restrained joints. All ductile iron (and PVC) pipe on this project shall be restrained joint. However, there is one thrust block required at the connection to the existing 8-inch pipe. Provide a thrust block there per the Details on the Drawings.

B. Joint restraints may be tie rods, **TR Flex piping system as manufactured by US Pipe**, or approved equal, or a **Megalug system as manufactured by EBAA Iron**. Where the required pipeline deflection exceeds the recommended deflection of the TR Flex piping system, CONTRACTOR shall use Megalugs to achieve specified deflections.

C. “RJ MJ” means “Restrained Joint Mechanical Joint” piping with Megalugs (or Engineer approved equal) to provide restraint.

D. Restrained joints shall be suitable for 250 psi test pressures.

2.13 SAFETY TAPE

A. Safety tape shall be a minimum of 3-inch wide by 5.0 mil overall thickness, with no less than a 0.35 gauge solid aluminum foil core. It shall be Safety Blue in color per American Public Works Association (APWA) National Color Code and shall be clearly labeled with the words “CAUTION WATER LINE BELOW” or similar wording approved by ENGINEER. Safety tape shall be **MagnaTec by Empire Level Mfg Corp**, or approved equal.

2.14 TRACER WIRE

A. All piping (including service lines) shall be installed with 12 gauge solid copper THHN tracer wire for pipeline location purposes by means of an electronic line tracer.

1. The wires must be installed along the entire length of the pipe at the top centerline of the pipe and be held in place with poly tape at all pipe joints and at 5 foot intervals.
2. Sections of wire shall be spliced together using approved splice caps and waterproof seals. Twisting the wires together is not acceptable.

2.15 PIPE COATINGS

A. All exposed piping, valves, and fittings including inside vaults and buildings shall be painted as specified in Section 09 90 00 – Painting and Finishes. Exposed piping, valves and fittings to be painted shall be primed by the manufacturer in preparation for painting. CONTRACTOR shall provide verification from the finish coating supplier that the field applied coatings are compatible with the manufacturer’s prime coat. Pipe to be painted shall not have asphalt emulsion coating. The exterior of buried pipe and fittings shall be an asphaltic coating approximately one-mil thick.

2.16 COLD-APPLIED WAX TAPE COATING FOR BURIED PIPE

A. Apply wax tape coating over all the following buried pipe features: flanges, dismantling joints, mechanical joints, Megalug joints, valves, actuators, joints, nuts, bolts, and all metallic appurtenances which are buried.

B. Primer: Primer shall be a blend of petrolatums, plasticizers, and corrosion inhibitors having a paste-like consistency. The primer shall have the following properties:

1.	Color	Brown
2.	Pour Point	100°F to 110°F
3.	Flash Point	350°F
4.	Coverage	1 gallon/100 square feet
5.	Manufacturer	**Trenton Wax Tape Primer, Denso Paste Primer**, or approved equal.

C. Wax Tape: Wax tape shall consist of a synthetic-fiber felt, saturated with a blend of microcrystalline wax, petrolatums, plasticizers, and corrosion inhibitors, forming a tape

coating that is easily formable over irregular surfaces. The tape shall have the following properties:

1.	Color	Brown
2.	Saturant Pour Point	115°F to 120°F
3.	Thickness	50 to 70 mils
4.	Tape Width	6 inches
5.	Dielectric Strength	100 volts/mil
6.	Manufacturer	**Trenton No. 1 Wax Tape, Denso "Densyl Tape",** or approved equal.

D. Plastic Wrapper: Wrapper shall be a polyvinylidene chloride plastic with three 50-gauge plies wound together as a single sheet. The wrapper shall have the following properties:

1.	Color	Clear
2.	Thickness	1.5 mils
3.	Tape Width	6 inches
4.	Manufacturer	**Trenton Poly-Ply, Denso Tape PVC Self-Adhesive**, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Excavation and backfill of trenches and for appurtenances shall be in accordance with Section 31 23 15 - Excavation and Backfill for Buried Pipelines.

B. Ductile iron fittings shall be installed in accordance with the ANSI/AWWA C600. Inspect each pipe and fitting prior to installation to verify there is no damage and clean each pipe and fitting prior to installation.

C. Pipe shall be laid directly on the bedding material. Bell holes shall be formed at the ends of the pipe to prevent point loading.

D. No pipe shall be installed on a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation before backfilling occurs.

E. Immediately before joining the pipe, the bell end of the pipe shall be thoroughly cleaned. The spigot end of the pipe and the inside surface of the gasket shall be cleaned and lubricated. The lubricant shall be non-toxic, shall not support bacteria growth, shall not be harmful to the gasket material, and shall be compliant with NSF/ANSI 61 requirements. The lubricant shall not impart a taste or odor to the water in the pipe. Tilting of the pipe to insert the spigot into the bell will not be permitted.

F. Buried Ductile Iron pipe shall be polyethylene encased in accordance with the requirements of AWWA C105 Method A. Remove all lumps of clay, mud, cinders, etc. on the pipe surface before installation of the encasement. During installation, soil or embedment material shall not be trapped between the pipe and the polyethylene. Cut polyethylene tube to a length at least 2 feet longer than the pipe section. Wrap shall overlap the adjacent pipe joint at least 1 foot. After assembling the pipe joint, overlap the joint with the polyethylene tube and secure to the pipe with adhesive tape completely

around the seam. Overlap the joint on the previous pipe with the polyethylene tube and secure to the existing wrap with adhesive tape and completely seal the seam. Take up the slack width at the top of the pipe to make a snug but not tight fit along the barrel of the pipe and secure with poly tape at 5 foot intervals. For installations below the water table or wet areas, circumferential wraps of tape should be placed at 2 foot intervals along the barrel of the pipe prior to lowering the pipe into the trench.

G. **DO NOT coat buried bolted joints and valves with food grade grease. Wax tape coat them per AWWA C217 and this spec.** Then encase them with polyethylene wrap and install in conformance with AWWA C105 standards. Tape polyethylene seams with **Polyken #900, 3M Scotchrap 51,** adhesive tape, or approved equal, to completely seal the seam.

H. Repair punctures to the polyethylene wrap with adhesive tape. Repair cuts, tears, or damage to the polyethylene wrap with a tube cut open, wrapped around the pipe to cover the damaged area, and secure in place with **Polyken #900, 3M Scotchrap 51,** adhesive tape, or approved equal, to completely seal the seam.

I. Provide openings for branches, service taps, blowoffs, air valves, and similar appurtenances by cutting an “X” in the polyethylene and temporarily folding back the film. After the appurtenance is installed, tape the slack securely to the appurtenance, and repair the cut and any other damaged areas.

J. To make a direct tap, apply two or three wraps of adhesive tape completely around the polyethylene encased pipe to cover the area where the tapping machine and chain will be mounted. Install the corporation stop directly through the tape and polyethylene encasement. After the direct tap is completed, inspect for damage and repair if needed.

K. Where polyethylene wrapped pipe joins an adjacent pipe that is not wrapped, extend the polyethylene wrap to cover the adjacent pipe for a distance of 3 feet. Secure the end with adhesive tape completely around the seam. Service lines with dissimilar metals shall be wrapped with polyethylene or approved dielectric tape for a minimum clear distance of 3 feet away from the ductile iron pipe.

L. Valves shall be handled in a manner to prevent damage to any part of the valve. CONTRACTOR shall adjust stem packing and operate each valve prior to installation to insure proper operation. Valves shall be installed so that the valve stems are plumb and, in the location, indicated on the drawings.

M. The pipe shall be plugged at the end of each work day or period of suspension.

N. Safety tracer tape shall be installed 12-inches (atop pipe zone) above the pipe along the entire length of pipeline.

O. Bring up tracer wire at valve boxes and fire hydrants as shown on the Drawings. Tracer wire does not need to be brought up at shut-off valves for fire hydrants. When splicing a wire use a greased filled or approved connector. All splices should occur within a valve box. Wire is to be continuous underground. Underground splices may only be used by specific permission of the OWNER and must be inspected before backfill.

3.2 THRUST BLOCKS

A. Thrust blocks shall be installed at points where the pipe changes direction such as: at all tees, elbows, wyes, caps, valves, hydrants, reducers, etc.

B. Thrust blocks shall be constructed so that the bearing surface is in direct line with the major force created by the pipe or fitting.

C. Thrust blocks shall bear against solid undisturbed earth at the side and bottom of the trench excavation and shall be shaped so as not to obstruct access to the joints or the pipe or fitting.

D. Thrust blocks shall be sized and constructed per OWNER's Standards or the drawings, whichever is greater.

3.3 PRELIMINARY CLEANING AND FLUSHING

A. CONTRACTOR shall flush the pipeline as the work progresses by a means in accordance with good practice to ensure that sand, rocks, or other foreign material do not remain in any of the pipeline. If possible, the flushing shall be made with an open pipe end.

B. CONTRACTOR shall provide to ENGINEER a proposed schedule and method of flushing for review before the flushing starts.

3.4 BOLTING PROCEDURES FOR FLANGED JOINTS

A. Flange joints shall be assembled per the gasket manufacturer's instructions and as specified herein. Utilize calibrated bolting equipment capable of applying a measured torque to flange bolts during joining. Bolting patterns, procedures, and bolting equipment data shall be submitted prior to pipe fitting and bolting.

B. Gaskets, bolts, and anti-seize lubricant used in the bolting procedure shall be selected from those specified herein. Submit target torque calculations for each application. Calculations shall identify specific gasket (manufacturer, model, size, configuration, material), bolts (size and material), and anti-seize lubricant. The calculations shall document and take into consideration the pipe service, working and test pressures, pipe diameter, gasket data sheet, bolt material, gasket supplier-recommended assembly stress, and gasket-supplier recommended bolt stress. Calculations shall be stamped by a professional engineer. Target torque calculations shall be used in the assembly of bolted joints.

C. Flange bolts, nuts, and washers shall be visually inspected and cleaned prior to bolting. Lubricate bolts and nuts; if hardened washers are not used, lubricate the flange surface around the bolt holes. This lubricant must be removed by cleaning solvent prior to applying a coating system. Hand-tighten all nuts and bolts then tighten them to 10 to 20 percent of the target torque. The initial torque shall not exceed 20 percent of the target torque. The bolts shall be tightened according to the pattern included in AWWA Manual M11, Figure 12-3.

D. For flanges having 4 to 8 bolts there shall be three rounds of tightening, after hand tightening, to 30 percent, 60 percent and then 100 percent of the target torque. For flanges having 12 or more bolts there shall be four rounds of tightening, after hand tightening, to

20 percent, 40 percent, 80 percent and 100 percent of the target torque. At 100 percent of target torque the flange gap shall be measured at every other bolt to confirm uniformity. The bolts shall be re-tightened to the target torque 24 hours after completion of the initial bolting sequence.

3.5 COLD-APPLIED WAX TAPE COATING APPLICATION

A. Surfaces shall be clean and free of all dirt, grease, water, and other foreign material prior to the application of the primer and wax tape.

B. Apply primer by hand or brush to all surfaces of the pipefitting or valve. Work the primer into all crevices and completely cover all exposed metal surfaces.

C. Apply the wax tape immediately after the primer application. Work the tape into the crevices around fittings. Wrap the wax tape spirally around the pipe and across the fitting. Use a minimum overlap of 55 percent of the tape width.

D. Work the tape into the crevices and contours of irregularly shaped surfaces and smooth out so that there is a continuous protective layer with no voids or spaces under the tape. For larger voids or irregular shaped surfaces fill spaces with a moldable mastic. Moldable mastic shall be **Trenton Fill-Pro PM-GP**, or approved equal.

E. Overwrap the completed wax tape installation with the plastic wrapping material. Wrap spirally around the pipe and across the fitting. Use a minimum overlap of 55 percent of the tape width and apply two layers or applications of overwrap. Secure plastic wrapper to pipe with adhesive tape.

3.6 TRACER WIRE TESTING

A. Tracer wire shall be installed where indicated above or shown on the Contract Drawings on the pipe along the entire length of pipeline.

B. Upon completion of the pipe installation, CONTRACTOR shall demonstrate that the wire is continuous and unbroken through the entire run of the pipe.

1. Demonstration shall include full signal conductivity (including splices) when energizing for the entire run in the presence of OWNER and/or ENGINEER.
2. If the wire is broken, CONTRACTOR shall repair or replace it. Pipeline installation will not be accepted until the wire passes a continuity test.

3.7 TESTING OF PIPELINE

A. CONTRACTOR shall provide additional temporary blow-off valves and fittings as required to flush and disinfect new pipelines. Temporary blow-off valves and fittings shall be removed prior to placing pipeline into service.

B. Source of Water

1. CONTRACTOR shall assume all responsibility to obtain the necessary water supplies for pressure testing of the pipeline.

C. Testing Procedure

1. Pipe shall be tested at a static pressure of 200 psi for 2 hours and in accordance with the AWWA C600 standards. Pipe shall be tested in segments such that the test pressure at the low point of the segment shall be 200 psi, and the minimum pressure at the high point in the segment shall be 200 psi.
2. In the case of pipelines that fail to pass the leakage test, CONTRACTOR shall determine the cause of the excessive leakage, shall take corrective measures necessary to repair the leaks, and shall repeat the pipeline test, all at no additional cost to OWNER.
3. ENGINEER shall be notified at least 48 hours before the pipeline is to be tested so that ENGINEER may be present during the test.

D. Pressure and Leak Test

1. CONTRACTOR shall test all piping either in sections or as a unit. The test shall be made by placing temporary bulkheads as needed in the pipe and filling the line slowly with water. Care shall be taken to see that all air vents are open during the filling. Bulkheads, valves, and connections shall be examined for leaks. If any leaks are found, corrective measures satisfactory to ENGINEER shall be taken. The test shall consist of holding a minimum pressure as shown on the Drawings in the section being tested for a minimum period of two hours using either pneumatic or hydraulic means to maintain the pressure. Suitable means shall be provided by CONTRACTOR for determining the quantity of water lost by leakage under the test pressure. The testing allowance is defined as the quantity of water that must be applied to the pipe section being tested to maintain a pressure within 5 psi of the specified hydrostatic test pressure. The maximum allowable leakage shall be defined as follows:

$$L = SD(P)1/2/148,000$$

L = Testing allowance (makeup water) in gallons per hour of test
S = Length of pipe in feet
D = Nominal diameter of pipe in inches
P = Average Test Pressure in pounds per square inch (gauge)

3.8 DISINFECTING

A. Disinfection shall be in accordance with Section 33 13 00 – Pipeline Testing and Disinfection.

3.9 PAINTING

A. All exposed piping including inside vaults shall be painted as specified in Section 09 90 00 – Painting and Finishes.

- END OF SECTION –

SECTION 33 05 07
POLYVINYL CHLORIDE (PVC) PRESSURE PIPE, RUBBER JOINTS (AWWA C900)

PART 1 GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall furnish and install all PVC pipe, fittings, closure pieces, supports, gaskets, jointing material and appurtenances as shown and specified, and as required for a complete and workable piping system.

B. This Section includes PVC pressure pipe meeting the requirements of AWWA C900. PVC pressure pipe with solved-welded, flanged, or threaded joints is included in Section 33 05 07.1 - PVC Pressure Pipe (ASTM D 1785, modified).

1.2 RELATED WORK

A. Related work specified in other sections:

1. Section 01 33 00 Submittal Procedures
2. Section 01 50 30 Protection of Existing Facilities
3. Section 31 23 15 Excavation and Backfill for Pipelines
4. Section 33 05 05.1 Ductile Iron Fittings for PVC Pipe
5. Section 33 12 00 Mechanical Appurtenances
6. Section 33 13 00 Pipeline Testing and Disinfection

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publication is referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM D 1784 Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
2. ASTM D 3139 Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
3. ASTM F 477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

C. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C 605 Standard for Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
2. AWWA C 651 Standard for Disinfecting Water Mains
3. AWWA C 900 Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4-Inch through 60-Inch for Water Transmission and Distribution

4. AWWA M 23 Manual of Water Supply Practices - PVC Pipe - Design and Installation

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit manufacturer's affidavit certifying product was manufactured, tested and supplied in accordance with applicable references in this section together with a report of the test results and the date each test was completed.

C. Submit shop drawings of pipe, fittings, and appurtenances showing compliance with this Section; and manufacturer’s literature on tracer wire and accessories.

D. Submit plan for commissioning the waterline, including but not limited to cleaning, pressure testing, and disinfection.

PART 2 PRODUCTS

2.1 POLYVINYL CHLORIDE PIPE

A. All polyvinyl chloride (PVC) pipe intended for use in public drinking water supply pipelines or in pressure pipeline systems shall be manufactured of material conforming to AWWA C900, ASTM D1784, and cell classification 12454 PVC materials for the size and class required. All PVC pipe must be certified for potable water use by the National Sanitation Foundation (ANSI/NSF 61) and must bear the logo "NSF-pw" or "NSF-61" indicating such certification. Standard laying lengths shall be 20-feet. Pipe sections shall be clearly marked to:

1. Identify manufacturer's name or trademark
2. Nominal pipe size and OD base
3. AWWA material code designation
4. Dimension ratio
5. AWWA pressure class
6. AWWA specification designation
7. Product record code

B. The PVC pipe shall be DR-18 (235 psi).

2.2 POLYVINYL CHLORIDE JOINTS

A. All joints and accessories shall be as manufactured and furnished by the pipe supplier. Joints shall be bell and spigot conforming to the requirements of ASTM D3139. Gaskets shall comply with the requirements of ASTM F477.

B. Deflection at the joint shall not exceed 1.0 degree for AWWA C900 pipe or the maximum deflection recommended by the pipe manufacturer. No deflection of the joint shall be allowed for joints that are over-inserted or not inserted to the assembly or stop mark.

2.3 FITTINGS

A. Fittings shall be in accordance with Section 33 05 05.1 – Ductile Iron Fittings for PVC Pipe.

2.4 THRUST BLOCKS/ RESTRAINTS

A. All fittings shall have proper thrust blocks and restraints as noted for the type of installation required. Joint restraint shall be provided for all bends, fittings, and valves regardless of pipe size or location. Thrust blocks shall be 3,000 psi concrete.

B. Joint restraints may be **EBAA Iron Megalug Series 2000PV and Series 2200, Star Pipe Product Series 1100 Pipe Restrainers, Romac Industries RomaGrip for PVC Pipe or 470 Series Pipe Restraining System with tie rods**, or approved equal. (RESTRAINTS WITH A POINT LOADING ON THE PIPE WILL NOT BE ALLOWED ON PVC PIPE.)

C. Restrained joints shall be suitable for a minimum of 150 psi test pressures or the required project test pressure.

2.5 TRACER WIRE

A. All piping (including service lines) shall be installed with 12 gauge solid copper THHN tracer wire for pipeline location purposes by means of an electronic line tracer.

1. The wires must be installed along the entire length of the pipe on the top of the pipe and be held in place with ties or hitches spaced not more than 12-feet apart.
2. Sections of wire shall be spliced together using approved splice caps and waterproof seals or solder. Twisting the wires together is not acceptable.

PART 3 EXECUTION

3.1 INSTALLATION

A. Excavation and backfill of trenches and for appurtenances shall be in accordance with Section 31 23 15 - Excavation and Backfill for Buried Pipelines.

B. Polyvinyl Chloride (PVC) pipe shall be installed in accordance with AWWA Manual M23.

C. The pipe shall be plugged at the end of each work day, or period of work suspension.

D. Tracer wire shall be installed 3-inch minimum above pipe as required by the Drawings.

3.2 THRUST BLOCKS AND JOINT RESTRAINTS

A. Thrust blocks and/or joint restraints (as indicated on the drawings) shall be installed at points where the pipe changes direction such as: at all tees, elbows, wyes, caps, valves, hydrants, reducers, etc.

B. Thrust blocks shall be constructed so that the bearing surface is in direct line with the major force created by the pipe or fitting.

C. Thrust blocks shall bear against solid undisturbed earth at the side and bottom of the trench excavation and shall be shaped so as not to obstruct access to the joints or the pipe or fitting.

D. Thrust blocks shall be sized and constructed per the drawings.

3.3 PRELIMINARY CLEANING AND FLUSHING

A. CONTRACTOR shall flush the pipeline as the work progresses by a means in accordance with good practice to insure that sand, rocks, or other foreign material are not left in any of the pipeline. If possible the flushing shall be made with an open pipe end.

B. CONTRACTOR shall provide to ENGINEER a proposed schedule and method of flushing for review before the flushing starts.

3.4 TRACER WIRE TESTING

A. Upon completion of the pipe installation, CONTRACTOR shall demonstrate that the wire is continuous and unbroken through the entire run of the pipe.

1. Demonstration shall include full signal conductivity (including splices) when energizing for the entire run in the presence of OWNER OR ENGINEER.
2. If the wire is broken, CONTRACTOR shall repair or replace it. Pipeline installation will not be accepted until the wire passes a continuity test.

3.5 TESTING OF PIPELINE

A. CONTRACTOR shall provide temporary blow-off valves and fittings as required to flush and disinfect new pipelines. Temporary blow-off valves and fittings shall be removed prior to placing pipeline into service.

B. Source of Water

1. CONTRACTOR shall assume all responsibility to obtain the necessary water supplies for disinfection and pressure testing of the pipeline.

C. Testing Procedure

1. PVC pipe shall be tested at a static pressure of 150 psi for 2 hours and in accordance with the AWWA C605 standards. Pipe shall be tested in segments such that the test pressure at the low point of the segment shall be 150 psi.
2. In the case of pipelines that fail to pass the leakage test, CONTRACTOR shall determine the cause of the excessive leakage, shall take corrective measures necessary to repair the leaks, and shall repeat the pipeline test, all at no additional cost to OWNER.
3. ENGINEER shall be notified at least 48 hours before the pipeline is to be tested so that the ENGINEER may be present during the test.

D. Pressure and Leak Test

1. The Contractor shall test all piping either in sections or as a unit. The test shall be made by placing temporary bulkheads as needed in the pipe and filling the line slowly with water. Care shall be taken to see that all air vents are open during the filling. Bulkheads, valves, and connections shall be examined for leaks. If any leaks are found, corrective measures satisfactory to ENGINEER shall be taken. The test shall consist of holding a minimum pressure as shown on the Drawings on the section being tested for a minimum period of two hours using either pneumatic or

hydraulic means to maintain the pressure. Suitable means shall be provided by CONTRACTOR for determining the quantity of water lost by leakage under the test pressure. The testing allowance is defined as the quantity of water that must be applied to the pipe section being tested to maintain a pressure within 5 psi of the specified hydrostatic test pressure. The maximum allowable leakage shall be defined as follows:

L = SD(P)1/2/148,000

L = Testing allowance (makeup water) in gallons per hour of test
S = Length of pipe in feet
D = Nominal diameter of pipe in inches
P = Average Test Pressure in pounds per square inch (gauge)

3.6 DISINFECTING

A. Disinfection shall be in accordance with Section 33 13 00 - Pipeline Testing and Disinfection.

- END OF SECTION –

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SECTION 33 05 07.1
POLYVINYL CHLORIDE (PVC) PRESSURE PIPE
(ASTM D 1785, modified)

PART 1 GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall furnish and install all PVC pressure pipe and appurtenances as shown and specified, and as required for a complete and workable piping system.

B. This Section includes PVC pressure pipe with solvent-welded, flanged, or threaded joints in accordance with ASTM D 1785 as modified herein. PVC pipe with bell and spigot joints is included in Section 33 05 07 - PVC Pressure Pipe, Rubber Joints (AWWA C900 and C905).

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 05 45 00 Mechanical Metal Supports
3. Section 31 23 15 Excavation and Backfill for Pipelines
4. Section 33 05 07 PVC Pressure Pipe, Rubber Joints (AWWA C900 and C905)
5. Section 33 12 00 Mechanical Appurtenances
6. Section 33 13 00 Pipeline Testing and Disinfection

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publication is referred to in the text by basic designation only.

B. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1. ANSI B 16.5 Pipe Flanges and Flanged Fittings Class 150

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM D 1785 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
2. ASTM D 2467 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
3. ASTM F 1498 Standard Specification for Taper Pipe Threads 60 Degrees for Thermoplastic Pipe and Fittings

D. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C 605 Standard for Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
2. AWWA C 651 Standard for Disinfecting Water Mains

3. AWWA C 900 Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4-Inch through 12-Inch for Water Transmission and Distribution
4. AWWA C 905 Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings 14-Inch through 48-inch
5. AWWA M 23 Manual of Water Supply Practices - PVC Pipe - Design and Installation

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit manufacturer's affidavit certifying product was manufactured, tested and supplied in accordance with applicable references in this section together with a report of the test results and the date each test was completed.

C. Submit shop drawings of pipe, fittings, and appurtenances showing compliance with this Section; and manufacturer’s literature on tracer wire and accessories.

D. Submit plan for commissioning the waterline, including but not limited to cleaning, pressure testing, and disinfection.

PART 2 PRODUCTS

2.1 POLYVINYL CHLORIDE PIPE

A. PVC pipe shall be made from new rigid unplasticized polyvinyl chloride and shall be normal impact Type 1, Grade 1, class 12454, listed as compliant with NSF Standard 61, unless otherwise indicated, in accordance with ASTM D 1785. Use Schedule 80 pipe unless noted otherwise.

B. Pipe sections shall be clearly marked to:

1. Identify manufacturer's name or trademark
2. Nominal pipe size and OD base
3. ASTM material code designation
4. Schedule
5. Pressure class
6. ASTM specification designation
7. Product record code

C. The PVC pipe shall be Schedule 80. .

2.2 PIPE JOINTS

A. Pipe joints shall be solvent-welded type with solvent cement and primer as recommended by the pipe manufacturer for the chemical in the pipe.

B. Threaded joints that are necessary to match up to threaded valves or fittings shall be made up with appropriate thread sealant, either paste or tape.

C. Flanged joints shall be made with solvent-welded PVC flanges, drilled to ASME B 16.5 - Pipe Flanges and Flanged Fittings, Class 150, unless otherwise indicated. Gaskets

shall be ANSI 150 lb. full face, 1/8-inch thick Neoprene for water or wastewater service. Gasket material for chemicals shall be suitable for the chemical service.

2.3 FITTINGS

A. Solvent-welded and threaded fittings shall be Schedule 80 PVC fittings in accordance with ASTM D 2467 - Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

B. Flanged fittings shall be Schedule 80 fabricated PVC fittings with 150 lb. flanges to ASME B 16.5.

2.4 TRACER WIRE

A. All buried piping (including service lines) shall be installed with 12 gauge solid copper THHN tracer wire for pipeline location purposes by means of an electronic line tracer.

1. The wires must be installed along the entire length of the pipe on the top of the pipe and be held in place with ties or hitches spaced not more than 12-feet apart.
2. Sections of wire shall be spliced together using approved splice caps and waterproof seals or solder. Twisting the wires together is not acceptable.

PART 3 EXECUTION

3.1 INSTALLATION

A. Excavation and backfill of trenches and for appurtenances shall be in accordance with Section 31 23 15 - Excavation and Backfill for Buried Pipelines.

B. PVC pipe shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipe shall afford maximum headroom and access to equipment, and where necessary, piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points.

C. Piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 05 45 00 – Mechanical Metal Supports (Pipe Supports). Where necessary to avoid stress on equipment or structural members, the pipe shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature changes.

D. Unless otherwise indicated, connections to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection. Valves and flanges attached to PVC pipe shall be provided with adequate supports.

3.2 PIPE PREPARATION

A. Prior to installation, each pipe length shall be carefully inspected, flushed clean of any debris or dust, and be straightened, if not true. Ends of threaded pipes shall be reamed and filed smooth. Pipe fittings shall be equally cleaned before assembly

3.3 PIPE JOINTS

A. Pipe threads shall conform to ASTM F 1498 and shall be full and cleanly cut with sharp dies or molded. Joints shall be made with Teflon tape or thread sealant.

B. Solvent-welded joints shall be made with fresh primer and solvent cement on clean, dry pipe ends. The primer and cement cans shall be kept closed at all times and the joints shall be made up at the recommended ambient temperatures, according to the pipe or cement manufacturer's written recommendations. Pipe ends shall be inserted to the full depth of the socket. Solvents used on potable water pipes shall be ANSI/NSF 61 certified.

C. Flanged joints shall be made with gaskets and Type 316 stainless steel bolts and nuts, unless noted otherwise. Care shall be taken not to over-torque the bolts, in accordance with the manufacturer's written recommendations.

3.4 PRELIMINARY CLEANING AND FLUSHING

A. CONTRACTOR shall flush the pipeline as the work progresses by a means in accordance with good practice to insure that sand, rocks, or other foreign material are not left in any of the pipeline. If possible the flushing shall be made with an open pipe end.

B. CONTRACTOR shall provide to ENGINEER a proposed schedule and method of flushing for review before the flushing starts.

3.5 TRACER WIRE TESTING

A. Upon completion of the pipe installation, CONTRACTOR shall demonstrate that the wire is continuous and unbroken through the entire run of the pipe.

1. Demonstration shall include full signal conductivity (including splices) when energizing for the entire run in the presence of OWNER OR ENGINEER.
2. If the wire is broken, CONTRACTOR shall repair or replace it. Pipeline installation will not be accepted until the wire passes a continuity test.

3.6 INSPECTION AND TESTING OF PIPELINE

A. CONTRACTOR shall provide temporary blow-off valves and fittings as required to flush and disinfect new pipelines. Temporary blow-off valves and fittings shall be removed prior to placing pipeline into service.

B. Source of Water

1. CONTRACTOR shall assume all responsibility to obtain the necessary water supplies for disinfection and/or pressure testing of the pipeline.

C. Testing Procedure

1. CONTRACTOR shall allow adequate time for the solvent cement joints to cure. Curing time shall be per the solvent cement manufacturer's recommendation. Prior to enclosure or burying, piping systems shall be pressure tested as required on the Contract Drawings, for a period of not less than one hour, without exceeding the

tolerances listed on the Contract Drawings. Caution - Do not use air or gas for testing PVC pipe. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. CONTRACTOR shall furnish test equipment, labor, materials, and devices

2. In Leakage shall be determined by loss of pressure. Fixtures, devices, or other accessories that would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines shall be plugged or capped as appropriate during the testing procedures.

3. Leaks shall be repaired, and the piping shall be re-tested until no leaks are found.

4. ENGINEER shall be notified at least 48 hours before the pipeline is to be tested so that ENGINEER may be present during the test.

3.7 DISINFECTING

A. Disinfection shall be in accordance with Section 33 13 00 – Pipeline Testing and Disinfection.

- END OF SECTION –

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SECTION 33 05 11
HDPE PRESSURE PIPE (AWWA C901, C906)

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers furnishing and installation of the solid wall high density polyethylene (HDPE) pipe (3-inch diameter and smaller) in Contract Drawings and specified herein. Use HDPE pressure pipe for buried water service pipe and buried fluoride water pipe.

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittals
2. Section 31 23 15 Excavation and Backfill of Buried Pipelines
3. Section 33 05 07 PVC Pipe
4. Section 33 05 24 Horizontal Directional Drilling
5. Section 33 13 00 Pipeline Disinfection

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING MATERIALS (ASTM)

1. ASTM D 1248 Standard Specifications for Polyethylene Plastics Extrusion Materials for Wire and Cable
2. ASTM D 2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
3. ASTM D 2683 Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
4. ASTM D 2837 Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
5. ASTM D 3261 Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
6. ASTM D 3350 Standard Specification for Polyethylene Plastic Pipe and Fittings Materials
7. ASTM F 714 Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
8. ASTM F 1055 Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing

C. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C 901 Polyethylene (PE) Pressure Pipe and Tubing, 1/2"-inch through 3-inch, for Water Service.

2. AWWA C 906 Polyethylene (PE) Pressure Pipe and Fittings, 4-inch through 63-inch, for Water Distribution and Transmission.
3. AWWA M 55 PE Pipe – Design and Installation

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittals.

B. The following shall be submitted:

1. Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed.
2. A plan for pipe joining and installation. The plan must be reviewed and approved by ENGINEER prior to pipe installation.

1.5 QUALITY ASSURANCE

A. Pipe shall be subject to inspection at the place of manufacture. Notify ENGINEER not less than 14 days prior to the start of any phase of the pipe manufacture. During manufacture the ENGINEER shall be given access to all areas of the process and shall be permitted to make inspections necessary to confirm compliance with the Specifications.

B. Materials used in the manufacture of the pipe shall be tested in accordance with this Section and the referenced standards. CONTRACTOR shall perform said material tests. ENGINEER shall have the right to witness testing provided that CONTRACTOR's schedule is not delayed for convenience of ENGINEER.

PART 2 PRODUCTS

2.1 PIPE

A. Pipe up to 3-inch nominal diameter shall meet the requirements of AWWA C901. Pipe 4-inch through 63-inch nominal diameter shall meet the requirements of AWWA C906.

B. The high density polyethylene pipe shall be as manufactured by **ISCO Industries, WL Plastics Corp.**, or approved equal, and shall have a minimum pressure rating as noted on the Contract Drawings. The HDPE pipe shall have designation of PE 4710 (IPS size), made from prime virgin resin with a minimum cell classification of PE 445574C or higher in accordance with ASTM F-714 and D 3350. The resin shall be listed by the Plastic Pipe Institute (PPI) in its pipe-grade registry Technical Report (TR) 4, "Listing of HDB/HDS/SDB/PDB/MRS for Thermoplastic Piping Materials or Pipe".

C. The manufacturer shall comply with NSF Standard 14 and NSF 61 by certifying in writing to the design engineer and making the pipe with the NSF logo in the print line. The manufacturer shall comply with AWWA Standard C901 or C906 by certifying to the design engineer and marking the pipe with the appropriate AWWA standard in the print line.

D. Pipe shall be marked per AWWA C901 or C906 and NSF. Pipe markings shall include nominal size, OD base, dimension ratio, pressure class, manufacturer's name,

manufacturer’s production code including day, month, and year extruded, and manufacturer’s plant and extrusion line.

2.2 TRACER WIRE

A. All HDPE piping installed by horizontal directional drilling shall be installed with continuous tracer wire, 12 AWG **SoloShot Extra High Strength (EHS) 1245B by Copperhead Industries**, or approved equal, with 45 mil HDPE jacket with minimum 1150 pound break load or approved equal.

B. All direct bury piping (including service lines) shall be installed with 12 gauge solid copper THHN tracer wire for pipeline location purposes by means of an electronic line tracer.

1. The wires must be installed along the entire length of the pipe on the top of the pipe and be held in place with ties or hitches spaced not more than 12-feet apart.
2. Sections of wire shall be spliced together using approved splice caps and waterproof seals or solder. Twisting the wires together is not acceptable.

PART 3 EXECUTION

3.1 STORAGE AND HANDLING

A. Pipe shall be stored on clean level ground to prevent undue scratching or gouging. Sections of pipe with deep cuts or gouges shall be removed and ends of pipes rejoined. Handling of the joined pipe shall be in such a manner that the pipe is not damaged by dragging over sharp or cutting objects.

B. Lifting of joined pipe sections shall preclude concentration of bending stresses at joints and shall be done in a manner which evenly distributes lifting stresses along the full length of the pipe.

C. Pipe shall be stored in a shaded area or covered to avoid temperature extremes which may cause the pipe to bow or warp.

3.2 EXCAVATION AND BACKFILL

A. Excavation and backfill of trenches and for appurtenances and backfilling for high density polyethylene pipe shall be in accordance with Section 31 23 15 Excavation and Backfill for Buried Pipelines.

3.3 INSTALLATION

A. High density polyethylene pipe shall be installed according to the requirements of ASTM D 2321, AWWA M 55, and the manufacturer's requirements. Wherever the aforementioned requirements are in conflict, the more stringent requirement shall apply.

B. Sections of pipe shall be joined into continuous lengths by the butt fusion method and shall be performed in strict conformance with the pipe manufacturer's recommendations using approved equipment. Sections of pipe shall be as long as practical to minimize the number of joints.

C. High density polyethylene pipe shall be installed, backfilled, and allowed to acclimatize to the typical soil temperatures prior to connection to other piping systems.

3.4 TRACER WIRE TESTING

A. Safety tracer tape shall be installed above pipe as required by the Contract Drawings. Tracer wire shall also be installed as required by the Contract Drawings.

B. Upon completion of the pipe installation, CONTRACTOR shall demonstrate that the wire is continuous and unbroken through the entire run of the pipe. Demonstration shall include full signal conductivity (including splices) when energizing for the entire run in the presence of OWNER or ENGINEER. If the wire is broken, CONTRACTOR shall repair or replace it. Pipeline installation will not be accepted until the wire passes a continuity test.

3.5 PRELIMINARY CLEANING AND FLUSHING

A. CONTRACTOR shall flush the pipeline as the work progresses by a means in accordance with good practice to ensure that sand, rocks, or other foreign material are not left in any of the pipeline. If possible, the flushing shall be made with an open pipe end.

B. CONTRACTOR shall provide to ENGINEER a proposed schedule and method of flushing for review before the flushing starts.

3.6 PRESSURE AND LEAK TEST

A. There is no pressure test, leak test, or disinfection test for HDPE (solid wall) storm drain.

- END OF SECTION –

SECTION 33 05 13
PRECAST CONCRETE MANHOLES AND STRUCTURES

PART 1 GENERAL

1.1 SUMMARY

A. CONTRACTOR shall provide precast concrete manholes and vaults, complete and in place, in accordance with the Contract Documents.

1.2 RELATED WORK

A. Related Work specified in other sections includes, but is not limited to:

1.	Section 01 33 00	Submittal Procedures
2.	Section 01 45 00	Quality Control and Materials Testing
3.	Section 01 60 00	Product Requirements
4.	Section 31 23 15	Excavation and Backfill for Buried Pipelines
5.	Section 31 23 23	Excavation and Backfill for Structures
6.	Section 33 05 05	Ductile Iron Pipe
7.	Section 33 05 07	Polyvinyl Chloride (PVC) Pipe
8.	Section 33 05 07.2	PVC Sewer Pipe

1.3 REFERENCES

A. The latest edition of the following publications form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN SOCIETY FOR TESTING MATERIALS (ASTM)

1.	ASTM A 48	Standard Specification for Gray Iron Castings
2.	ASTM A 536	Standard Specification for Ductile Iron Castings
3.	ASTM A 615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
4.	ASTM C 150	Standard Specification for Portland Cement
5.	ASTM C 478	Standard Specification for Precast Reinforced Concrete Manhole Sections
6.	ASTM C 497	Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile
7.	ASTM C 857	Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
8.	ASTM C 858	Standard Specification for Underground Precast Concrete Utility Structures
9.	ASTM C 913	Standard Specification for Precast Concrete Water and Wastewater Structures
10.	ASTM C 923	Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.
11.	ASTM C 990	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate manhole and concrete structure locations, elevations, and piping sizes, material, and elevations of penetrations.

C. Product Data: Submit cover and frame construction, features, configuration and dimensions. Submit pipe connector materials and dimensions. Submit manhole step materials and dimensions. Submit manhole and structure joint sealant materials.

1.5 QUALITY ASSURANCE

A. CONTRACTOR shall demonstrate that manholes and structures have been properly installed, level, with tight joints, at correct elevations and orientations, and have been backfilled and compacted in accordance with the specifications.

1.6 DELIVERY, STORAGE AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Comply with precast concrete manufacturer's instructions for unloading, storing and moving precast manholes and structures.

C. Store precast concrete manholes and structures to prevent damage to Owner's property or other public or private property. Repair property damaged from materials storage.

D. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers shown on Drawings to indicate its intended use.

PART 2 PRODUCTS

2.1 MANHOLES

A. Reinforced precast concrete manholes in accordance with ASTM C 478 with HS-20 loading. Axial length of barrel sections shall be selected to provide the correct total height with the fewest joints. Conical sections shall be designed to support cast iron frames and covers under HS-20 loading, unless noted otherwise. Design criteria shall be as shown on the Contract Drawings. Manholes shall be manufactured by **Oldcastle Precast, Geneva Pipe and Precast**, or approved equal.

B. Provide water tight, epoxy lined (per spec 09 90 00) 72-inch concrete manhole (with water level monitoring device tied to WCWCD SCADA alarm) on drain from Fluoride building.

C. Joints shall be sealed with butyl-rubber sealants, **ConSeal CS-102, Ram-Nek RN101**, or approved equal, conformation to ASTM C 990. Wrap exterior section joints with membrane waterproofing and exterior joint wrap meeting the requirements of ASTM C877, Type III, **Marmac, Conseal CS212, or Press-Seal Corp EA-Wrap**, or approved equal.

D. Barrel section to pipe connections shall be sealed with resilient connectors, **Kor-N-Seal by Trelleborg**, or approved equal, complying with ASTM C 923. Mechanical devices shall be stainless steel.

2.2 STRUCTURES

A. Provide reinforced concrete structures and vaults designed for the applications and sizes as shown on the drawings. Structures shall conform to the requirements of ASTM C 857, ASTM C 858, or ASTM C 913 as required. Minimum wall thickness shall be 5-inches. Cement shall be Type V Portland cement conforming to the requirements of ASTM C 150. The minimum 28-day concrete compressive strength shall be 4,000 psi. Reinforcing steel shall be embedded in the concrete with a minimum rebar clear cover as recommended by ACI 318. Structure and vaults shall be manufactured by **Oldcastle Precast, Geneva Pipe and Precast**, or approved equal

B. Provide water-tight precast concrete vault (8 ft x 16 ft x 9 foot high inside dims) and connections for detaining 6000 gallons of backwash water. Provide a water level monitoring device that can governs Filter Backwash timing and actuation. See plans.

C. Structures shall be designed for H-20 traffic loading.

D. Where joints are required, joints shall be interlocking to secure proper alignment between members and shall prevent migration of soil through the joint. Joints shall be sealed with butyl-rubber sealants, **ConSeal CS-102, Ram-Nek RN101**, or approved equal, conformation to ASTM C 990.

E. Openings, where required, shall be of the size and location indicated on the drawings and shall be provided without obstructions from brackets and supports. Unless noted otherwise, frames and covers shall be fabricated from steel and galvanized after fabrication. Frames shall be integrally cast into the structure concrete sections. Covers shall be tight fitting to prevent dirt and debris entering the structure.

F. Where penetrations are required for piping, conduits, or ducts, such penetrations shall be through precast openings or core drilled through unreinforced thin-wall knock-out sections. Penetrations shall be smooth and exposed reinforcing steel will not be allowed. Unless noted otherwise, structures do not need to be designed to resist thrust from piping passing through the structure.

2.3 FRAMES AND COVERS

A. Manufacturers:

1. **D & L Foundry and Supply, East Jordan Iron Works, Neenah Foundry Co.,** or approved equal. Model Number as shown on the Drawings.

B. Product Description: Casting frames and covers shall be non-rocking and shall conform to the requirements of ASTM A 48, Class 35B for Gray Iron and ASTM A 536 for ductile iron. Unless noted otherwise, cast iron covers and frames shall be 30-inches in diameter, machined flat bearing surface, removable lid; HS-20 load rating; with embossed lettering saying (“IRRIGATION”, “WATER”, “SEWER”, “STORM DRAIN”) cast into cover.

2.4 COMPONENTS

A. Provide in all Manholes and Structures: Steps that shall have a 1/2-inch ASTM A 615 grade 60 steel reinforcement rod encased inpolypropylene copolymer plastic. Steps shall

have a tread width of 14-inches nominal. Steps shall be manufactured by **American Step Company, Inc., M.A. Industries**, or approved equal.

2.5 CONFIGURATION

A. Shaft Construction: Square or rectangular with flat lid top section; lipped male/female joints; shaped to receive pipe sections.

B. Clear Inside Dimensions: As indicated on Drawings.

C. Design Depth: As indicated on Drawings.

D. Clear Cover Opening: As indicated on Drawings.

2.6 BEDDING AND COVER MATERIALS

A. Bedding: 3/4" Washed Rock as specified in Section 31 23 23.

B. Soil Backfill to Finish Grade: Trench Backfill Material as specified in Section 31 23 15.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify items provided by other sections of Work are properly sized and located.

B. Verify built-in items are in proper location, and ready for roughing into Work.

C. Verify correct size of manhole and structure excavation.

3.2 PREPARATION

A. Do not install structures where site conditions induce loads exceeding structural capacity of structures.

B. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units.

3.3 PRECAST CONCRETE MANHOLE AND STRUCTURE INSTALLATION

A. Lift precast components at lifting points designated by manufacturer.

B. When lowering manholes and structures into excavations and joining pipe to units, take precautions to ensure interior of pipeline and structure remains clean.

C. Set precast structures bearing firmly and fully on crushed stone bedding, compacted in accordance with provisions of Section 31 23 23.

D. Assemble multi-section structures by lowering each section into excavation. Lower, set level, and firmly position base section before placing additional sections.

E. Remove foreign materials from joint surfaces and verify sealing materials are placed properly. Maintain alignment between sections by using guide devices affixed to lower section.

F. Joint sealing materials may be installed on site or at manufacturer's plant.

G. Verify manholes and structures installed satisfy required alignment and grade.

H. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe.

I. Steps shall be installed 12-inches on centers vertically not more than 1/2-inch out of plumb. The top step shall not be more than 12-inches below the manhole cover.

J. Prior to backfilling, fill all cracks and voids in the manholes or vaults with non-shrink grout, polyurethane sealant, or both.

3.4 FRAME AND COVER INSTALLATION

A. Set frame and cover 2-inches above finished grade for manholes and structures with covers located within unpaved areas to allow area to be graded away from cover beginning 1-inch below top surface of frame.

B. In paved areas set frame and cover 1/4" below finished grade and install concrete collar.

3.5 FIELD QUALITY CONTROL

A. Section 01 45 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Leak Tests. Field Test the water tightness of both the 72-inch epoxy lined manhole and of the 8-ft x 16-ft x 9 foot tall vault - by (closing downstream valve) and filling each with clean water and verifying water level does not drop over 24 hours. If the water drops, repair the leaks acceptably to Engineer and retest until both are water tight

C. Water Level Remote Alarm and Filter Actuation Tests.

1. Field test 72-inch manhole water level alarm proving that when it gets 6-inches of water depth that sets off a alarm in WCWCD SCADA controls center.
2. Field test 8ft x 16 ft x 9ft deep backwash vault water level monitor proving that when water levels drop to level of 2-inch outlet pipe (ie vault is fully drained to outlet pipe), then filtration equipment actuates the next filter to automatically begin backwashing.

D. Vertical Adjustment of Existing Manholes and Structures

1. Where required, adjust top elevation of manholes and structures to finished grades shown on Drawings.

2. Reset existing frames, grates and covers, carefully removed, cleaned of mortar fragments, to required elevation in accordance with requirements specified for installation of castings.

- END OF SECTION –

SECTION 33 05 26
UTILITY IDENTIFICATION

PART 1 GENERAL

1.1 DESCRIPTION

A. The CONTRACTOR shall provide and install identification markers for all exposed valves, piping, equipment, tanks, and warning signs, all in accordance with these specifications and the Contract Documents.

1.2 RELATED WORK

A. Related work specified in other sections includes:

1. Section 01 33 00 Submittal Procedures
2. Section 09 90 00 Painting and Finishes

1.3 REFERENCES

A. The latest edition of the following publications form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1. ANSI A13.1 Scheme for the Identification of Piping Systems
2. ANSI Z535 Safety Signs and Colors

C. AMERICAN SOCIETY FOR TESTING MATERIALS (ASTM)

1. ASTM D 1593 Standard Specification for Nonrigid Vinyl Chloride Plastic Film and Sheeting

2. ASTM D 3652 Standard Test Method for Thickness of Pressure-Sensitive Tapes

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit manufacturer’s data sheets showing wording, symbols, letter size, and color coding.

C. Submit one sample of each type of identification device to be used.

D. Submit sample of each proposed color required by the color schedule.

E. Submit the manufacturer’s installation instructions.

1.5 QUALITY ASSURANCE

A. Product manufacturer shall be ISO 9001 Quality Certified.

PART 2 PRODUCTS

2.1 VALVE TAGS

A. General: Provide each valve of size 2-inch and larger with an identification tag. Tag shall show the pipeline station (if applicable), type, manufacturer, date of manufacture, and pressure rating.

B. Plastic Tags:

1. Acrylic: Flexible 0.060-inch (1.52 mm) thick, multi-layered acrylic engraved tags. Model **Setonply by Seton, B-418 by Brady**, or approved equal.

C. Metal Tags:

1. Brass: 19 gauge thick solid brass, with 3/16-inch (5 mm) top hole for fastener, natural brass finish. Manufacturer shall be **Seton, Brady**, or approved equal.

2. Aluminum: 19 gauge thick aluminum. Teflon coated both sides, with Code 39 bar codes. Manufacturer shall be Seton, Brady, or approved equal.

3. Stainless Steel: 0.6 mm (0.025 inch) thick, Grade 304 stainless steel. Manufacturer shall be **Seton, Brady**, or approved equal.

4. Lettering: stamped or engraved letters; character size and words according to ANSI A13.1.

D. Beaded Chains: No. 6 (brass or nickel over steel, or stainless steel, 114 mm (4-1/2 inch) long, with locking link.

E. OR Nylon Ties: 150 mm (min), 6 to 10 inches long, nonconductive.

F. Chart: Typewritten letter size list in anodized aluminum frame.

2.2 PIPE MARKERS

A. General: Labels for piping shall bear the full piping system name. Provide flow arrows and working pressure next to each label.

B. Mechanically Fastened Pipe Markers:

1. Vinyl: Factory fabricated vinyl, 0.020 inch to 0.030 inch thick, performed to fit around pipe or pipe covering. Model **Setmark by Seton, B-915 Brady SnapOn Vinyl by Brady**, or approved equal.

2. Polyester: Factory fabricated polyester, 0.1 mm (4 mil) thick, laminated with UV-resistant poly vinyl fluoride (PVF), preformed to fit around pipe or pipe covering. Model **Ultramark by Seton, B-689 High Performance by Brady**, or approved equal.

C. Self-Adhesive Pipe Markers:

1. Vinyl: Factory fabricated vinyl, 0.102 mm (5 mil) thick, preformed to fit around pipe or pipe covering. Model **Opti-Code by Seton, B-946 by Brady**, or approved equal.

2. Polyester: Factory fabricated polyester, 0.05 mm (2 mil) thick, coated with acrylic adhesive. Model **Poly-Code by Seton**, or approved equal.

3. Plastic: Factory fabricated plastic film, roll formed, clear laminated to protect lettering.

D. Nylon Ties: 150 mm (min), 6 to 10 inches long, nonconductive.

E. Identify fluid being conveyed and include flow direction arrow.

1. Language: English.
2. Lettering: Size and Color according to ANSI A 13.1.

F. Color and Text per the Schedule at the end of this Section.

2.3 LABELS FOR EQUIPMENT AND TANKS

A. Provide a label for each piece of mechanical equipment and/or tank. The label shall contain the equipment name, tag number, and identifying information such as size, liquid, horsepower, etc. Minimum label size shall be1-1/2 inches by 4-inches. Labels shall be stainless steel, brass, or aluminum. Fiberglass labels may be used for corrosive environments. Manufacturer shall be **Brady, Seton**, or approved equal.

2.4 LABELS FOR AUTOMATIC START/STOP EQUIPMENT

A. Provide a sign reading “CAUTION – EQUIPMENT STARTS AND STOPS AUTOMATICALLY” on equipment as shown on the drawings on identified in the specifications. Signs shall be vinyl with self-adhesive for application to the equipment. Minimum size shall be 7-inches by 10-inches. Manufacturer shall be **Brady, Seton**, or approved equal.

2.5 WARNING SIGNS

A. Provide a properly labeled, rigid warning sign as shown on the drawings. Signs shall contain the header, pictogram/alert symbol, and messaging conforming to OSHA/ANSI A 535 requirements. Minimum size shall be 7-inch high by 10-inch wide. Signs shall be plastic with overlaminate and be pre-drilled for mounting. Manufacturer shall be **Seton, Brady**, or approved equal.

PART 3 EXECUTION

3.1 GENERAL

A. Markers and identification tags shall be installed in accordance with the manufacturer’s printed instructions and shall be neat and uniform in appearance. Tags and markers shall be readily visible from all normal working locations.

3.2 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.3 INSTALLATION

A. Valve Tags:

1. Install tags with corrosion resistant chains or ties.

2. Identify valves in main and branch piping with tags.

3. Identify small devices, such as in-line pumps, with tags.

4. Tag automatic controls, instruments, and relays.

B. Pipe Markers:

1. Identify all above grade piping. Include service, flow direction, and working pressure.

2. Provide snap-on type markers for pipes 6-inch diameter and smaller. Provide strap-on type for pipes over 6-inch diameter.

3. Each pipe shall me marked at:

a. Intervals of 20-feet in straight runs.
b. At least once in every room.
c. Within 2 –feet of bends and valves.
d. On the upstream side of Tees, branches, and other distribution points.
e. On both sides of walls and floors through which the piping passes.

C. Automatic Start/Stop Equipment

1. Attach signs for exposed equipment directly to the equipment.

2. Attach signs for sump pumps on the adjacent wall.

D. Warning Signs

1. Attach to walls according to the manufacturer’s recommendations.

E. Equipment and Tank Labels

1. Attach labels to equipment with a pop rivet or equal.

3.4 SCHEDULES

Color Schedule				
Pipe Contents		Pipe Color	Marker Color	Letter Color
Abbreviation	Identification			
AHP	Air, High Pressure	Dark Green	Blue	White
AI	Air, Instrument	Dark Green	Blue	White
CL	Chlorine (gas or liquid state)	Yellow	Orange	Black
CLS	Chlorine Solution	Yellow	Orange	Black
CLV	Chlorine Gas Under Vacuum	Yellow	Orange	Black
CV	Chlorine Vent & Detection Line	Yellow	Orange	Black
EE	Engine Exhaust		Yellow	Black
EWR	Engine Cooling Water Return		Green	White
EWS	Engine Cooling Water Supply		Green	White
FL	Fluoride	Light Blue/Red	Orange	Black
FOR	Fuel Oil Return		Brown	White
FOS	Fuel Oil Supply		Brown	White
FSP	Fire Protection Sprinkler System	Red	Red	White
HWR	Domestic Hot Water Return		Yellow	Black
HWS	Domestic Hot Water Supply		Yellow	Black
LSS	Landscape Sprinkler System		Green	White
NG	Natural Gas	Org-Red/Black	Yellow	Black
OF	Overflow		Green	White
PD	Plant Drain	Green	Green	White
PPS	Pump Suction (Potable Water)	Light Blue	Green	White
PTW	Pump to Waste	Green	Yellow	Black
PW	Potable Water	Dark Blue	Green	White
RS	Raw Sludge	Black	Yellow	Black
RWL	Rain Water Leader		Green	White
RW	Raw Water	Olive Green	Green	White
SA	Sample Line		Yellow	Black
SD	Sanitary Drains	Dark Gray	Yellow	Black
SDR	Storm Drain	Green	Green	White
SL	Sludge	Dark Brown	Yellow	Black
SUC	Structure Underdrain Collector		Green	White
UW	Utility Water (Non-Potable Water)	Magenta	Yellow	Black
V	Vent	Dark Brown	Yellow	Black

- END OF SECTION –

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SECTION 33 12 00
MECHANICAL APPURTENANCES

PART 1 GENERAL

1.1 SUMMARY

A. CONTRACTOR shall furnish and install all valves, and equipment, complete and operable in accordance with the Specifications. All system components shall be rated to max system pressure or higher.

B. Where 2 or more valves or equipment of the same type and size are required, the valves shall be furnished by the same manufacturer.

C. CONTRACTOR shall verify that flanges on pipe match the bolt hole pattern of the flanges on the mechanical appurtenances

D. All products specified herein shall be NSF 61 certified for use on drinking water systems.

1.2 RELATED WORK

A. Related work specified in other sections:

1.	Section 01 33 00	Submittals
2.	Section 01 45 00	Quality Control & Materials Testing
3.	Section 01 50 00	Temporary Construction Utilities and Environmental Controls
4.	Section 22 10 10	Plumbing Piping and Specialties
5.	Section 31 23 15	Excavation and Backfill for Buried Pipelines
6.	Section 31 23 23	Excavation and Backfill for Structures
7.	Section 33 05 05	Ductile Iron Pipe and Fittings
8.	Section 33 07 05	Polyvinyl Chloride (PVC) Pressure Pipe, Rubber Joints (AWWA C 900)
9.	Section 33 05 07.1	Polyvinyl Chloride (PVC) Pressure Pipe (ASTM D 1785)
10.	Section 33 92 10	Steel Pipe, Specials, and Fittings (AWWA C200, modified)

1.3 REFERENCES

A. The latest edition of the following publications form a part of these specifications to the extent referenced. The publications are referred to in the text to by basic designation only.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1.	A 126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
2.	A 216	Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
3.	B 584	Standard Specification for Copper Alloy Sand Castings for General Applications

C. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. C 504 Rubber-Seated Butterfly Valves, 3-inch through 72-inch
2. C509 Resilient-Seated Gate Valves for Water Supply Service
3. C512 Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service
4. C 515 Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
5. C 518 Dual-Disc Swing-Check Valves for Waterworks Service
6. C 550 Protective Interior Coatings for Valves and Hydrants

D. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1. B 16.1 Gray Iron Pipe Flanges and Flanged Fittings
2. B 16.34 Valves – Flanged, Threaded, and Welding End

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittals.

B. Submit catalog cut sheets on all mechanical appurtenances including: fittings, valves, or other items shown on the Drawings referencing each item by mark number. Information shall indicate manufacturer specification compliance, Cv factor, pressure rating, and dimensional data. Indicate NSF 61 compliance of all appurtenances and valves.

PART 2 PRODUCTS

2.1 GATE VALVES

A. Gate valves shall conform to the requirements of AWWA C-509 or C-515. Valves shall be of the resilient-seat type with non-rising stem (NRS), opening to the left, and provided with a 2-inch square operating nut for buried valves or hand wheel for valves located in structures. Buried valves shall be of flange or mechanical joint design to match pipe joint system.

B. Valves, valve-operating units, stem extensions and other accessories shall be installed by CONTRACTOR where shown, or where required in the opinion of ENGINEER, to provide for convenience in operation. Where buried valves are indicated, CONTRACTOR shall furnish and install valve boxes to 3-inches above grade in unimproved areas or at grade with concrete collar in improved areas. All valves and gates shall be new and of current manufacture.

C. The valve shall have a two part thermosetting or fusion bonded epoxy protective coating (10 mil minimum inside and out) system that is non-toxic and imparts no taste to water. The epoxy shall be applied in accordance with AWWA C550 and be ANSI/NSF 61 certified.

D. The flanges of valves may be raised or plain faced. Flanges of valves shall be faced and drilled to 125-lb American Standard template. Provide ASME Class 250 flanges for valves located on the high pressure discharge side piping.

E. All valves shall be furnished with pressure classes equal to or better than the pressure class of the pipe with which the valves are to be used. Unless otherwise specified, each valve body shall be tested under a test pressure equal to twice its design water-working pressure. Certify valves have zero leakage across closed valve during a 250 psi test.

F. Valves shall be manufactured by **Mueller Co., Clow Valve Co., American Flow Control, Kennedy Valve Co., American AVK Company (high pressure)**, or approved equal.

2.2 DOUBLE ECCENTRIC BUTTERFLY VALVES

A. Butterfly valves shall be double eccentric type - so that EPDM seat is not in compression to any degree except at full closure – shall be rated for 250 psi and 16 fps velocity (min), certified compliant with AWWA C504 Class 150B and NSF 61, with 2-flanges (ANSI B16.1 Class 150B drilled), ductile iron body tested to 400 psi. All bolting shall be 316 SS.

B. Zero Leakage Seats. Provide EPDM seat clamped to disc by continuous 316 SS ring. Resilient seats shall be field replaceable without special tools or epoxy. Body seat shall be 316 SS welded to, or mounted on, valve body. *Certify valves have zero leakage across closed valve during a 250 psi test in both directions*.

C. Line and coat all iron parts of valve with 10 mils min of polyamide cured epoxy or fusion bonded epoxy in accordance with AWWA C550.

D. Provide dry shaft design with double O-ring seal on shafts that keep water out of disc portion and body portion of shaft. O-ring seals shall be replaceable without removing shaft from valve. Provide shaft bearings of self-lubricating sleeve type made of bronze.

E. Provide AWWA C540 compliant actuator, rated at 450 ft lbs torque, with integral disc position indicator and self-locking worm gear that holds disc in any position without creep or flutter. Provide handwheel with each valve.

F. Where shown on the Drawings valves shall be electrically actuated rated for continuous modulation at voltage provided. See Section 40 92 57 Electric Motor Actuators.

G. Provide 1-year warrantee against manufacturer defects, with labor replacement costs.

H. Double eccentric butterfly valves shall be **Av-Tek, VAG, AVK,** or approved equal

2.3 BALL VALVES

A. Valves shall MSS SP-110 compliant.

B. **Stainless Steel Ball Valves** (1000 psi rated) shall be full port opening stainless steel and have adjustable stem packing gland. Body and ball shall be stainless steel in accordance with ASTM A351. Seats shall be reinforced PTFE and packing stem shall be PTFE. The handle shall be Type 304 stainless steel with vinyl insulator. Provide **Apollo 76F-100, NIBCO T-585-S6-R-66-LL, Watts Series S-FBV-1**, or approved equal.

C. **Brass Ball Valves** (600 psi rated) shall be full port opening brass, 600 psi min CWP NSF 16 compliant, blow out proof stem design, adjustable stem packing, secondary O-ring stem seal, zinc plated steel handle with vinyl insulator. Provide **Apollo Series 64, Watts Series LFFBV, NIBCO FP600A-LF,** or approved equal.

D. **PVC Ball Valves** shall be Industrial Grade Sealed Unit Heavy Body full port opening with all wetted materials composed of Schedule 80 PVC. Valve shall have true union ends or flanged ends to mate with ANSI B16.5 Class 150 flanges. PVC ball valves shall be **NIBCO Chemtrol Series, Spears Mfg. Co. TU-2-2025**, or approved equal.

2.4 SERVICE SADDLES

A. Shall consist of a 2-piece bronze body and strap, meeting applicable sections of AWWA C800.

B. Outlet shall be tapped with AWWA I.P. thread (F.I.P.T.). Outlet shall be o ring sealed. Saddles shall be ANSI/NSF 61 certified.

C. Shall be **Mueller H-13000 Series, Romac Style 202B**, or approved equal.

2.5 TAPPING SADDLE AND TAPPING SLEEVES

A. Tapping Saddles (Service Saddle) shall be as-manufactured by Romac, or approved equal. Saddles shall be Style 202S for exposed saddles and Style 202NS for buried services.

2.6 WATER SERVICE CONNECTIONS AND FITTINGS

A. Water service pipe shall be polyethylene tubing (PE 3408 IPS, 200 psi) for buried service lines. Poly piping shall be 3/4-inch, 1-inch or 2-inch minimum as indicated on the Contract Drawings. Replacement service pipes shall be the same diameter as existing pipes.

B. All water service connections, except 2-inch, shall be made using **Mueller Insta-Tite Connections, Ford Ultra-Tite**, or approved equal, fittings and shall conform to AWWA C800. All 2-inch water service connections shall be made using **Mueller Pack Joint, Ford Pack Joint**, or approved equal.

C. If the existing service is poly pipe, a coupling can be used to extend the poly service to the new waterline.

D. New water service lines shall be bored, jacked or augered under the existing pavement, gutters or sidewalks.

E. Where the new service line will pass under an existing gas line, in order to prevent damage, the gas line shall be potholed and shall remain exposed until the service line is installed.

2.7 CORP STOPS

A. Corp Stops shall be Brass Alloy 85-5-5-5 ASTM B62 and conform to the requirements of AWWA C800.

B. Corp Stops for 3/4-inch and 1-inch sizes shall be **Mueller H-15026, Ford F1100 Ultra-Tite joint**, or approved equal.

C. Corp Stops for 2-inch size shall be **Mueller E-25029, Ford F1100 Pack Joint**, or approved equal.

2.8 VALVE BOXES AND LIDS

A. All buried valves shall be installed complete with 6-inch diameter slide type, two-piece cast iron valve box. Manufacturer be **Tyler 562 Series**, or approved equal. The valve box lid shall be designated “WATER” unless noted otherwise on the Contract Drawings.

B. Valves and valve boxes shall be set plumb. Valve boxes shall be centered directly over the valve operating nut. If the top of the valve nut is greater than five (5) feet below finished grade a valve nut extension shall be required. Earth fill shall be carefully tamped around the valve box to a distance of four (4) feet on all sides of the box, or to the undisturbed trench face if less than four (4) feet. Valves shall have the interiors cleaned of all foreign matter before installation.

C. Road base around the valve box shall be re-compacted, and the concrete collar placed. Valve boxes placed in asphalt surfacing shall be constructed such that the cast iron ring is one-quarter inch (1/4”) lower than the pavement. Valve boxes must be cleaned of all debris after setting of collars.

D. Concrete Collars shall be 10" thick x 2'- 6" in diameter centered on the valve box. They shall have two circumscribing #4 bars, one at three inches from the outside edge and a second bar nine inches from the outside edge each centered in the concrete. Concrete shall be 3000 psi.

2.9 PRESSURE GAUGES

A. Pressure gauges shall be provided where shown on the drawings. Gauges shall meet the requirements of ASME B40.1 Grade 2A and be industrial type with stainless steel movement, liquid filled, and stainless steel, Polypropylene, or Phenolic case. Gauges shall have a rear blowout disc or panel. Unless noted otherwise on the drawings, pressure gauges shall have a 4-1/2-inch dial with white face and black lettering, a ½-inch threaded connection, and shut-off valve. Measuring element shall be a stainless steel Bourdon Tube. Gauges shall be calibrated to read in applicable units, with an accuracy of ± 0.5 percent to 150 percent of the working pressure. Gauges shall be manufactured be **Ashcroft Model 1279 Duragauge, 1900 Series SOLFRUNT by Ametek (U.S. Gauge), Process Gauge by Marsh Bellofram**, or approved equal.

2.10 PUMP CONTROL VALVE

A. The pump control valve shall be a deep well pump control valve pilot operated valve designed to eliminate pipe surges caused by the starting and stopping of vertical turbine pumps. A four-way solenoid pilot valve controls the valve operation. It shall contain a resilient, synthetic rubber disc.

B. The pump control valves shall be manufactured by **Cla-Val, Model 61-02KO** (anti cavitation required), for installation at the location shown on the drawings. The valve shall be full port globe style and shall include the required pilot, dual position indicator switches (one for open and one for closed), and solenoid system assemblies. The pressure class shall be 150 lb, rated for 250 psi working pressure, and the valve shall include opening and closing speed adjustments, stainless steel trim, stainless steel tubing, and “Y” strainers. The solenoid shall operate on 120 volts AC.

C. The pump control valve shall be equipped with the CLA Valve internal check feature.

D. A direct factory representative shall provide start-up assistance, inspection and adjustments. The representative shall provide 2 to 4 hours of assistance for each valve installed on the project.

2.11 PRESSURE RELIEF AND SURGE ANTICIPATOR VALVE

A. The pressure relief and surge anticipator valve shall be a pilot operated valve designed to eliminate pipe surges caused by the rapid changes of flow velocity within a pipeline. The pressure relief and surge anticipator valves shall be manufactured by **Cla-Val Co., Model 52-03.** The valve shall be globe style, full port, flanged, and shall include stainless steel pilot system and valve position indicator. The pressure class shall be 150 lb, rated for 250 psi working pressure, and the valve shall include stainless steel trim, stainless steel tubing, and isolation valve. The adjustment range for the high pressure pilot CRL-60 shall be 20 to 200 psi, and for the low pressure pilot CRA 30 to 300 psi.

2.12 PRESSURE REDUCING VALVES

A. Pressure reducing valves 1/2-inch to 2-1/2-inch shall have a bronze ASTM B62 body and cover with stainless steel trim. Diaphragm shall be reinforced EPDM and the disc EPDM. Valves shall be balanced, direct acting type **Model 990 by Cla-Val Co.**, or approved equal. Valves shall be installed at the location(s) shown on the drawings. The pressure class shall be 150 lb, and the valve shall be set to operate at the pressure indicated on the drawings.

B. Pressure reducing valves 1/8-inch to 1/4-inch shall be brass with stainless steel stem and spring. Valves shall be provided with a gauge and be **Model #560G by Watts**, or approved equal. Valves shall be installed at the location shown on the drawings. The valve shall be set to operate at the pressure indicated on the drawings.

2.13 RUBBER FLAPPER SWING CHECK VALVES

A. Provide rubber flapper type swing check valve, 250 psi rated, complying with AWWA C508, with flanges complying with ANSI B16.1, Class 125, having a valve body with full flow area equal to pipe nominal diameter at all points, and a seating surface on a 45-degree angle to minimize disc travel. Provide a stainless steel disc closure accelerator.

B. Valve body and cover shall be ASTM A536 Grade 65-45-12 ductile iron. Disc shall be precision molded Buna-N (NBR) ASTM D2000-BG. Valve shall be NSF 61 certified.

C. Check valve shall be Valmatic Series 7200 Surgebuster, or approved equal.

2.14 DRAIN LINE CHECK VALVE

A. Drain line check valves shall be the low-head “duck bill” type installed at the locations shown on the drawings. Valves shall be constructed of Rubber, Neoprene, Hypalon, Chlorobutyl, Buna-N, EPDM, Viton and be **Tideflex Model TF-1 by Red Valve**, (no approved equal).

2.15 SMALL CHECK VALVES

A. The globe style check valves shall be **APCO Globe Style Series 600 Silent Check Valves**, or approved equal, and shall be rated at 150 psi.

B. The 1-inch and 2-inch brass check valves shall be **Watts CVY Series**, or approved equal, with rating 125 WSP/200 WOG.

C. The 1-inch PVC check valves shall be **Spears Industrial Ball Check Valve Model 4521**, or approved equal, with a pressure rating of 235 psi.

2.16 HOSE BIBBS and SAMPLING TAPS

A. Hose bibbs shall be as-manufactured by Watts, or approved equal, and shall include an integral vacuum breaker or built-in backflow protection devices and cast iron wheel handle. Sampling Taps shall be smooth nose type. Valves shall be stainless steel.

2.17 AIR VALVE FOR DEEP VERTICAL TURBINE SERVICE

A. Provide AWWA C512 compliant air valve for deep well vertical turbine pump rated to 150 psi min **Valmatic 102 ST**, well service air valves, or Engineer approved equal.

B. Provide valve with the following functions:

1. Provides regulated exhausting of large volumes of air during pump startup and filling
2. Admits large volumes of air during shut down and draining of well
3. Provides air related surge protection
4. Protects against column separation
5. Maintains pipeline efficiency
6. Provides protection against damage to pipe joints, gaskets, packing

2.18 COMBINATION AIR/VACUUM VALVES

A. Combination Air/Vacuum valves shall be single body, double orifice valves conforming to the requirements of AWWA C 512. Valve float shall be stainless steel. Valves shall be the size indicated on the drawings and shall be **Valmatic 201.C2**, or approved equal.

2.19 FLOW METER

A. See Section 40 91 23 – Miscellaneous Properties Measurement Devices.

2.20 PRESSURE TRANSMITTERS

A. See Section 40 91 23 – Miscellaneous Properties Measurement Devices.

PART 3 EXECUTION

3.1 INSTALLATION

A. Valves, valve-operating units, stem extensions and other accessories shall be installed by CONTRACTOR where shown, or where required in the opinion of ENGINEER, to provide for convenience in operation. Where buried valves are indicated, CONTRACTOR shall furnish and install valve boxes at grade with concrete collars. All valves and boxes shall be new and recently manufactured.

B. Install mechanical appurtenances as indicated on the Drawings and in accordance with the manufacturer's written instructions.

- END OF SECTION -

SECTION 33 12 30
DEEP WELL PUMP AND PUMP MOTOR – OIL LUBE

PART 1 GENERAL

1.1 DESCRIPTION

A. Furnish, deliver and install an oil lubricated surface discharge deep well turbine pump into the well casing to depths as shown on the drawings.

1.2 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at time of award of the Contract:

B. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1. ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800
2. ANSI/HI 9.6.4 Rotodynamic Pumps for Vibration Measurements and Allowable Values

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 36 Structural Steel
2. ASTM A 48 Gray Iron Castings
3. ASTM A 53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
4. ASTM A 108 Steel Bars, Carbon, Cold Finished, Standard Quality
5. ASTM A 269 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
6. ASTM A 536 Standard Specification for Ductile Iron Castings
7. ASTM A 582 Standard Specification for Free-Machining Stainless Steel Bars
8. ASTM B 584 Standard Specification for Copper Alloy Sand Castings for General Applications

D. AMERICAN WATER WORKS ASSOCIATION

1. AWWA C 651 Standard for Disinfecting Water Mains
2. AWWA C 654 Standard for Disinfecting of Wells
3. AWWA E 103 Standard Specifications for Horizontal and Vertical Turbine Line-Shaft Pumps

E. NATIONAL SANITATION FOUNDATION

1. NSF/ANSI 60 Drinking Water Treatment Chemicals
2. NSF/ANSI 61 Drinking Water System Components – Health Components
3. NSF/ANSI 372 Drinking Water System Components – Lead Content

1.3 SUBMITTALS

A. CONTRACTOR shall submit for review to ENGINEER, sufficient literature, detailed specifications, and drawings to show dimensions, make, style, speed, size, type,

horsepower, head-capacity, efficiency, materials used, design features, internal construction, weights, and any other information required by ENGINEER for review of all pumping equipment. No pumping equipment will be accepted, and installation will not be allowed, until such review has been completed. All submittals shall clearly state any deviations from specified requirements. Provide the following with the submittal:

1. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. The equipment shall indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the specified design point.
2. Equipment manufactured shall provide complete and detailed information regarding the installation of the pumps. Any installation requirements or operating conditions which the supplier or manufacturer' feel to be critical to the safe and reliable operation of the pumps should be identified and described in detail.
3. Shop drawings submitted for review also shall include detailed description of motor, including electrical diagrams, schematic control diagrams, and a detailed description of how the control system is to function, where applicable.

1.4 OPERATING CONDITIONS

A. Table I indicates the operating conditions of the pumps.

TABLE I - OPERATING CONDITIONS DEEP WELL TURBINE PUMP

DESCRIPTION	RED BRIDGE WELL
Design capacity of pump (gpm)	600
Design total dynamic head at discharge of bowl assembly (feet)	635
Pump Setting Depth	420
Nominal Operating Speed (rpm)	1770
Minimum Efficiency at Design Point	83%
Maximum NPSHR at Design Point	20 feet
Minimum Motor Horsepower	150
Column Size (diameter) (0.375" Wall)	8-inch
Min Shaft & Oil Tube Size (inches)	1-1/2 (C1045)
Diameter of Well Casing (inches)	16-inch (15.25" I.D.)
Maximum Bowl Diameter (inches)	10.5
Approx. Elevation (ft. above MSL)	4600
Design Pump, Model No:	National K10MC, 14 stage
Utility Power (volts, phase, hertz)	480, 3, 60

1.5 MECHANICAL DEFECTS AND REJECTIONS

A. CONTRACTOR furnished pumps that have mechanical defects or do not meet the requirements for head-capacity, horsepower, efficiency, and vibration requirements will be rejected, and shall be replaced without additional cost to OWNER for furnishing, removal, reinstallation, and retesting. Mechanical defects shall include excessive vibration, improper balancing of any rotating parts, improper tolerances, binding, excessive bearing or motor heating, defective materials, including materials that do not conform to the Specifications, improper fitting of parts, and any other defect which will in time damage the pump or unreasonably impair its efficiency or operation.

1.6 WARRANTY

A. CONTRACTOR furnished equipment covered by these specifications shall be warranted against defective parts due to faulty material or workmanship for one (1) year after date of start-up. CONTRACTOR shall guarantee to replace any defective parts within the period of time specified at no additional cost to OWNER. If CONTRACTOR has to pull pump to replace defective parts, CONTRACTOR shall guarantee to pull and replace pump at no additional cost to OWNER.

1.7 MEASUREMENT AND PAYMENT

A. The pumping system and motor shall be measured and paid under the bid item for Pumping System and Pump Motor.

1.8 FACTORY TESTING

A. Factory testing is not required for this project.

PART 2 PRODUCTS

2.1 DEEP WELL VERTICAL TURBINE PUMP

A. The pumps shall be of the deep well, oil lubricated, vertical turbine pump suitable for pumping culinary water. All material, manufacturing and performance standards shall be in compliance with AWWA E 103, NSF 60, NSF 61 and NSF 372 as applicable.

B. Performance Requirements

1. Pump Speed - The pumps shall operate as specified in Table I.
2. Pump Characteristics - The pump shall be characterized by head capacity curves of steadily decreasing head with increasing capacity. Maximum head shall be at zero flow. The pump shall have a minimum efficiency as provided in Table I during operation against the system head. Pump head - capacity curves shall indicate that these losses have been included. Pumps shall have head-capacity curves similar to that of the specified pump. Pumps having curves that show a flatter or near horizontal slope over a section in the head – capacity curve will not be accepted. Curves with head-capacity curves with slopes of the curve flatter than that shown for the specified pump will not be accepted.

3. The pump and motor shall be capable of producing the flow rate and total dynamic heads indicated in Table I.
4. Motor Characteristics - Under no operating conditions shall the required pump brake horsepower exceed the nameplate rating of the motor being furnished.
5. The pump shall be designed to operate throughout its entire range without excessive vibration or noise. Pump shall meet the requirements of the Hydraulic Institute (2016) paragraph 9.6.4 vibration limits.

C. Vertical Turbine Pump Components

1. Pumps
   a. The vertical turbine pump for the wells shall be as manufactured by National Pump Company or approved equal and shall be a multi-stage oil lube bowl assembly (or equal). Equals are: Flowserve, Floway, American Marsh if they meet other spec conditions.
   b. Unless otherwise stated herein, the pump shall in all respects conform to the American National Standard ANSI/AWWA-E103 for “Horizontal and Vertical Turbine Line Shaft Pumps” and shall comply with all local and state sanitary and safety regulations.
2. Discharge Head
   a. The discharge head shall be fabricated steel (ASTM A53 Grade B Pipe and ASTM A 36 Steel Plate or as recommended by the manufacturer), accurately machined and with a surface discharge. Discharge flange shall be machined and drilled to ANSI standards for 150 lb. rating and shall be sized to match the specified system. The top of the discharge head shall have a rabbet fit to accurately locate the vertical hollow shaft driver, and have a diameter equal to the driver base diameter (BD). Lifting lugs of sufficient strength to support the weight of the complete unit shall be provided. The base shall be round or square. Head must be able to accept the monitoring tube, sounding tube, and well vent as shown on the drawings. The design shall allow the head shaft to couple above the tube tension assembly. The tube tension assembly shall consist of a tension bearing installed in the top oil tube. CONTRACTOR shall modify the well base dimensions on the drawings to match supplied head.
   b. The discharge head shall be furnished with a one gallon oil reservoir with copper tubing, manual isolation valve, a sight feed drip oiler and a solenoid valve to initiate or shut-off oil feed. Drip oil system shall be **Hoffman Dripmaster EDD-4C**. Mount it on discharge head in accordance with manufacturer.
   c. The head shaft shall be C carbon steel.
   d. The head shaft not exceed 10 feet in length. Impeller adjustment shall be provided at the top of the head shaft by means of a bronze adjusting nut of ASTM B 584 alloy C876/C903 which shall be positively locked in position.
   e. The pump manufacturer shall include the method of adjusting the pump impellers at the top of the head shaft.
   f. CONTRACTOR shall be responsible for ensuring that the discharge head is structurally and mechanically adequate for the provided and installed pump configuration.
   g. Head shall be painted inside and out with an NSF 60 approved epoxy paint conforming to AWWA C210 and D102. OWNER shall select the color.
3. Column Assembly
   a. The line shaft for the well shall be of C-1045. They shall be furnished in interchangeable sections not over 20 feet in length.

b. The butting faces shall be machined square to the axis of the shaft, with maximum permissible axial misalignment of the thread axis with the shaft axis 0.002" in 6". The size of the shaft shall be no less than that determined by ANSI/AWWA E103 Specifications, Section 4.4.2.2 – Line Shaft, for C1045 line shaft, and shall be such that elongation due to hydraulic thrust will not exceed the axial clearance of the impellers in the pump bowls. Maximum runout in 20-feet shall not exceed 0.010-inches.
c. *Shaft Enclosing Tubes:* shall be ASTM A53, Grade A Sch 80 steel pipe with ends machined square and parallel and shall butt to ensure proper alignment sealing; they shall be straight within 0.005 inches total indicator reading for a 5 ft section; and threaded internally to receive the line shaft bearings. The enclosing tube shall be stabilized and centered in the column pipe by rubber centering spiders spaced at 40 ft intervals throughout the column pipe assemblies.
d. *Line shaft Bearings:* shall be bronze, internally grooved to allow proper lubrication to enclosed lineshaft and threaded externally for connecting oil tube sections.
e. The outer column piping shall be of ASTM A53 Grade B Standard Wall steel pipe in interchangeable sections not over 20 feet in length with the ends of each section faced parallel and machined with 8 straight threads per inch permitting the ends to butt and ensuring alignment when connected by standard mill steel couplings. The weight of the column pipe shall be no less than that stated in ANSI E 103, Section E.3 Table E.1, "Diameters and Weights of Standard Discharge Column Pipe Sizes". Top and bottom sections of column pipe shall not exceed 5-feet in length.
f. CONTRACTOR shall be responsible for ensuring that the column piping is structurally and mechanically adequate for the provided and installed pump configuration.

4. Pump Bowl Assembly
   a. Pump bowl castings shall be of close-grained cast iron ASTM A48 Class 30 or ASTM A536 ductile iron Class 60-40-18 where required to meet the hydrostatic pressure criteria listed below. The water passages shall be free of blowholes, sand holes, and other detrimental defects, shall be lined with porcelain enamel, and shall be accurately machined and fitted. The finished bowls shall be capable of withstanding a hydrostatic pressure equal to twice the head at rated capacity or equal to or greater than the shut-off head, whichever is greater.
   b. The impellers shall be ASTM B584 alloy C87600 lead free bronze, enclosed type, and shall be statically balanced, and shall be fastened securely to the impeller shaft with 316 stainless steel collets. Impellers shall be adjustable vertically by an external means. Impeller skirt and series case throat area shall be thick enough to allow for machining and wearing at the time of repair. The bowl wear rings and impeller wear rings shall be hardened stainless steel.
   c. The pump shaft shall be of A582 Grade 416 Stainless Steel turned, ground and polished. Bearings shall be Morse or Durmax Marine Bearings consisting of sleeve bearings and a fluted rubber bearing surface (or approved equal) above and below each impeller. The pump shaft shall have chromed journals at the bearing points. The size of the shaft shall be no less than that determined by ANSI/AWWA Specifications E103.
   d. The discharge case shall be threaded on the outside for column sizes up to 14 inches and fitted with a cast iron ASTM A48 Class 30 column adaptor of the proper size to connect to the column selected. Likewise, the suction case shall also be threaded on the I.D. and fitted with a cast iron or steel suction adaptor.

5. Suction Pipe and Strainer
   a. A suction pipe shall not be required.
   b. A stainless steel cone strainer shall be provided having a net inlet area equal to at least four times the suction pipe area. The maximum opening size shall not be more than 75% of the minimum opening of the water passage through the bowl or impeller.

2.2 MOTOR

A. Pump motor shall be a vertical hollow shaft, premium efficiency, inverter duty, WP1 enclosure, electric motor, and shall be sized as noted in Table 1. Motor shall have a non-reverse ratchet, P-base, squirrel cage induction design. Motor shall have Class B or Class F insulation with temperature rise as specified by NEMA standards for class of insulation used and shall have a 1.15 service factor. The pump motor will be operating in an ambient temperature range of 50E - 110E Fahrenheit.

B. Pump motors shall be provided with a vibration switch. Switch rating 120 VAC, 2 amps minimum.

C. Pump motors shall have over temperature protection, which shall consist of a minimum of six RTD's embedded in the motor windings and two RTD's at the two bearings. Wiring to an external junction box shall be provided. RTD's shall be 100– ohm platinum three wire elements.

D. Thrust bearing shall be chosen to handle the continuous down-thrust as specified by the pump manufacturer with an AFMBA L-10 bearing life of 12,320 hours and an L-50 of 61,600 hours. Provisions shall be made for momentary up-thrust equal to 30% of rated down-thrust.

E. The motor shall be suitable for across-the-line starting, soft start, be inverter duty, and shall be capable of reduced-voltage starting. It shall also have shaft grounding rings.

F. The motor rating shall be such that at design it will not be loaded beyond nameplate rating and at no place on the pump curve shall the loading exceed the service factor.

G. The motor temperature shall be rated no higher than the allowable operating temperature of the motor thrust and radial bearings and in no case shall it exceed the temperature rating of the insulation class used to wind the motor.

H. The junction box shall be oversized to accommodate wiring connection, and shall be a minimum of 24"H x 18"W x 14"D with 2 - 4" conduit penetrations on the bottom.

I. Motors connected to VFD's shall have factory installed shaft grounding rings. Supplier shall provide a warranty against VFD-induced bearing damage or failure for the life of the motor. Motor shall also include insulated bearings to prevent circulation and other bearing currents.

2.3 APPURTENANCES

A. Well Monitoring and Sounding Tubes

1. The CONTRACTOR shall furnish and install two 1 1/4-inch diameter well monitoring tubes in each well consisting of flush thread Schedule 80 PVC pipe. The PVC tube shall be joined and banded to the pump column with stainless steel bands at maximum of 10 feet. A minimum of two 1/4-inch diameter vent holes for every 10 feet of length shall be provided throughout the entire length of the monitoring tube. The depth of the monitoring tube shall be as indicated on the drawings. The bottom end shall be capped with a ¼-inch hole drilled in the end.

B. Well Vent

1. The well vent shall consist of galvanized steel 1 inch diameter pipe through the soul plate extended above the bottom plate of the pump discharge head with a 180 degree bend made of two steel ells. The outlet end of the vent pipe shall be covered with No. 14 stainless steel wire mesh securely fastened by a stainless steel band. The lower end of the vent pipe shall be threaded into the well surface plate and provide a water tight seal. See Drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install new pump and motor at the location shown on the drawings and according with manufacturer's recommendations.

B. All pumps, complete with drive system, in place at the jobsite, shall not exceed acceptable field vibration limits given in the latest revisions of the Hydraulic Institute Standards. All pumps shall be free of static unbalance; shall be free of dynamic unbalance up to the maximum speed of the pump and drive system; shall be free of torsional vibration from 10 percent below the minimum speed to 10 percent above the maximum speed of the pump and drive system; and shall be free of apparent unbalance caused by defective bearings, by close fittings parts which may rub on the rotating parts intermittently, or by loose discs or rotor parts, or unbalanced loads.

C. The motor/discharge head assembly shall be shimmed with respect to the well casing flange to bring the motor/discharge assembly into optimum alignment with any variations that the pump column and line shaft may exhibit from being truly plumb. Such shims must be structurally sound and securely attached. The water tight seal between the discharge head and the well casing flange must be maintained.

3.2 FIELD TESTS

A. After installation, the pump shall be given an operating test to demonstrate freedom from mechanical defects, excessive noise, and vibration. The test shall include operating the pump continuously while throttling the discharge as needed. The operating test shall be performed for a minimum of one hour, or as directed by ENGINEER. Pumps with variable speed drives shall be tested at maximum speed, and at the average and minimum speeds listed under the specification for the pumps. A copy of actual test data shall be furnished to ENGINEER.

B. Tests for acceptable vibration shall be made, at no additional cost to OWNER, in the field on each pump system, which in the opinion of ENGINEER, seem to have excessive

vibration. All field tests shall be running tests with the pump pumping the product for which it is intended and each pump system shall be tested separately with no other pumps running. All testing shall be done in the presence of ENGINEER. Amplitude as used in this Specification, shall mean total peak-to-peak displacement. The required test for acceptable vibration will be the measurement of this peak-to-peak displacement and will be performed with an IRD Vibration Meter, Model 306; Bently-Nevada TK-8; or equal.

3.3 DISINFECTING

A. Source of Water

1. The Contractor shall assume all responsibility to obtain the necessary water supplies for disinfection of the pumping system.

B. Testing Procedure

1. Leakage and pressure testing must be completed, and all leaks repaired prior to disinfection procedures.
2. Pump and related piping installed under this Contract shall be disinfected using an approved disinfection method in accordance with the "American Water Works Association Standard for Disinfecting Water Mains" (AWWA C651) and “American Water Works Association Standard for Disinfecting Wells” (AWWA C654).
3. Heavily chlorinated water shall not be discharged onto the ground. Upon completion of disinfection, Sodium Bisulfate ($NaHSO_3$) shall be applied to the heavily chlorinated water to neutralize thoroughly the chlorine residual remaining. Water shall be neutralized to less than 1 ppm.
4. After completion of the disinfection, CONTRACTOR shall flush the new system until the chlorine residual is a maximum of 0.3 ppm after which bacteriological test will be performed by OWNER.
5. At the end of 24 hours after the first sample is taken, a second bacteriological test will be performed by OWNER to insure adequate disinfection. If the initial or second disinfection fails to provide satisfactory bacteriological results, or shows the presence of coliform, then the well line shall be re-chlorinated, flushed, and retested until satisfactory results are obtained at the expense to the Contractor.

- END OF SECTION -

SECTION 33 13 00
PIPELINE TESTING AND DISINFECTION

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers testing and disinfection in order to remove bacteriological contamination of the pipeline. Disinfection is only required if the pipeline is used for potable water.

B. CONTRACTOR shall be responsible for obtaining permits for discharging excess testing water and dechlorination of such water, if required.

1.2 RELATED SECTIONS

A. Related Work specified in other Sections includes but is not limited to the following:

1. Section 01 33 00 Submittal procedures
2. Section 33 05 05 Ductile Iron Fittings
3. Section 33 05 07 Polyvinyl Chloride (PVC) Pipe (AWWA C900 and C905)
4. Section 33 92 10 Steel Pipe, Specials, and Fittings (AWWA C200, Modified)

1.3 REFERENCES

A. The latest edition of the following publications form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

1. AWWA C-651 - Disinfecting Water Mains
2. Utah Public Drinking Water Regulations

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Furnish a written testing plan and schedule, including water source and methods for conveyance to the project, sequence, control, and disposal. Include the name of the certified bacteriological testing laboratory.

C. Disinfection Report:

1. Type and form of disinfectant used.
2. Date and time of disinfectant injection start and time of completion.
3. Test locations.
4. Name of person collecting samples.
5. Initial and 24 hour disinfectant residuals in treated water in parts per million (ppm) for each outlet tested.
6. Date and time of flushing start and completion.
7. Disinfectant residual after flushing in ppm for each outlet tested.

PART 2 MATERIALS

2.1 DESCRIPTION

A. All test equipment, temporary valves, bulkheads, and other water control equipment, shall be as determined by CONTRACTOR. No materials shall be used which damage the project pipelines for future conveyance of potable water.

B. Disinfecting materials shall consist of liquid chlorine, sodium hypochlorite solution, or calcium hypochlorite granules or tablets.

C. Dechlorination agents may be sodium bisulfate, sodium sulfite, or sodium thiosulfate.

PART 3 EXECUTION

3.1 GENERAL

A. Source of Water

1. CONTRACTOR shall assume all responsibility to obtain the necessary water for testing and disinfection of the water line system. All testing water used in the pipeline shall be potable water from a State approved drinking water system.
2. All pressure pipelines shall be tested.
3. Disposal of flushing water and water containing chlorine shall be by methods acceptable to the State of Utah, Division of Water Quality.

3.2 HYDROSTATIC TESTING OF PIPELINES PROCEDURE

A. Prior to hydrostatic testing, pipelines 24-inches diameter and larger shall be swept free of debris and visually inspected that all debris has been removed prior to filling.

B. Prior to hydrostatic testing, pipelines shall be flushed or blown out as appropriate. CONTRACTOR may test pipelines in sections. Sections to be tested shall be defined by isolation valves in the pipeline. Where such valves are not present, CONTRACTOR shall install temporary bulkheads or plugs for the purpose of testing. Sections that do not have isolation valves shall be tested in approximate one-mile segments. Sections that have a zero leakage allowance may be tested as a unit. No section of the pipeline shall be tested until field-placed concrete or mortar has attained an age of 14 Days. The test shall be made by closing valves when available or by placing bulkheads and filling the line slowly with water (maximum filling velocity shall not exceed 0.25 foot per second, calculation based on the full area of the pipe). CONTRACTOR shall be responsible for ascertaining that test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to or movement of the adjacent pipe. Unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test to avoid movement and damage to piping and equipment. Remove or protect any pipeline-mounted devices that may be damaged by the test pressure. CONTRACTOR shall provide sufficient temporary tappings in the pipelines to allow for trapped air to exit or for water to be drained. After completion of the tests, such taps shall be permanently plugged. Care shall be taken that air relief valves are open during filling.

C. The pipeline shall be filled at a rate which will not cause any surges or exceed the rate at which the air can be released through the release valves at a reasonable velocity. The air within the pipeline shall be allowed to escape completely. The differential pressure across the orifices in the air release valves shall not be allowed to exceed 5 psi at any time during filling. After the pipeline or section thereof has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb water and to allow the escape of air from air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to ENGINEER shall be taken. Additional water shall be added to the pipeline to replace any water absorbed by the cement mortar lining.

D. The hydrostatic test shall consist of holding 125% of the design operating pressure on the pipeline segment for a period of 2 hours. Visible leaks that appear during testing shall be repaired. Add water to restore the test pressure if the pressure decreases 5 psi below test pressure during the test period.

E. Pipe with welded joints shall have no leakage. In the case of pipelines that fail to pass the leakage test, CONTRACTOR shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipeline, repeating as necessary until the pipeline passes.

F. Exposed piping and valves shall show no visible leaks and no pressure loss during the test.

G. Blowoff isolation gate valves and plug valves (throttling valves) shall be operated and tested during a simulated blow down operation to demonstrate functionality of the valves to the satisfaction of ENGINEER. Isolation valves (gate valves) shall not be used for throttling.

3.3 DISINFECTING OF PIPELINES PROCEDURE

A. Leakage and pressure testing must be completed prior to disinfection procedures.

B. All water and solution piping installed under this Contract shall be disinfected using an approved disinfection method in accordance with the "American Water Works Association Standard for Disinfecting Water Mains" (AWWA C651).

C. CONTRACTOR may use one of the three chlorination methods – tablet, continuous feed, and slug, as outlined in AWWA C651 that is acceptable to OWNER. Care must be taken to prevent the strong chlorine solution in the line being disinfected from flowing back into the line supplying the water.

D. CONTRACTOR shall provide sampling ports along the pipeline as defined in AWWA C651. Taps may be at manways and air valves to help facilitate the spacing requirement.

E. Heavily chlorinated water shall not be discharged onto the ground. Upon completion of disinfection, Sodium Bisulfate (NaHSO4), or other approved dechlorination agent, shall be applied to the heavily chlorinated water to neutralize thoroughly the chlorine residual remaining. Water shall be neutralized to less than 1 ppm total chlorine residual.

F. After approval of disinfection, CONTRACTOR shall flush the new system until the chlorine residual is a maximum of 0.3 ppm.

G. After final flushing and before the new water main is connected to the distribution system, two consecutive sets of acceptable samples, taken at least 24 hours apart, shall be collected from the pipeline being tested. Sampling and testing will be completed by CONTRACTOR. CONTRACTOR shall collect at least one set of samples from every 1,200 feet of pipeline, plus one set from the end of the line and at least one set from each branch. All samples shall be tested for bacteriological (chemical and physical) quality in accordance with "Standard Methods for Examination of Water and Wastewater" and shall show the absence of coliform organisms. If the initial disinfection fails to provide satisfactory bacteriological results, or shows the presence of coliform, then the line shall be re-chlorinated, flushed, and retested until satisfactory results are obtained at the expense of CONTRACTOR.

3.4 CONNECTIONS TO EXISTING SYSTEM

A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before installation. Thorough flushing shall be started as soon as the connection is completed and shall be continued until discolored water is eliminated.

B. Final Fill: After a successful pressure and disinfection tests, the pipeline(s) shall be filled with fresh potable water and shall remain filled.

- END OF SECTION –

SECTION 33 14 13
DRAINAGE SYSTEM

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers the work to furnish excavate, install, backfill and complete the subdrainage system (ring drain), consisting of the drainage pipe, washed rock, geosynthetics, pipe and pipe fittings as necessary to complete installation of drainage pipe at the locations and grades shown on the drawings and as specified herein.

B. This section also includes the supply and installation of the storm drain piping.

1.2 RELATED WORK

A. Related work specified in other sections:

1. Section 01 50 00 - Temporary Construction Utilities and Environmental Controls
2. Section 22 10 10 - Plumbing Piping and Specialties
3. Section 31 05 19 - Geosynthetics
4. Section 31 23 15 - Excavation, and Backfilling for Buried Pipelines
5. Section 31 23 23 - Excavation and Backfill for Structures
6. Section 33 16 16 - Underground Water Storage Reservoir

1.3 REFERENCES

A. The latest edition of the following publications form a part of this specifications to the extent referenced. The publications are referred to in the text to by basic designation only.

B. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO

1. AASHTO M 294 Corrugated Polyethylene Pipe, 12 to 36-in. Diameter.

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM C 150 Portland Cement
2. ASTM D 422 Particle-Size Analysis of Soils
3. ASTM D 1248 Standard Specifications for Polyethylene Plastics Extrusion Materials for Wire and Cable
4. ASTM D 2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
5. ASTM D 2683 Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
6. ASTM D 2837 Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
7. ASTM D 3261 Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

8. ASTM D 3350 Standard Specification for Polyethylene Plastic Pipe and Fittings Materials
9. ASTM F 714 Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
10. ASTM F 1055 Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing

D. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C 901 Polyethylene (PE) Pressure Pipe and Tubing, 1/2"-inch through 3-inch, for Water Service
2. AWWA C 906 Polyethylene (PE) Pressure Pipe and Fittings, 4-inch through 63-inch, for Water Distribution and Transmission
3. AWWA M 55 PE Pipe – Design and Installation.

1.4 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for this section. Full compensation for the drainage system shall be considered as included in the contract unit or lump sum bid prices for the various items of the contract to which the drainage system relates.

1.5 SUBMITTALS

A. The following shall be submitted:

1. Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed.
2. A plan for pipe joining and installation. The plan must be reviewed and approved by ENGINEER prior to pipe installation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Storage: Materials delivered to the site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Plastic materials adversely impacted by ultraviolet light shall be protected from exposure to the direct sunlight over extended periods.

B. Handling: Materials shall be handled in such a manner as to insure delivery to the trench in sound, undamaged condition. Pipe and other materials shall be carried to the trench, not dragged.

PART 2 PRODUCTS

2.1 BACKFILL FOR STORM DRAIN

A. Backfill for the reinforced concrete pipe shall be in accordance with Section 31 23 15 - Excavation and Backfill for Pipelines.

2.2 CURB INLET TYPE PRECAST STORM DRAIN BOXES & GRATES

A. Provide and install curb inlet type precast concrete storm drain boxes and grates in accordance with APWA (UT) Plans 315.1 and 308

2.3 PIPE FOR STORM DRAIN

A. Storm Drain Pipe shall either **RCP or "ADS HP Storm"** drain pipe as follows.

B. Reinforced Concrete Pipe (RCP)

1. RCP for gravity service shall be ASTM C76, Class III minimum. RCP for low head pressure service shall be ASTM C361, Class A-25 minimum. Cement shall be ASTM C150 Type II.
2. Joints shall use either concrete bell and spigot or a double spigot and sleeve. In the latter case, the sleeve shall be a reinforced thermoset plastic collar. Joints shall be rubber gasket conforming to ASTM C443

C. HP Storm Drain Pipe shall be of polypropylene meeting ASTM F2881, Section 5 & AASHTO M330, Section 6.1; made by ADS, with a smooth interior (Manning's n=0.012) and with exterior corrugations. Joints shall meet ASTM F2881 or AASHTO M330. Submit ADS installation recommendations. Install as recommended by manufacturer.

2.4 TRACER WIRE

A. All direct bury piping (including service lines) shall be installed with 12 gauge solid copper THHN tracer wire for pipeline location purposes by means of an electronic line tracer.

1. The wires must be installed along the entire length of the pipe on the top of the pipe and be held in place with ties or hitches spaced not more than 12-feet apart.
2. Sections of wire shall be spliced together using approved splice caps and waterproof seals or solder. Twisting the wires together is not acceptable.

2.5 DRAIN PIPE FOR BUILDINGS AND BACKWASHING

A. See Section 22 10 10, Plumbing and Piping Specialties.

PART 3 EXECUTION

3.1 EXCAVATION AND BACKFILL

A. Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by ENGINEER, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, and compacted as provided in these specifications. When removal of unstable material is due to the fault or neglect of Contractor in his performance of shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to Owner.

3.2 SAFETY

A. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable State safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29 CFR1926).

3.3 TRENCH PREPARATION

A. Each trench shall be excavated so that the pipe can be laid to the alignment and grade as required. The trench wall shall be so braced that the workmen may work safely and efficiently. All trenches shall be drained so the pipe laying may take place in dewatered conditions.

B. The trench bottom shall be given a final trim using a string line, laser, or another method approved by the ENGINEER for establishing grade, such that each pipe section when first laid will be continually in contact with the ground along the extreme bottom of the pipe.

3.4 REMOVAL OF WATER

A. CONTRACTOR shall provide and maintain at all times ample means and devices with which to remove promptly and to properly dispose of all water entering the trench excavation.

B. Water shall be disposed of in a suitable manner without damage to adjacent property or without being a menace to public health and convenience. No water shall be drained into work built or under construction without prior consent of the Engineer.

C. Dewatering shall be accomplished by well points, sumping, or any other acceptable method which will insure a dewatered trench. Any dewatering method shall be subject to the approval of the Engineer.

- END OF SECTION -

SECTION 33 92 10
STEEL PIPE, SPECIALS, AND FITTINGS (AWWA C 200, modified)

PART 1 GENERAL

1.1 DESCRIPTION

A. Provide steel pipe per this section, Section 40 05 13.13, and as follows.

1. Below Grade Pipe:
   a. Mortar line per this Section. End mortar lining at first flange above floor.
   b. Tape coat per Section 09 99 10, PIPELINE COATINGS AND LININGS
2. Exposed Pipe:
   a. Galvanize where called for.
   b. Epoxy line and coat in buildings and vaults per Section 09 90 00 unless noted otherwise. Lap epoxy coating into floor. Raise trowelled floor conc up ¼" around epoxy coated pipe so any water condensing on pipe flows away from pipe.
3. and tape coat below grade piping per this Section ProFabricate

B. CONTRACTOR shall provide fabrication and installation of steel pipe, specials, and fittings, complete and in place, in accordance with AWWA C200 and as modified herein.

C. A single pipe manufacturer shall be made responsible for furnishing steel pipe, specials, fittings, and appurtenances such as bolts and gaskets.

D. A special is defined as any piece of pipe other than a normal full length of straight pipe. This includes, but is not limited to, elbows, manhole sections, short pieces of straight pipe, reducers, tees, and bulk heads.

1.2 RELATED WORK

A. Related Work specified in other sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 01 50 30 Protection of Existing Facilities
3. Section 31 23 15 Excavation and Backfill for Pipelines
4. Section 33 12 00 Mechanical Appurtenances
5. Section 33 13 00 Pipeline Testing and Disinfection

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract:

B. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

1. ANSI B16.1 Cast-Iron Pipe Flanges and Flanged Fittings Class 25, 125, and 250
2. ANSI B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard
3. ANSI/AWS B2.1 Specification for Welding Procedure and Performance Qualification

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 20 Standard Specification for General Requirements for Steel Plates for Pressure Vessels
2. ASTM A 193 Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
3. ASTM A 194 Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
4. ASTM A 234 Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
5. ASTM A 283 Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
6. ASTM A 307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
7. ASTM A 370 Standard Test Methods and Definitions for Mechanical Testing of Steel Products
8. ASTM A 563 Standard Specification for Carbon and Alloy Steel Nuts
9. ASTM A 572 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
10. ASTM A 578 Standard Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications
11. ASTM A 1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
12. ASTM A 1018 Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
13. ASTM E 165 Standard Practice for Liquid Penetrant Examination for General Industry

D. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C 200 Steel Water Pipe 6-inch and Larger
2. AWWA C 205 Cement-Mortar Protective Lining and Coating for Steel Water Pipe – 4-inch and Larger-Shop Applied
3. AWWA C 206 Field Welding of Steel Water Pipe
4. AWWA C 207 Steel Pipe Flanges for Waterworks Service - Sizes 4-inch Through 144-inch
5. AWWA C 208 Dimensions for Fabricated Steel Water Pipe Fittings
6. AWWA C 209 Cold-Applied Tape Coatings for Steel Water Pipe, Special Sections, Connections, and Fittings
7. AWWA C 210 Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
8. AWWA C 214 Tape Coating Systems for the Exterior of Steel Water Pipelines
9. AWWA C 216 Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings
10. AWWA C 219 Bolted, Sleeve-Type Couplings for Plain-End Pipe
11. AWWA C 606 Standard for Grooved and Shouldered Joints

12. AWWA C 651 Standard for Disinfecting Water Mains
13. AWWA M 11 Manual of Water Supply Practices – Steel Pipe – A Guide for Design and Installation

1.4 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Prepare and submit certified dimensional drawings consistent with the pipeline alignment and grade on the Drawings, including all fittings and appurtenances, and with the size, location, elevation and slope information of existing utilities, pipelines, and encasements obtained by CONTRACTOR in accordance with Section 01 50 30 - Protection of Existing.
2. Joint and pipe/fitting wall construction details which indicate the type and thickness of cylinder; the position, type, size, and area of reinforcement; coating and lining holdbacks, manufacturing tolerances; and other pertinent information required for the manufacture of the product. Standard joint details shall be submitted where deep bell or butt strap joints are required for control of temperature stresses.
3. Details for elbows, wyes, tees, outlets, connections, test bulkheads, and nozzles or other specials that indicate amount and position of reinforcement. Fittings and specials shall be properly reinforced to withstand the internal pressure, both circumferential and longitudinal, and the external loading conditions as indicated in the drawings. Provide design calculations for all fittings and specials, including all reinforcement requirements.
4. Material lists and steel reinforcement schedules that describe materials to be utilized.
5. Line layout and marking diagrams which indicate the specific number of each pipe and fitting, the location of each pipe, and the direction of each fitting in the completed line compatible with requirements of AWWA Manual 11 (M-11). In addition, the line layouts shall include:
    a. The pipe station and invert elevation at every change in grade or horizontal alignment.
    b. The station and invert elevation to which the bell end of each pipe will be laid.
    c. Elements of curves and bends, both in horizontal and vertical alignment.
    d. Pipe joint type.
    e. The limits within each reach of each type of field-welded joint and of concrete encasement.
    f. Location of mitered pipe sections, beveled ends, butt straps and deep bell lap joints for temperature stress control.
    g. Location and details for each valve, meter, pump, fitting, and other equipment as shown on the drawings used to determine pipe dimensions. Include location of closures, cut-off sections for length adjustment, temporary access manways, vents, and weld lead outlets for construction convenience.
    h. Location of bulkheads, including those shown and as required, for hydrostatic testing of pipeline.
6. Welding Information
    a. The Shop Drawings shall define the weld type and distinguish between shop and field welds. Shop Drawings shall indicate by welding symbols or sketches the details of the welded joints and the preparation of parent metal required to make them. Joints or groups of joints in which welding sequence or technique are

especially important and shall be carefully controlled to minimize shrinkage stresses and distortion.

b. Written welding procedures for shop and field welds, including Welding Procedures Specifications (WPS's) and Procedure Qualification Records (PQR's) shall be submitted.
c. Written nondestructive testing procedure specifications and nondestructive testing personal qualifications for shop and field welds shall be submitted.
d. Current (within the last 6 months) Welder Performance Qualifications (WPQ's) shall be submitted for each welder used prior to their performing any Work either in the shop or field. Qualification testing shall be as specified in paragraph 1.3 – Quality Assurance.
e. Submit the credentials of CONTRACTOR's Certified Welding Inspectors (CWI's) and quality control specialist for review prior to starting any welding in the shop or field. The credentials shall include, but not be limited to, American Welding Society (AWS), QC-1 Certification. Other nondestructive testing (NDT) quality control personnel shall be certified as required by AWS D1.1.
f. Submit NDT data for each shop-welded and field-welded joint. This data shall include all testing on each weld joint, including re-examination of repaired welds, using radiographic testing (RT), magnetic particle testing (MT), dye penetrant testing (PT), ultrasonic testing (UT), or air test examination methods as specified. Test data shall be reviewed and signed by the CWI.
g. Submit a welder log for field and shop welding. Log shall list all welders to be used for the Work and the types of welds each welder is qualified to perform.
h. Submit a written weld repair procedure for each type of shop and field weld proposed for use on the project.
i. Submit a written rod control procedure for shop and field operations demonstrating how CONTRACTOR intends to maintain rods in good condition throughout the Work. The rod control procedure shall also demonstrate how the rods are used for each weld.

7. Drawings showing the location, design, and details of bulkheads for hydrostatic testing of the pipeline, and details for removal of test bulkheads and repair of the lining.
8. Details and locations of closures for length adjustment and for construction convenience. Submit proposed sequencing of events to control temperature stresses in the pipe wall during installation prior to starting any field welding. Submit the proposed sequencing of events or special techniques to minimize distortion of the steel as may result from shop welding procedures. Submit plan for monitoring pipeline temperatures.
9. Detail drawings indicating the type, number, and other pertinent details of the slings, strutting, and other methods proposed for pipe handling during manufacturing, transport, and installation.
10. Manufacturer's written Quality Assurance/Control Program.

C. Certifications: CONTRACTOR shall furnish a certified affidavit of compliance for pipe and other products or materials in AWWA C 200, AWWA C 205, AWWA C 206, AWWA C 207, AWWA C 208, AWWA C 209, AWWA C 214, AWWA C 216, AWWA C 219, and the following supplemental requirements:

1. Certified copies of mill test reports on each heat from which steel is rolled. Test shall include physical and chemical properties. Submit certified copies of mill test reports for flanges.
2. Hydrostatic test reports.
3. Results of production weld tests.
4. Sand, cement, and mortar tests.
5. Records of coating application, including technical data sheets, manufacturer name, product name and thickness.

D. Performing and paying for sampling and testing necessary for certification are CONTRACTOR's responsibility.

E. Manufacturer's Qualifications: Furnish a copy of manufacturer's certification to ISO 9000, SPFA, or LRQA, and documentation of manufacturer's experience in fabricating AWWA C200 pipe. Credentials shall include reference names, telephone numbers, and descriptions of projects for pipe conforming to AWWA C200 that is of similar diameter, length, and wall thickness to the pipe for this project.

F. Design Calculations of Fittings and Specials: Furnish a copy of design calculations for fittings and specials including miters, welds, and reinforcement, prior to manufacture of pipe, fittings, and specials.

1.5 QUALITY ASSURANCE

A. Pipe Manufacturer Qualifications: The pipe manufacturer shall be certified to ISO 9000, the Steel Plate Fabricator's Association (SPFA), or Lloyd's Register Quality Assurance (LRQA) and shall be experienced in fabrication of AWWA C200 pipe of similar diameters, lengths, and wall thickness to this project. The manufacturer shall have the capability of meeting the schedule requirements of this project. Experience shall be in the production facilities and personnel, not the name of the company that owns the production facility or employs the personnel. Verification of experience and production capability will be conducted as part of the initial submittal review process for steel pipe and the CONTRACTOR's progress schedule.

B. Inspection: Pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of AWWA C200, C205, C206, C208, and C214 as supplemented by the requirements herein. CONTRACTOR shall notify ENGINEER in writing of the manufacturing start date not less than 14 Days prior to the start of any phase of the pipe manufacture.

C. Tests: Except as modified herein, materials used in the manufacture of the pipe shall be tested in accordance with the requirements of AWWA C200, C205, C206, C208, and C214 as applicable.

1. After the joint configuration is completed and prior to lining with cement mortar, each length of pipe of each diameter and pressure class shall be shop-tested and certified to a pressure of at least 75 percent of the yield strength of the steel. The test pressure shall be held for 2 minutes and the pipe visually inspected to confirm that welds are sound and leak-free.
2. In addition to the tests required in AWWA C200, weld tests shall be conducted on each 5,000-feet of production welds and at any other times there is a change in the

grade of steel, welding procedure, or welding equipment. One set of tests per operator per work shift shall be performed.

3. Fittings fabricated from straight pipe previously passing a hydrostatic test need not have an additional hydrostatic test provided welds are tested by nondestructive means and demonstrated to be sound.
4. Material tests shall be performed at no additional cost to OWNER. ENGINEER and OWNER shall have the right to witness testing conducted by CONTRACTOR or pipe manufacturer/fabricator; provided that CONTRACTOR's schedule is not delayed for the convenience of ENGINEER or OWNER.

D. Welding Procedure Specifications: Welding procedures used to fabricate and install pipe shall be in accordance with the ASME Boiler and Pressure Vessel Code (BPVC) for shop welds and ANSI/AWS D1.1 for field welds. Written welding procedures shall be required for welds in the shop or the field. Welds qualified per the ASME BPVC shall include supplementary Essential Variables for notch-tough welding. Provisions of ANSI/AWS D1.1 qualified welds pertaining to notch-tough welding shall apply.

E. Welder Performance Qualifications: Welding shall be performed by skilled welders, welding operators, and tackers who have had experience in the methods and materials to be used. Welders shall be qualified per the provisions of ASME BPVC for shop welds and ANSI/AWS D1.1 for field welds.

F. Shop Testing of Steel Plate Specials:

1. If any special has been fabricated from straight pipe not previously tested and is of the type listed below, the special shall be hydrostatically tested with a pressure equal to 1-1/2 times the design working pressure: This applies to bends, wyes, crosses, tees with side outlet diameter greater than 30 percent of the main pipe diameter, and manifolds.
2. Specials not required to be hydrostatically tested shall be tested by liquid dye penetrant inspection method in accordance with ASTM E 165, Method A or the magnetic particle method in ASME Section VIII, Division 1, Appendix VI.
3. Reinforcing plates shall be tested by the solution method using approximately 40 psi air pressure introduced between the plates through a threaded test hole. Test hole shall be properly plugged following successful testing.
4. Any weld defects, cracks, leaks, distortion, or signs of distress during testing shall require corrective measures. Weld defects shall be gouged out and re-welded. After corrections, the special shall be retested.
5. Where welded test heads or bulkheads are used, extra length shall be provided to each opening of the special. After removal of each test head, the special shall be trimmed back to the design points with finished plate edges ground smooth, straight, and prepared for the field joint.
6. Testing shall be performed before joints have been coated or lined.
7. Ultrasonic examination shall be performed in accordance with the following:
   a. Steel plate that will be in welded joints or welded stiffener elements shall be examined ultrasonically for laminar discontinuities where both of the following conditions exist:

1) Any plate in the welded joint has a thickness exceeding 1/2-inch.
2) Any plate in the welded joint is subject to transverse tensile stress through its thickness during the welding or service.

b. Ultrasonic examination may be waived where joints are designated to minimize potential laminar tearing.
c. The ultrasonic examination shall be in accordance with ASTM A578 with a Level I acceptance standard.

8. Plates that are not in conformance with the acceptance criteria in ASTM A578 may be used in the WORK if the areas that contain the discontinuities are a distance at least 4 times the greatest dimension of the discontinuity away from the weld joint.

G. Shop Nondestructive Testing: Nondestructive testing shall be performed for various weld categories as indicated below. Testing shall include submitting written documentation of procedures per Section V of the ASME Boiler and Pressure Vessel Code, and acceptance criteria shall be in accordance with Section VIII of the ASME BPVC.

1. Field Butt Joint Welds: Spot radiographically examine pipe in accordance with Paragraph UW-52 of the ASME BPVC Section VIII Division 1. If in the opinion of the ENGINEER, the welds cannot readily be radiographed, they shall be 100 percent ultrasonically examined.
2. Fillet Welds: 100 percent examine every fillet weld using the magnetic particle inspection method.
3. Groove Welds: 100 percent ultrasonically examine groove welds that cannot be readily radiographically spot examined.
4. CONTRACTOR's certified welding inspector (CWI) shall 100 percent visually examine every weld as a minimum.
5. In addition to weld tests indicated, doubler pads shall be air tested as stated in AWWA C206.
6. CONTRACTOR shall be responsible for performing and paying for said tests and the ENGINEER has the right to witness testing conducted by CONTRACTOR.

H. Onsite Observation: SUPPLIER shall provide an experienced staff member if requested by CONTRACTOR to be onsite while the pipe and fittings are being installed. The staff member's duties shall include, but not be limited to the following:

1. Observe the installation and welding of the pipe and fittings.
2. Report any concerns to OWNER'S on-site observer.
3. Answer questions and provide assistance to OWNER and CONTRACTOR.

I. Certified Welding Inspector: Furnish the services of a certified welding inspector(s) (CWI) for the shop welding (no field welding allowed) as specified in AWWA C200 and C206. After receiving CWI qualification, the CWI shall have at least 3 years of professional work experience similar to the work being performed for the project. The CWI's shall be directed by a CWI supervisor with at least 5 years of professional work experience similar to the work being performed for the project. The certified welding inspector(s) shall submit written certification that all welds were performed in conformance with these documents. Shop weld tests shall be reviewed and signed by the certified welding inspector(s).

J. Field Testing: Field testing shall conform to the requirements of Section 33 13 00 - Pipeline Testing and Disinfection.

K. Welding Requirements: Welding procedures used to fabricate and install pipe shall be prequalified under the provisions of ANSI/AWS D1.1 - Structural Welding Code-Steel or the ASME Boiler and Pressure Vessel Code, Section 9. Welding procedures shall be required for longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections.

L. Welder Qualifications: Welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 or the ASME Boiler and Pressure Vessel Code, Section 9 by an independent local, approved testing agency not more than 6 months prior to commencing work on the pipeline. Machines and electrodes similar to those used in the project shall be used in qualification tests.

1.6 WARRANTY

A. A one-year warranty for the pipe shall be included from CONTRACTOR and shall cover the cost of replacement pipe and freight to the project site, should the pipe have any defects in material or workmanship.

B. In addition to the standard pipe warranty, the welding contractor shall provide in writing a warranty for a period of one year for all welded joints, including formation, installation, and pressure testing.

C. Unless otherwise noted, the warranty periods shall begin when Substantial Completion is issued for the contract.

PART 2 PRODUCTS

2.1 GENERAL

A. Manufacturers of steel pipe and steel fittings or specials shall be under the direction and management of one steel pipe manufacturer only. This does not prevent a separate fabricator from fabricating specials or fittings; however, WORK shall be directed by the Main Pipe Manufacturer. The responsibility of the Main Pipe Manufacturer shall include at a minimum:

1. Verify pipe, fittings, and specials are being manufactured in full accordance with the drawings and specifications and applicable codes and standards.
2. Manage the design, fabrication, testing and delivery of the pipe, fittings, and specials. Provide field support if requested to CONTRACTOR during installation and testing.
3. Prepare and submit submittal information and Shop Drawings.
4. Make any corrections that may be required to the submittal information and Shop Drawings.
5. Certify that the pipe and specials have been manufactured in accordance with the Drawings and Specifications.

B. Lined and coated steel pipe and specials shall conform to AWWA C 200, C 205, C 209, C210, C 214, and C 216 subject to the following supplemental requirements. The pipe, specials, and fittings shall be of the diameter and class indicated and shall be provided

complete with welded joints as indicated on the Drawings. For pipe, specials, and fittings 14-inches diameter and larger, the nominal inside diameter after lining shall not be less than the diameter indicated on the Drawings, allowing for tolerances according to AWWA C 200 and C 205. Pipe, specials, and fittings smaller than 14-inches diameter may be furnished in standard outside diameters. When indicated as a minimum, wall thickness tolerance shall be as allowed by AWWA C200 or the ASTM nominal sheet or plate tolerance, whichever is less.

C. Markings: The manufacturer shall legibly mark pipe, specials, and fittings in accordance with the laying schedule and marking diagram. Each pipe, special, and fitting shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. Each pipe, special, and fitting number shall be located on the inside and outside area of pipe, special, and fitting. Interior marking shall be in full conformance with NSF 61. Each pipe, fitting and special shall be marked at each end with top field centerline. The word “Top” shall be painted or marked on the outside top spigot of each pipe section or fitting. Mark “Top Match Point” for compound bends per AWWA C 208.

D. Handling and Storage: The pipe, specials, and fittings shall be handled by use of wide slings, padded cradles, or other devices designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment that might injure the pipe coating/exterior will not be permitted. Stockpiled pipe, specials, and fittings shall be supported on padded skids, sand or earth berms free of rock exceeding 2-inches diameter, sand bags, or suitable means so that the pipe including coating and lining coating will not be damaged. Pipe, specials, and fittings shall not be rolled and shall be secured to prevent accidental rolling. The ends of pipes shall be securely bulkheaded or otherwise sealed during transportation and shall remain sealed until installation.

E. CONTRACTOR shall replace or repair any pipe, specials, and fittings damaged at no additional cost to OWNER.

F. Laying Lengths: Maximum pipe laying lengths shall be 48-feet with shorter lengths provided as required to accommodate CONTRACTOR’s operation.

G. Lining: The pipe, specials, and fittings shall have smooth, dense interior surfaces and shall be free from fractures, excessive interior surface crazing, and roughness.

H. Closures and Correction Pieces: Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing indicated. The locations of the correction pieces and closure assemblies shall be shown on the pipe layout diagrams.

I. Backfill with CLSM: Where required, backfill with Controlled Low Strength Material (CLSM) shall be the full depth of the pipe zone from 6 inches below to 6 inches above the pipe as a minimum.

2.2 MATERIALS

A. Mortar: Materials for mortar shall conform to the requirements of AWWA C 205; provided, that cement for mortar coating shall be Type II modified or Type V and mortar

lining shall be Type II modified or Type V. Cement in mortar lining and coating shall not originate from kilns that burn metal-rich hazardous waste fuel, nor shall a fly ash or pozzolan be used as a cement replacement. Admixtures shall contain no calcium chloride.

B. Steel for Cylinder and Fittings: Pipe, specials, and fittings manufactured under AWWA C200 shall satisfy the following requirements:

1. Minimum yield strength of steel is 42,000 psi.
2. Be manufactured by a continuous casting process.
3. Be fully killed.
4. Be fine grain practice.
5. Maximum carbon content of 0.25 percent.
6. Maximum sulfur content of 0.015 percent.
7. Minimum elongation of 22 percent in a 2-inch gauge length.
8. Be in accordance with one of the following, ASTM A1011, ASTM A283, ASTM A572, or ASTM A1018.
9. Maximum carbon equivalent of 0.45, calculated as follows:

$$CE = C + \frac{(Mn+Si)}{6} + \frac{(Cr+Mo+V)}{5} + \frac{(Ni+Cu)}{15}$$

C. Pipe shall be manufactured as fabricated pipe per AWWA C 200 as modified herein. ASTM pipe manufacturing standards referenced in AWWA C 200 shall not be used. Pipe sections shall be fabricated by either of the following methods:

1. Pipe sections may be fabricated by spirally welded short cylindrical coils of steel, joined circumferentially by complete penetration butt joint welds.
2. Pipe sections may be rolled or pressed from no more than three (3) sheets the full length of the pipe and welded with no more than three (3) longitudinal seams.

D. Steel equal to or greater than 1/2-inch thick used in fabricating pipe shall be tested for notch toughness using the Charpy V-Notch test in accordance with ASTM A370. Test each heat of steel by taking one specimen from any two coils per heat number. The steel shall withstand a minimum impact of 25 ft-lb at a temperature of 30 deg F.

1. Plate: Charpy tests shall be conducted on each plate as required in ASTM A 20.
2. Coils: Charpy tests shall be conducted on the first 500 tons of steel by testing each coil as follows:
   a. Tests shall include representative sampling of steel thicknesses required for the Work.
   b. Each coil shall be tested by taking coupons from the outer, middle, and inner wrap of the coil. Middle coil coupons may be taken from the ends of full-length pipes that are closest to the middle of the coil.
   c. Coils that do not meet the above Charpy acceptance criteria shall not be used in the production of the pipe.

E. External Pipeline Coating (for buried pipe): In accordance with Section 09 98 10 – Pipeline Coatings and Linings.

2.3 DESIGN OF PIPE

A. General: The pipe shall be suitable to transmit potable water under the conditions indicated on the Contract Drawings. The steel pipe shall have field welded joints as indicated. The pipe shall be cement mortar lined per Section 09 98 10 (or epoxy lined as noted in opening paragraph of this Section) as. Field lining will only be allowed where specifically approved in advance by ENGINEER.

B. The pipe shall be designed, manufactured, tested, inspected, and marked according to applicable requirements previously stated and, except as hereinafter modified, shall conform to AWWA C200.

C. Pipe Dimensions: Pipe shall be of the diameter and minimum wall thickness indicated on the Drawings.

D. Fitting Dimensions: Fittings shall be of the diameter and class to match adjacent piping.

E. Field Welded Joint Design: Field welded joints are not allowed on this project.

F. Spiral weld seams shall be tested by the visible penetrant method of ASTM E 165 or magnetic particle inspection method of ASME Section VIII, Division 1, Appendix VI, for a minimum distance of 12-inches from each end of each joint after the spigot and bell are formed. Defects shall be repaired at no additional cost to OWNER.

G. Shop-applied interior linings and exterior coatings shall be held back from the ends of the pipe as indicated. Holdback areas shall be coated as indicated in Section 09 98 10 – Pipeline Coatings and Linings.

H. Joint Shop Coating: Holdback areas for welded joints and butt straps shall be thoroughly cleaned and given a shop coat of rust-inhibitive primer. The surface preparation and primer shall be compatible with the intended finish coating as specified in Section 09 98 10 - Pipeline Coatings and Linings and Section 09 90 00 Painting and Finishes.

I. Shop Fit Test: Make certain that joints are correctly field assembled and that excessive annular space between spigots and bells and that the pipe meets the requirements of AWWA C 200. The pipe fabricator shall perform dimensional measurements for all pipe joints to verify joints are within manufacturing tolerances prior to shipment. The pipe ends shall be match marked after shop assembly.

    1. The shop fit test shall join the pipe ends in the shop with proposed adjacent pipe end.
    2. Record the actual annular space with the data to include as a minimum:
        a. Maximum/minimum space at any point.
        b. Space at 90-degree intervals top, bottom, and at springline.

J. Restrained Joints

    1. Located where indicated and where required to meet seismic requirements, restrained joints shall be field-welded joints, either single, or double lap-weld, or butt-weld, flanges, or butt-straps as indicated on the Contract Drawings. Designs shall include stresses created by the greater of:

a. Temperature differential of 50 degrees F plus Poisson's effect in combination with hoop stress, or;
b. Thrust due to bulkheads, bends, reducers, and line valves resulting from working pressure in combination with hoop stress.

K. Flanges

1. Flanges shall be in accordance with AWWA C 207 Class D for operating pressures up to 175 psi on 4-inch through 12-inch diameter, and operating pressures to 150 psi on diameters over 12-inches.
2. Flanges shall be AWWA C 207 Class E for operating pressures over 150 psi to 275 psi or shall be Class F for pressures to 300 psi (drilling matches ANSI B 16.5 Class 250).
3. Shop lining and coating shall be continuous to the end of the pipe or back of the flange. Flanges shall be shop coated with a soluble rust preventive compound which is NSF 61 certified if used on potable water pipelines.
4. Gaskets shall be full-face, 1/8-inch thick, cloth-inserted rubber, **Garlock 3505, Durlon 7910**, or approved equal.

L. Bolts and Nuts for Flanges

1. Bolts for flanges shall be carbon steel, ASTM A 307, Grade B for Class B and D flanges and nuts shall be ASTM A 563, Grade A heavy hex. Bolts for Class E and F flanges shall be ASTM A 193, Grade B7 and nuts shall be ASTM A 194, Grade 2H heavy hex.

2.4 SPECIALS AND FITTINGS

A. Design: Except as otherwise indicated, materials, fabrication and shop testing of Specials and fittings shall conform to the requirements stated above for pipe and shall conform to the dimensions of AWWA C 208. (Specials consisting of access manways, outlets for air valves, blow-off valves, etc. are excluded from the criteria as follows and collar plates, wrapper plates or crotch plates shall be required for reinforcing the outlet connections in accordance with AWWA M-11 and AWWA C208 requirements.) The minimum thickness of plate for pipe from which specials are to be fabricated shall be the greatest of those determined by the following 3 criteria:

1. Working and Transient Pressure Design

$$T = \frac{PwD/2}{Y/Sw} \qquad T = \frac{PtD/2}{Y/St}$$

Where:

T	=	Steel cylinder thickness in inches
D	=	Outside diameter of steel cylinder in inches
Pw	=	Design working pressure in psi
Pt	=	Design transient pressure in psi
Y	=	Specified minimum yield point of steel in psi
Sw	=	Safety factor of 2.5 at design working pressure
St	=	Safety factor at design transient pressure; for elbows 1.875 and 2.0 for other specials

2. Mainline Pipe Thickness: Plate thickness for specials shall not be less than for the adjacent mainline pipe.
3. Thickness Based on Pipe Diameter

Nominal Pipe Diameter, in	Pipe Manifolds Piping Above Ground Piping Structures
24 and under	3/16-in
25 to 48	1/4-in
over 48	5/16-in

   a. Minimum plate thickness shall be the greater of the adjacent mainline pipe, the thickness on the Drawings, the thickness calculated as indicated herein or as shown on the table above indicating the minimum thickness based on pipe diameter.
   b. Refer to ASME B36.10M for dimensions of wall thickness for standard weight pipe and nominal pipe size.

B. Specials installed on saddle supports shall be designed to limit the longitudinal bending stress to a maximum of 10,000 psi. Design shall be in accordance with the provisions of Chapter 7 of AWWA Manual M 11.

C. Reinforcement for wyes, tees, outlets, and nozzles shall be designed in accordance with AWWA Manual M 11. Reinforcement shall be designed for the design pressure indicated and shall be in accordance with the Drawings. Specials and fittings shall be equal in pressure design strength and shall have the same lining and coating as the adjoining pipe. Unless otherwise indicated, the minimum radius of elbows shall be 2.5 times the pipe diameter and the maximum miter angle on each section of the elbow shall not exceed 11-1/4 degrees.

D. Outlets, Tees, Wyes, and Crosses

1. Outlets 12-inches and smaller may be fabricated from Schedule 30 or heavier steel pipe in the standard outside diameters. Minimum plate thickness for reinforcements shall be 10-gauge.
2. The design of outlet reinforcement shall be in accordance with the procedures given in Chapter 13 of AWWA Manual M 11 and the design pressures and factors of safety above.
3. In lieu of saddle or wrapper reinforcement as provided by the design procedure in Manual M 11, pipe or specials with outlets may be fabricated entirely of steel plate having a thickness equal to the sum of the pipe wall plus the required reinforcement.
4. Where Manual M 11 requires the design procedure for crotch plate reinforcement, such reinforcement shall be provided.
5. Outlets shall be fabricated so that there is always at least a 12-inch distance between the outer edge of the reinforcing plate and any field welded joints. For outlets without reinforcing plates, outlets shall penetrate the steel cylinders so that there is at least a 12-inch clearance between the outlet and any field-welded joints.

6. Tees, wyes, crosses, elbows, and manifolds shall be fabricated so that the outlet clearances and reinforcing plates from any weld joints are a minimum of 5 times cylinder thickness or 2-inches, whichever is greater. Longitudinal weld joints in adjacent cylinder sections shall be oriented so that there is a minimum offset of 5 times cylinder thickness or 2-inches, whichever is greater.

E. Steel Welding Fittings: Steel welding fittings shall conform to ASTM A 234.

F. Ends for Grooved Mechanical-Type Couplings: Except as otherwise indicated, where mechanical-type couplings are indicated, the ends of pipe shall be banded with Type C collared ends using double fillet welds. The collared ends shall be grooved for the fitting. Where pipe 12-inches and smaller is furnished in standard schedule thickness and where the wall thickness after grooving equals or exceeds the coupling manufacturer's minimum wall thickness, the pipe ends may be grooved.

2.5 CEMENT-MORTAR LINING

A. Cement-Mortar Lining for Shop Application: Unless indicated otherwise, interior surfaces of pipe, specials, and fittings shall be cleaned and lined in the shop with cement mortar lining applied centrifugally in conformity with AWWA C 205. Lining for all mitered fittings produced by cutting, rolling and re-welding such as elbows from 5 to 90 degrees up to 72-inches in diameter shall be centrifugally applied in the shop. Fabricated tees, manifolds or elbows greater than 72-inches or tees with crotch plates where heat treating or normalization is required may be lined in accordance with AWWA C205. During the lining operation and thereafter, the pipe, specials, and fittings shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found defective at the Site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications at no additional cost to OWNER.

B. The minimum lining thickness and tolerance shall be in accordance with Section 09 98 10 – Pipeline Coatings and Linings and AWWA C 205.

C. Defective linings shall be removed from the pipe wall and shall be replaced to the full thickness required. Defective linings shall be cut back to a square shoulder in order to avoid feather edged joints. Temperature and shrinkage cracks in the mortar less than 1/16-inch wide need not be repaired. Pipe specials or fittings with cracks wider than 1/16-inch shall be removed and patched.

D. The progress of the application of mortar lining shall be regulated in order that handwork, including the repair of defective areas, is cured in accordance with the provisions of AWWA C205. Cement mortar for patching shall be the same materials as the mortar for machine lining, except that a finer grading of sand and mortar richer in cement shall be used when field inspection indicates that such mix will improve the finished lining of the pipe.

E. Specials and fittings that cannot be mechanically lined and coated shall be lined and coated by hand-application using the same materials as used for the pipe and in accordance with the applicable AWWA or ASTM standards and this Section. Coating and lining applied in this manner shall provide protection equal to that for the pipe. Fittings may be fabricated from pipe that has been mechanically lined and/or coated.

Areas of lining and coating that have been damaged by such fabrication shall be repaired by hand-application.

F. Protection of Pipe Lining/Interior: All pipe, specials, and fittings with plant-applied cement-mortar linings, shall be supplied with a 12-mil polyethylene sheet or other suitable bulkhead on the ends of the pipe and on each opening to prevent drying out of the lining. Bulkheads shall be substantial enough to remain intact during shipping and storage until the pipe is installed.

2.6 EXTERIOR COATING OF PIPE

A. Exterior Coating of Exposed Piping: The exterior surfaces of pipe, specials, and fittings that will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of primer compatible with the finish coating required by Section 09 98 10 - Pipeline Coatings and Linings.

B. Exterior Coating of Buried Piping: Pipe for buried service, including bumped heads, shall be coated per Section 09 98 10 – Pipeline Coatings and Linings.

2.7 PIPE APPURTENANCES

A. Pipe appurtenances shall be in accordance with the requirements of the Specifications and Contract Drawings. Access manholes with covers shall be as indicated, installed during fabrication, not in the field. Threaded outlets shall be forged steel suitable for 3000 psi service.

PART 3 EXECUTION

3.1 INSTALLATION

A. Handling and Storage: Pipe, specials, and fittings shall be carefully handled and protected against damage to lining and coating/interior and exterior surfaces, and impact shocks and free fall. Pipe, specials, and fittings shall not be placed directly on rough ground but shall be supported in a manner that will protect the pipe against injury whenever stored at the Site or elsewhere. Pipe, specials, and fittings shall be handled and stored at the Site in accordance with the requirements stated in Part 2, above. No pipe shall be installed when the lining or coating/interior or exterior surfaces show cracks that may be harmful as determined by ENGINEER. Such damaged lining and coating/interior and exterior surfaces shall be repaired or a new undamaged pipe, special, or fitting shall be provided at no additional cost to OWNER.

B. Pipe damaged prior to Substantial Completion shall be repaired or replaced at no additional cost to OWNER.

C. Repair of Defects: Patching inserts, overlays, or pounding out defects shall not be permitted. Repair of notches or laminations on second ends shall not be permitted. Deformation of pipe ends through mechanical means or other methods to achieve pipe fit up of defective pipe shall not be permitted. Damaged ends shall be removed to a point of uniform, non-damaged cylinder end and properly prepared. Distorted or flattened lengths shall be rejected. Buckled sections shall be removed and replaced with a full pipe cylinder. CONTRACTOR shall submit a written repair plan and receive favorable review from OWNER prior to the start of any repair work.

D. CONTRACTOR shall inspect each pipe, special, and fitting for damage. CONTRACTOR shall remove or smooth out any burrs, gouges, weld splatter, or other small defects prior to laying the pipe, special, or fitting.

E. Before placement of pipe, specials, or fittings in the trench, each shall be thoroughly cleaned of any foreign substance that may have collected thereon and shall be kept clean thereafter. For this purpose, the openings of pipes, specials, and fittings in the trench shall be closed during any interruption to the project.

F. Pipe, specials, and fittings backfilled with CLSM shall be laid directly on moist sandbags or other suitable supports in preparation for the CLSM pipe zone material. Sandbags shall be placed to provide at least 6-inches of CLSM below the bottom of the pipe. Sandbags shall be spaced at a maximum interval of 8-feet and one set shall be placed within 3-feet on both sides of each joint. CONTRACTOR shall provide additional sandbags as needed to support the pipe on line and grade. Excavation outside the normal trench section shall be made at field joints as needed to permit adequate access to the joints for field connection operations and for application of coating on field joints.

G. Pipe Cleanup: As pipe laying progresses, CONTRACTOR shall keep the pipe interior free of debris. CONTRACTOR shall completely clean the interior of the pipe of sand, dirt, mortar splatter, and any other debris following completion of pipe laying, pointing of joints, and any necessary interior repairs prior to testing and disinfecting the completed pipeline. When pipe laying is not in progress and at the end of each day, CONTRACTOR shall cover the exposed ends of all pipes to prevent animals, dust, dirt and other debris from entering the pipe.

3.2 FIELD WELDED JOINTS

A. Field welded joints are not allowed on this project.

3.3 BURIED FIELD JOINT COATING AND LINING

A. Buried field joint coating and lining is per Section 09 98 10..

3.4 INSTALLATION OF PIPE APPURTENANCES

A. Protection of Appurtenances: Where the joining pipe is tape-coated, buried appurtenances shall be coated with cold-applied tape in accordance with Section 09 98 10 – Pipeline Coatings and Linings.

B. Installation of Valves: Valves shall be handled in a manner to prevent any injury or damage to the valve or any part of it. Joints shall be thoroughly cleaned and prepared prior to installation. CONTRACTOR shall adjust stem packing and operate each valve prior to installation to verify proper operation.

C. Valves shall be installed so that the valve stems are plumb and in the location indicated.

D. Buried valves and flanges shall be coated and protected in accordance with Section 09 98 10 - Pipeline Coatings and Linings.

E. Installation of Flanged Joints: Before the joint is assembled, the flange faces shall be thoroughly cleaned of foreign material with a power wire brush. The gasket shall be

centered and the connecting flanges drawn up watertight without unnecessarily stressing the flanges. Bolts shall be tightened in a progressive diametrically opposite sequence and torqued with a suitable calibrated torque wrench. Clamping torque shall be applied to the nuts only. Full face reinforced rubber gaskets shall be applied to the inside face of blind flanges with adhesive.

F. Insulated Joints: Insulated joints and appurtenant features shall be provided as required. CONTRACTOR shall exercise special care when installing these joints to prevent electrical conductivity across the joint. After the insulated joint is completed, an electrical resistance test shall be performed by CONTRACTOR. If the resistance test indicates a short circuit, CONTRACTOR shall remove the insulating units to inspect for damage, replace all damaged portions, and reassemble the insulating joint. The insulated joint shall then be retested to assure proper insulation.

G. Flexible Coupled Joints: When installing flexible couplings, care shall be taken that the connecting pipe ends, couplings, and gaskets are clean and free of dirt and foreign matter with special attention given to the contact surfaces of the pipe, gaskets, and couplings. The couplings shall be assembled and installed in conformity with the recommendation and instruction of the coupling manufacturer.

H. Wrenches used in bolting couplings shall be of a type and size recommended by the coupling manufacturer. Coupling bolts shall be tightened so as to secure a uniform annular space between the follower rings and the body of the pipe. Bolts shall be tightened approximately the same amount. Diametrically opposite bolts shall be tightened progressively and evenly. Final tightening shall be done with a suitable calibrated torque wrench set for the torque recommended by the coupling manufacturer. Clamping torque shall be applied to the nut only.

3.5 PRESSURE TESTING

A. Pressure testing and disposal of test water shall be in accordance with Section 33 13 00 – Pipeline Testing and Disinfection.

- END OF SECTION –

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SECTION 40 05 13.13
STEEL PROCESS PIPING

PART 1 GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall furnish and install all steel process piping and appurtenances as shown and specified, and as required for a complete and workable piping system.

B. This Section includes schedule 40 and 80 steel process pipe in accordance with ASTM A53 and ASTM A106 with welded, flanged, grooved, or threaded joints **intended for use within pump station.** Fabricated steel pipe **and fittings may be used in pump station but shall be noted and submitted** in accordance with AWWA C200 – Steel Water Pipe, 6-inch and Larger, is included in Section 33 92 10 – Steel Pipe, Specials, and Fittings (AWWA C200, modified).

1.2 RELATED WORK

A. Related Work specified in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 31 23 15 Excavation and Backfill for Pipelines
3. Section 33 92 10 Steel Pipe, Specials, and Fittings (AWWA C200, modified)
4. Section 33 12 00 Mechanical Appurtenances
5. Section 33 13 00 Pipeline Testing and Disinfection

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publication is referred to in the text by basic designation only.

B. AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

1. ASME B 16.1 Gray Iron Flanges and Fittings, Classes 25, 125, and 250
2. ASME B 16.3 Malleable Iron Threaded Fittings, Classes 150 and 300
3. ASME B 16.4 Gray Iron Threaded Fittings, Classes 125 and 250
4. ASME B 16.5 Pipe Flanges and Flanged Fittings
5. ASME B 16.9 Factory-Made Wrought Butt Welded Fittings
6. ASME B 16.11 Forged Fittings, Socket-Welding and Threaded
7. ASME B 16.12 Cast Iron Threaded Drainage Fittings
8. ASME B 31.1 Power Piping

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
2. ASTM A 106 Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

D. AMERICA WELDING SOCIETY (AWS)

1. AWS D1.1 Structural Welding Code

E. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C 207 Steel Pipe Flanges for Waterworks Services
2. AWWA C 606 Grooved and Shouldered Joints
3. AWWA C 651 Standard for Disinfecting Water Mains

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit manufacturer's affidavit certifying product was manufactured, tested and supplied in accordance with applicable references in this section together with a report of the test results and the date each test was completed.

C. Submit shop drawings of pipe, fittings, supports and appurtenances showing compliance with this Section including necessary dimensions, details, pipe joints and material lists.

D. Submit gasket material data including manufacturer’s catalog indicating that the proposed product is suitable for each fluid of service application.

E. Submit welders’ qualifications in accordance with AWS D1.1.

PART 2 PRODUCTS

2.1 STEEL PIPE

A. Fabricate steel pipe in accordance with the Plans and with ASTM A 53 or ASTM A 106, Grade B. When Drawings don’t specify a pipe wall thickness, use Standard Weight pipe, but in no case shall pipe be under 0.2 inch wall thickness.

B. Coat steel (buried and exposed) per Section 09 90 00 Painting and Coating.

C. Cement mortar line buried steel pipe per AWWA C205.

D. NSF 61 Epoxy line piping in wellhouse per Section 09 90 00 Painting and Coating.

E. Galvanized pipe shall galvanized inside and out.

F. Steel pipe and coatings shall be made by an ISO 9000 certified pipe fabricator, **Utility Coatings**, or approved equal.

2.2 PIPE JOINTS

A. Black steel pipe joints shall be screwed ends with NPT threads, welded, or flanged. Screwed joints shall be up with Teflon tape. Welded joints may have butt-weld or socket weld fittings or flanges. Where indicated on the Contract Drawings, provide grooved ends for rigid or flexible mechanical couplings or plain ends for sleeve-type couplings.

B. Galvanized steel pipe shall have screwed ends with NPT threads. Screwed joints shall be up with Teflon tape. Where indicated on the Contract Drawings, provide grooved ends for rigid or flexible mechanical couplings or plain ends for sleeve-type couplings.

C. Flanged joints shall be in accordance with ASME B16.5 or AWWA C207 flanges for the pressure class required for the project conditions or as indicated on the Contract Drawings. CONTRACTOR is responsible for providing the appropriate flanges required to connect steel pipe to equipment and other appurtenances. CONTRACTOR shall replace flanges that do not match the mating equipment or appurtenance at no additional cost to OWNER. Gaskets shall be ANSI 150 lb. full face, 1/8-inch thick Neoprene for water or wastewater service. Gasket material for chemicals shall be suitable for the chemical service

D. Bolts shall comply with ASTM AA193, with ASME 18.2.1, and have ASME B1.1, Class 2A threads with nuts having Class 2A fit and hex heavy dimensions per ASME 18.2.2.

1. Exposed Flanges: Bolts shall be A193, Grade B7 (high strength steel). Nuts shall be A194, Grade 2H. Both shall be PTFE coated.
2. Buried Flanges: Bolts shall be A193, Grade B8M (316 SS). Nuts shall be Grade A194, Grade 8B (made from 304 SS bars).

2.3 FITTINGS

A. Threaded fittings shall be in accordance with ASME B16.3 or ASME B16.4. Threaded fittings for gravity pipe systems shall be in accordance with ASME B 16.12.

B. Welded fittings shall be in accordance with ASME B 16.11 or ASME B 16.9. **Welded fittings may be fabricated per AWWA C208 requirements.**

C. Flanged fittings shall be in accordance with ASME B 16.1 or ASME B 16.5.

D. Grooved fittings shall conform to AWWA C 606.

PART 3 EXECUTION

3.1 INSTALLATION

A. Above ground steel process piping shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipe shall afford maximum headroom and access to equipment, and where necessary, piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points.

B. Piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 05 45 00 – Mechanical Metal Supports. Where necessary to avoid stress on equipment or structural members, the pipe shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature changes.

C. Unless otherwise indicated, connections to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection. Low points shall be provided with a drain valve.

3.2 PIPE PREPARATION

A. Prior to installation, each pipe length shall be carefully inspected, flushed clean of any debris or dust, and be straightened, if not true. Ends of threaded pipes shall be reamed and filed smooth. Pipe fittings shall be equally cleaned before assembly

3.3 PIPE JOINTS

A. Pipe threads shall be full and cleanly cut with sharp dies or molded. Joints shall be made with Teflon tape.

B. Welded joints shall conform to the requirements of this Section and the recommendations of ASME B 31.1. Welding shall be done by skilled and qualified welders. Welders shall be qualified under the provisions of AWS D1.1. Machines and electrodes similar to those used in the work shall be used in qualification tests.

C. Grooved couplings shall be installed per the manufacturer's recommendations and shall conform to AWWA C 606.

D. All joints shall be visually drip tight.

3.4 INSPECTION AND TESTING OF PIPELINE

A. Completed steel process piping systems shall be inspected for proper supports, anchorage, and damage to pipe, fittings, and coatings. Any damage shall be repaired by CONTRACTOR at no additional cost to OWNER.

B. CONTRACTOR shall provide temporary blow-off valves and fittings as required to flush and disinfect new pipelines. Temporary blow-off valves and fittings shall be removed prior to placing pipeline into service.

C. Source of Water. CONTRACTOR shall assume all responsibility to obtain the necessary water supplies for disinfection and/or pressure testing of the pipeline.

D. Testing Procedure

1. Prior to enclosure or burying, piping systems shall be pressure tested as required on the Drawings, for a period of not less than one hour, without exceeding the tolerances listed on the Drawings. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. CONTRACTOR shall furnish test equipment, labor, materials, and devices
2. Leakage shall be determined by loss of pressure, soap solution, or other positive and accurate method. Fixtures, devices, or other accessories that would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines shall be plugged or capped as appropriate during the testing procedures.
3. Leaks shall be repaired, and the piping shall be re-tested until no leaks are found.

4. ENGINEER shall be notified at least 48 hours before the pipeline is to be tested so that ENGINEER may be present during the test.

3.5 DISINFECTING

A. Disinfection shall be in accordance AWWA C 651 and the requirements of Section 33 13 00 – Pipeline Testing and Disinfection.

- END OF SECTION –

SECTION 40 05 13.19
STAINLESS STEEL PROCESS PIPING

PART 1 GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall furnish and install all stainless steel process piping and appurtenances as shown and specified, and as required for a complete and workable piping system.

1.2 RELATED WORK

A. Related Work specified in other sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 33 12 00 Mechanical Appurtenances

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publication is referred to in the text by basic designation only.

B. AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

1. ASME B 16.5 Pipe Flanges and Flanged Fittings
2. ASME B 16.9 Factory-Made Wrought Butt Welded Fittings
3. ASME B 16.11 Forged Fittings, Socket-Welding and Threaded
4. ASME B 31.1 Power Piping

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 312 Standard Specification for Seamless, Welded, and Heavy Cold Worked Austenitic Stainless Steel Pipes
2. ASTM A 403 Standard Specification for Wrought Austenitic Stainless Steel Piping and Fittings
3. ASTM A 409 Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service
4. ASTM A 778 Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products

D. AMERICA WELDING SOCIETY (AWS)

1. AWS D1.1 Structural Welding Code

E. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C 606 Grooved and Shouldered Joints
2. AWWA C 651 Standard for Disinfecting Water Mains

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit manufacturer's affidavit certifying product was manufactured, tested and supplied in accordance with applicable references in this section together with a report of the test results and the date each test was completed.

C. Submit shop drawings of pipe, fittings, supports and appurtenances showing compliance with this Section including necessary dimensions, details, pipe joints and material lists.

D. Submit gasket material data including manufacturer’s catalog indicating that the proposed product is suitable for each fluid of service application.

E. Submit welders’ qualifications in accordance with AWS D1.1.

PART 2 PRODUCTS

2.1 STAINLESS STEEL PIPE

A. Stainless steel process pipe shall be in accordance with ASTM A 312, Type 304 seamless, Schedule 40S or 80S as shown on the Drawings, with screwed fittings for sizes up to and including 3-inches and welded fittings for sizes 3-inches and larger. Flange fittings may be used for pipe diameters 2-inches and larger.

2.2 PIPE JOINTS

A. Stainless steel pipe 3-inches and smaller shall have screwed ends with NPT threads. Screwed joints shall be up with Teflon tape. Stainless steel pipe 3-inches and larger shall have welded joints or flanges. Flanges shall have stainless steel nuts and bolts the same material type as the pipe. Where indicated on the Drawings, provide grooved ends for rigid or flexible mechanical couplings. Pipe grooving is only allowed for Schedule 40S or 80S pipe. For plain end stainless steel pipe use sleeve-type couplings where noted on the Contract Drawings.

B. Flanged joints shall be in accordance with ASME B16.5 for the pressure class required for the project conditions or as indicated on the Drawings. CONTRACTOR is responsible for providing the appropriate flanges required to connect stainless steel process pipe to equipment and other appurtenances. CONTRACTOR shall replace flanges that do not match the mating equipment or appurtenance at no additional cost to OWNER. Gaskets shall be ANSI 150 lb. full face, 1/8-inch thick Neoprene for water or wastewater service. Gasket material for chemicals shall be suitable for the chemical service.

2.3 FITTINGS

A. Threaded fittings shall be forged stainless steel fittings in accordance with ASME B 16.11.

B. Socket welded fittings shall be forged stainless steel fittings in accordance with ASME B 16.11.

C. Butt-welded fittings shall be wrought stainless steel fittings in accordance with ASTM A 403 and ASME B 16.9.

D. Flanged fittings shall be in accordance with ASME B 16.5.

E. Grooved fittings shall be wrought stainless steel conforming to ASTM A 403 and ASME B 16.9 and to AWWA C 606. Gasket material shall be suitable for the intended service.

F. Fittings shall be in accordance with the pressure class shown on the Drawings or have the same pressure rating as the pipe.

PART 3 EXECUTION

3.1 INSTALLATION

A. Stainless steel process piping shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipe shall afford maximum headroom and access to equipment, and where necessary, piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points.

B. Piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 05 45 00 – Mechanical Metal Supports. Where necessary to avoid stress on equipment or structural members, the pipe shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature changes.

C. Unless otherwise indicated, connections to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection. Low points shall be provided with a drain valve.

3.2 PIPE PREPARATION

A. Prior to installation, each pipe length shall be carefully inspected, flushed clean of any debris or dust, and be straightened, if not true. Ends of threaded pipes shall be reamed and filed smooth. Pipe fittings shall be equally cleaned before assembly

3.3 PIPE JOINTS

A. Pipe threads shall be full and cleanly cut with sharp dies or molded. Joints shall be made with Teflon tape.

B. Welded joints shall conform to the requirements of this Section and the recommendations of ASME B 31.1. Welding shall be done by skilled and qualified welders. Welders shall be qualified under the provisions of AWS D1.1. Machines and electrodes similar to those used in the work shall be used in qualification tests. Field welds shall be kept to a minimum by using couplings or shop fabrication as much as possible. Weld residue, oxide, and heat stain shall be removed shall be removed by stainless steel wire brushes followed by cleaning with an agent, followed by complete removal of the agent. Cleaning agent shall be **BlueOne Pickling Paste 130 by Avesta**

Finishing Chemicals, STAR Gel by Krystal Surface Solution, or approved equal. Passivation must following the cleaning process using **FinishOne Passivator 630 by Avesta Finishing Chemicals, STAR Pass 1 by Krystal Surface Solution**, or approved equal. Following the manufacturer's instruction for the cleaning/pickling and passivation process.

C. Grooved couplings shall be installed per the manufacturer's recommendations and shall conform to AWWA C 606.

3.4 INSPECTION AND TESTING OF PIPELINE

A. Completed stainless steel process piping systems shall be inspected for proper supports, anchorage, and damage to pipe, fittings, and coatings. Any damage shall be repaired by CONTRACTOR at no additional cost to OWNER.

B. CONTRACTOR shall provide temporary blow-off valves and fittings as required to flush and disinfect new pipelines. Temporary blow-off valves and fittings shall be removed prior to placing pipeline into service.

C. Source of Water

1. CONTRACTOR shall assume all responsibility to obtain the necessary water supplies for disinfection and/or pressure testing of the pipeline.

D. Testing Procedure

1. Prior to enclosure or burying, piping systems shall be pressure tested as required on the Drawings, for a period of not less than one hour, without exceeding the tolerances listed on the Drawings. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. CONTRACTOR shall furnish test equipment, labor, materials, and devices

2. Leakage shall be determined by loss of pressure, soap solution, or other positive and accurate method. Fixtures, devices, or other accessories that would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines shall be plugged or capped as appropriate during the testing procedures.

3. Leaks shall be repaired, and the piping shall be re-tested until no leaks are found.

4. ENGINEER shall be notified at least 48 hours before the pipeline is to be tested so that ENGINEER may be present during the test.

3.5 DISINFECTING

A. Disinfection shall be in accordance AWWA C 651 and the requirements of Section 33 13 00 – Pipeline Testing and Disinfection.

- END OF SECTION –

SECTION 40 10 00 - PROCESS CONTROL AND INSTRUMENTATION SYSTEM - GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. General requirements applicable to all process control work.
   2. The requirements of this Section apply to all components of the Software Systems unless indicated otherwise.
   3. General requirements for programming submittals.

B. Related sections:
   1. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Subcontractors to review all sections to ensure a complete and coordinated project:
      a. Items involving electrical, control, and instrumentation construction may be shown on Drawings or referred to in Specifications that do not apply specifically to electrical, control and instrumentation systems.

C. The Programming Contractor shall program all PLC's and the SCADA system. The Programming Contractor shall provide all software as specified herein for programming the system. The Programming Contractor and the electrical contractor shall be responsible to test each device and loop to verify proper function of all equipment on the project, whether provided by the contractor or by the owner. They shall then work with the owner to test and commission the entire system as described herein. The programming contractor shall be present to test the I/O for each equipment subsystem. The I/O to the PLC systems shall be tested at this time. The programming contractor shall provide and install a simple testing routine in each PLC in order to verify all I/O is functioning properly. All I/O shall be tested from its respective field device to the software level in the PLC. If final PLC programming is complete at the time of testing, the final software programming shall be used to test each device

D. The Programming Contractor shall design the operator interface graphics, human machine interface (HMI) graphics, PLC logic, and control systems hardware as specified herein.

E. Contract Documents:
   1. General:
      a. Contract documents consist of drawings, specifications, and other documents issued by the ENGINEER. The Drawings and Specifications are complementary and are to be used together in order to fully describe the Work, and requirements shown, written or reasonably inferred there from on one is considered as written, shown or implied in all. In the event work is called for in more than one place and there are conflicting requirements, the right shall be reserved to require the installation of the larger or the more expensive.
      b. Schematic Diagrams:
         1) All controls are shown de-energized.
            a) Schematic diagrams show control function only. Incorporate other necessary functions for proper operation and protection of the system.

b) Control schematics are to be used as a guide in conjunction with the descriptive operating sequences found in the Drawings or Specifications. Combine all information and furnish a coordinated and fully functional control system program.

1.2 REFERENCES

A. Code Compliance:
1. The publications are referred to in the text by basic designation only. The latest edition accepted by the Authority Having Jurisdiction of referenced publications in effect at the time of Bid governs.
2. The following codes and standards are hereby incorporated into these Specifications:
   a. National Fire Protection Association (NFPA):
      1) NFPA 70 - National Electric Code (NEC).
      2) NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
      3) NFPA 496 - Purged and Pressurized Enclosures for Electrical Equipment, where applicable.
      4) NFPA 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
   b. Underwriters Laboratories, Inc. (UL):
      1) UL 508 - Industrial Control Equipment.
   c. American National Standards Institute (ANSI):
      1) ANSI B16.5 - Pipe Flanges and Flanged Fittings.
   d. American Petroleum Institute (API):
      1) API RP551 - Process Measurement Instrumentation.
      2) API RP552 - Transmission Systems.
      3) API RP553 - Refinery Control Valves.
      4) API RP554 - Process Instrumentation and Control.
      5) API RP555 - Process Analyzers.
      6) API RP556 - Fired Heaters & Steam Generators.
      7) API RP557 - Guide to Advanced Control Systems.
   e. American Society of Testing and Materials (ASTM):
      1) ASTM A269 - Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   f. Instrumentation, Systems, and Automation Society (ISA):
      1) ISA-5.1 - Instrumentation Symbols and Identification.
      2) ISA-5.2 - Binary Logic Diagrams for Process Operations.
      3) ISA-5.3 - Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.
      4) ISA-5.4 - Instrument Loop Diagrams.
      5) ISA-5.5 - Graphic Symbols for Process Displays.
      6) ANSI/ISA-7.00.01 - Quality Standard for Instrument Air.
      7) ISA-RP - 12.4 - Pressurized Enclosures.
      8) ANSI/ISA-18.1 - Annunciator Sequences and Specifications.
      9) ISA-20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.
      10) ISA-TR20.00.01 - Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations Updated with 27 New Specification Forms in 2004-2005.

11) ANSI/ISA-50.00.01 - Compatibility of Analog Signals for Electric Industrial Process Instruments.
12) ISA-51.1 - Process Instrumentation Terminology.
13) ISA-RP60.3 - Human Engineering for Control Centers.
14) ISA-71.01 - Environmental Conditions for Process Measurement and Control Systems: Temperature and Humidity.
15) ISA-71.02 - Environmental Conditions for Process Measurement and Control Systems: Power.
16) ISA-71.03 - Environmental Conditions for Process Measurement and Control Systems: Mechanical Influences.
17) ISA-71.04 - Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants.

1.3 DEFINITIONS

A. Definitions of terms and other electrical and instrumentation considerations as set forth in the:
   1. National Electrical Code.
   2. Institute of Electrical and Electronic Engineers.
   3. Instrumentation, Systems, and Automation Society.
   4. National Fire Protection Association.
   5. National Electrical Testing Association.

B. Specific Definitions:
   1. Control Circuit: Any circuit operating at 120 volts AC or DC or less, whose principal purpose is the conveyance of information (including performing logic) and not the conveyance of energy for the operation of an electrically powered device.
   2. Panel: An instrument support system that may be either a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems. Unless otherwise specified or clearly indicated by the context, the term “panel” in these Contract Documents is interpreted as a general term, which includes flat surfaces, enclosures, cabinets and consoles.
   3. Power Circuit: Any circuit operating at 90 volts (AC or DC) or more, whose principal purpose is the conveyance of energy for the operation of an electrically powered device.
   4. Signal Circuit: Any circuit operating at less than 50 volts AC or DC, which conveys analog information or digital communications information.
   5. Digital Bus: A communication network, such as Profibus, Foundation Fieldbus, or DeviceNet, allowing instruments and devices to transmit data, control functions and diagnostic information.
   6. 2-Wire Transmitter (Loop Powered): A transmitter that derives its operating power supply from the signal transmission circuit and requires no separate power supply connections. As used in this Specification, two-wire transmitter refers to a transmitter that provides 4 to 20 mA current regulation of a signal in a series circuit with an external 24 VDC driving potential.
   7. Field Bus Communications signal or both.
   8. Powered Transmitters: A transmitter that requires a separate power source (120 VAC, 240 VAC, etc.) in order for the transmitter to develop its signal. As used in this Specification, the produced signal may either be a 4 to 20 mA current signal, a Digital Bus communications signal or both.

9. Modifications: Changing, extending, interfacing to, removing or altering an existing circuit.

C. Acronym Definitions:
1. ES: Enterprise System: Computer based communications or data sharing system utilized for non-process control functions such as E-mail, sharing files, creating documents, etc.
2. FAT: Factory Acceptance Test.
3. HOA: Hand-Off-Auto control function that is totally PLC based. In the Hand mode of control equipment is started or stopped, valves are opened or closed through operator direction under the control of the PLC software. In the Auto mode of control equipment is started or stopped, valves are opened or closed through a control algorithm within the PLC software. In the Off mode the equipment is prohibited from responding from the PLC control.
4. HMI: Human Machine Interface: PLC based operator interface device consisting of an alphanumeric display and operator input devices. The HMI is typically a flat panel type of display with either a touch screen or tactile button interface.
5. HVAC Heating, Ventilation, & Air Conditioning.
6. ICSC: Instrumentation and Control System Contractor: Subcontractor who specializes in the design, construction, fabrication, software development, installation, testing, and commissioning of industrial instrumentation and control systems.
7. IJB: Instrument Junction boxes. A panel designed with cord sets to easily remove, replace or relocate instrument signals.
8. I/O: Input / Output.
9. LCP: Local Control Panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and does not contain a PLC or RIO.
10. LAN: Local Area Network: A control or communications network that is limited to the physical boundaries of the facility.
11. LOR: Local-Off-Remote control function. In the Remote mode equipment is started or stopped, valves are opened or closed through the PLC based upon the selection of the HOA. In Local control, equipment is started or stopped, valves are opened or closed based upon hardwired control circuits completely independent of the PLC with minimum interlocks and permissive conditions. In the Off mode, the equipment is prohibited from responding to any control commands.
12. OIT: Operator Interface Terminal. PC based interface device used for operator interface with the SCADA system.
13. P&ID: Process and Instrumentation Diagram.
14. PC: Personal Computer.
15. PCIS: Process Control and Instrumentation System, includes the entire instrumentation system, the entire control system, and all of the work specified in Division 17 and depicted on the Instrumentation Drawings.
16. PCM: Process Control Module: An enclosure containing any of the following devices: PLC, RIO.
17. PJB: Power Junction Box: An enclosure with terminal blocks that distribute power to multiple instruments.
18. PLC: Programmable Logic Controller.
19. RIO: Remote I/O device for the PLC consisting of remote I/O racks, or remote I/O blocks.

20. RTU: Remote Telemetry Unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.
21. SCADA: Supervisory Control and Data Acquisition system consists of the computer-based software system that includes the operator interface, data storage, data retrieval, archiving, alarming, historian, reports, trending, and other higher level control system software.
22. UPS Uninterruptible Power Supply.
23. VCP: Vendor Control Panel: Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, OIT, HMI, etc.
24. WAN: Wide Area Network: A control or communications network that extends beyond the physical boundaries of the facility.

1.4 SYSTEM DESCRIPTION

A. General Requirements:
   1. The Work includes everything necessary for and incidental to executing and completing the general requirements for programming the control system described in the Contract Drawings and Specifications and reasonably inferable there from including but not limited to:
      a. Procure all software.
      b. With the electrical contractor, perform post programming tests on panels.
      c. With the electrical contractor, oversee, document, and certify system pre-commissioning.
      d. With the electrical contractor, conduct the Performance Tests.
      e. Prepare Operation and Maintenance Manuals.
      f. Conduct training classes.
      g. Develop all requisite loop descriptions, functional narrative and instructions and record drawings associated with the programs provided under other Divisions of these Specifications.
   2. It is the intent of these Specifications that the programmed system be complete and operable.
   3. Furnish detailed, complete, and thorough operations and maintenance documentation, including, but not limited to: Operations Manuals, Maintenance Manuals, Training Manuals, As-Built Software Documentation, final as installed software configurations, and software disks including installed program disk.

1.5 SUBMITTALS

A. General:
   1. Furnish Submittals that are fully developed for a given section of the work and fully indexed with a tabbed divider for every element and component.
   2. Sequentially number the pages within the tabbed sections. Submittals and Operation and Maintenance manuals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
   3. Edit all Submittals and Operation and Maintenance Manuals so that the submittal specifically applies to only the equipment furnished. Neatly cross out all extraneous text, options, models, etc. that do not apply to the equipment being furnished, so that the information remaining is only applicable to the equipment being furnished.

4. Submittal Requirements:
    a. Submit copies of shop drawings, and product data, in accordance with the requirements of this Section:
        1) Show information on software to be supplied, SCADA screens, reports, menus, operation, etc.
5. Exceptions to Specifications and Drawings:
    a. Include a list of proposed exceptions to the Specifications and Drawings along with a detailed explanation of each.
    b. Any exceptions to the Specification and Drawings must be noted and the reason for the exception explained.
    c. If there is insufficient explanation for the deviation, the submittal will be returned requiring Revision and Re-submittal.
    d. Acceptance of any exception is at the sole discretion of the ENGINEER. Furnish all items (materials, features, functions, performance, etc.) that are not listed as exceptions strictly in accordance with the Specifications and Drawings.
    e. Replace all items that do not strictly meet the requirements of the Specifications, which were not previously accepted as exceptions, even if the Submittals contained information indicating the failure to meet the requirements.
6. Submittal Organization:
    a. First page:
        1) Specification Section reference.
        2) Name and telephone number of individual who reviewed submittal before delivery to ENGINEER.
        3) Name and telephone number of individual who is primarily responsible for the development of the submittal.
        4) Place for CONTRACTOR's review stamp and comments.

    b. Next pages:
        1) Provide confirmation of Specification compliance in a tabular form that individually lists each Specification section, paragraph, and sub-paragraphs and unequivocally states compliance with said requirement or takes exception to the requirement and lists the reason for said exception and offers alternative means for compliance.
        2) Include a response in writing to each of the ENGINEER’s comments or questions for submittal packages which are re-submitted:
    c. In the order that the comments or questions were presented throughout the submittal.
    d. Referenced by index section and page number on which the comment appeared.
    e. Acceptable responses to ENGINEER’s comments are either:
    f. ENGINEER’s comment or change is accepted and appropriate changes are made.
    g. Explain why comment is not accepted or requested change is not made.
    h. Explain how requirement will be satisfied in lieu of comment or change requested by ENGINEER.
    i. Any re-submittal, which does not contain responses to the ENGINEER’s previous comments, shall be returned for revision and re-submittal.

j. No further review by the ENGINEER will be performed until a response for previous comments has been received.
k. Remaining pages:
    1) Actual Submittal data:
        a) Organize Submittals in exactly the same order as the items are referenced, listed, and/or organized in the Specification section.
        b) For Submittals that cover multiple devices used in different areas under the same Specification section, the Submittal for the individual devices must list the area where the device is intended to be used.
l. Specific Submittal requirements:
    1) Furnish the submittals required by each Section or Division 17:
        a) Product Data.
        b) Shop Drawings.
m. Furnish submittals in the following general order, each in a separate bound set:
    1) Product Data.
    2) After approval of the Product Data, submit the Project Shop Drawing submittals
    3) Testing, Calibration and Start-up procedures.
    4) Operation and Maintenance Data.
    5) Training Submittals.
    6) Record Documents.

B. Product Data:
1. General:
    a. Submitted for non-custom manufactured material listed in this and other sections and shown on shop drawings.
    b. Furnish sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications.
    c. Include:
        1) Catalog cuts.
        2) Bulletins.
        3) Brochures.
        4) Quality photocopies of applicable pages from these documents.
        5) Identify on the data sheets the project name, applicable specification section, and paragraph.
        6) Identify model number and options for the actual equipment being furnished.
    d. Neatly cross out options that do not apply or equipment not intended to be supplied.
2. Software Data Sheets and Cut Sheets:
    a. Provide fully completed data sheets , in hardcopy, for each software package. Including the following information on the data sheet:
        1) License limitations, points, screens available.
        2) Description of software compatibilities with hardware (PLC’s, ethernet communications, P.C.’s, modems, HMI’s, etc.)
        3) Description of software capabilities, function and use.
3. Software Program Submittal:
    a. Prepare a program submittal to demonstrate how the programs address the following:
        1) Alarm indication and notification.

2) Alarm acknowledgement.
3) Operational sequences.
4) Communications.
5) Recording and trending – show for each recorded or tended tag.
6) Report generation with samples.
7) Maintenance information and notes storage.
8) Samples of each screen shot and report.

C. Operation and Maintenance Manuals:
1. Furnish the ENGINEER with a complete preliminary set of written Operation and Maintenance Manuals 2 weeks before start-up and/or testing.
2. Furnish in accordance with the following additional requirements.
3. Submit preliminary sets of these manuals to the ENGINEER for review of format and content:
   a. ENGINEER will return 1 set with comments.
   b. Revise and/or amended as required and submit the requisite number of copies to the ENGINEER 15 days before Pre-commissioning of the systems.
4. Incorporate changes that occur during startup and submit as part of the final manuals.
5. Provide comprehensive information on all systems and components to enable operation, service, maintenance, and repair.
6. Organize the Operation and Maintenance Manuals for each process in the following manner:
   a. Section A-Description of operation.
   b. Section B- Screen shots.
   c. Section C- Report samples.
   d. Section D- Trending/recording operations.
   e. Section E- Software information with disks.
   f. Section F- Operational Manual.
   g. Section G- Spare Parts List.
7. Training Submittals:
   a. Develop and submit for review a General Training Plan. Include complete descriptions of all planned training classes, a preliminary training schedule, a list of all proposed instructors along with resumes, examples of proposed training manuals, and a description of any special training tools to be used (simulators, self-paced modules, personal computer-based training, etc.).
   b. The ENGINEER will review the General Training Plan. Special emphasis will be placed on review of the qualifications of the proposed instructors and the timing of the individual courses to maximize their effectiveness. If, in the opinion of the ENGINEER, the proposed instructors are not sufficiently qualified to conduct the specified training courses, or lack experience, where required, on the specific configuration of the system provide more qualified instructors.
   c. Training Course Plan submittals:
      1) For each training course or other training activity, submit a detailed, complete outline and agenda for each lesson.
      2) Describe any student pre-requisites for the course or training activity.
      3) Provide an updated schedule for all sessions of the course, including dates, times, durations, and locations.
      4) Submit training materials.
   d. Incorporate all submittal review comments into the course.

e. Do not conduct training courses before review and acceptance of the Course Plan submittal for the course.

D. Responsibilities
   1. The Programming Contractor, shall be responsible to the OWNER for the implementation of the software and programmed systems.
   2. Instrumentation & Control System Contractor (ICSC) Responsibilities:
      a. The Programming Contractor shall assume full responsibility to perform all engineering to select, furnish, install, test, calibrate, and place into operation all software for PLC's and SCADA P.C.'s.
      b. The Programming Contractor shall be responsible for coordination with OWNER to provide a complete, integrated and functional software system.
      c. As a minimum, the Programming Contractor shall perform the following work:
         1) Prepare software submittals.
         2) Design, develop, and implement controls, screens, reporting, recording, etc.
         3) Prepare the test plan, the training plan, and the spare parts submittals.
         4) Procure all software.
         5) Perform tests on PLC and SCADA software.
         6) Participate in system pre-commissioning.
         7) Participate in the performance tests.
         8) Prepare Technical Manuals.
         9) Conduct training classes.
   3. Owner's Responsibilities:
      a. Assist the Programming Contractor in coordinating and integrating the system controls.
      b. The Programming Contractor shall not be responsible for providing or testing any hardware.
   4. The Programming Contractor and the Instrumentation & Control System Contractor will be one and the same for this contract.

E. Programmer Qualifications:
   1. The Qualification requirements specified in these paragraphs apply to the portions of the Process Control and Instrumentation System Work to be provided by the Programming Contractor.
   2. The Programming Contractor shall meet the following minimum qualifications:
      a. The Programming Contractor shall have completed at least five (5) successfully completed projects for a pumping system of similar scope and complexity in which the Programming Contractor used components the same as those intended for use on this project, performed system programming, documentation, including software configuration and documentation, field testing, calibration and start-up, operator instruction and maintenance training.
      b. The Programming Contractor company shall be actively involved in the instrumentation, PLC based control systems, and SCADA systems business for a minimum of ten years and has adequate facilities, organization structure, manpower and technical and managerial expertise to properly perform the WORK under and in conformance with these Specifications.

1.6 SEQUENCING

A. General:
   1. General scheduling requirements are specified in Section 01313.
   2. Refer to Section 01010 for summary of work.
   3. Testing requirements are specified in Division 27.

4. Work restrictions and other scheduling requirements are specified in Section 01140.

B. Pre-submittal Conferences:
   1. Before producing any submittals, schedule a pre-submittal Conference for the purposes of reviewing the entire project, equipment, control philosophy, schedules, and submittal requirements.

C. Training:
   1. Complete all training before the pre-commissioning phase of the project may start.
   2. Schedule the training sessions a minimum of 15 days prior to the start date of the courses.
   3. Submit training manuals to the ENGINEER a minimum of 10 days before starting the training session.
   4. Within 10 days after the completion of each session, submit the following:
      a. A list of all OWNER personnel that attended the session.
      b. A copy of the training materials utilized during the lesson with all notes, diagrams, and comments.

D. Performance Testing:
   1. Complete Pre-commissioning test a minimum of 5 days before the Performance Test.
   2. Conduct a 90-day Performance Test.

1.7 WARRANTY

A. Warrant the Software and Programming in accordance with the General Conditions:
   1. Provide additional warranty as specified in the individual Division 17 Specifications.

1.8 SYSTEM STARTUP

A. Replace or modify software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements:
   1. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the ENGINEER.

1.9 MAINTENANCE

A. Before Substantial Completion, perform all maintenance activities required by any sections of the Specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems in service.

PART 2 -

PART 3 -

3.1 DEMONSTRATION AND TRAINING

A. Training:
    1. General:
        a. Provide system maintenance and operator training courses for all the instrumentation and control systems furnished.
        b. Conduct all training at the Project Site unless another location is approved by the ENGINEER and OWNER.
            1) Include instruction on the use of all maintenance equipment and special tools provided under the contract.
        c. Tailor training classes to the specific needs of the class participants:
            1) The specific categories and number of personnel in each category are identified below.
            2) Furnish training courses that are a combination of classroom and hands-on training:
            3) Present the minimum number of sessions, specified in Table 1, for each course in order to satisfy class size restrictions and limitations scheduling OWNER staff.
            4) Furnish additional sessions if required to accommodate the total number of personnel identified for each course.
            5) Schedule individual training classes with the OWNER at least 3 weeks before the start of the class.
            6) Schedule all training classes Monday - Friday between 7:30 AM and 3:30 PM.
            7) Each individual daily training session, travel time excluded:
                a) Minimum duration of 4 hours.
                b) Maximum duration of 7 hours.
                c) Breaks scheduled at least every 90 minutes and 1 hour for lunch.
            8) Complete training for maintenance personnel 90-days before Performance Testing.
            9) Complete operator training classes before startup of the SCADA system, or any part of it:
            10) Refer to Paragraph 1.09 of this Section.
            11) Schedule follow-up training classes after SCADA startup on a schedule determined by the OWNER.
                a) Furnish highly qualified training instructors for technical training with demonstrated expertise in not only control system functionality but also professional training techniques:
                b) Provide completion reports in accordance with Paragraph 1.09 of this Section.
    2. Training Manuals and Materials:
        a. Furnish training manuals and other materials for training courses.
        b. Manuals are to be professionally written to present the course material in a format that is easy to comprehend.
        c. The manuals are to serve as teaching aids during presentation of the training classes.
        d. Manuals are to serve as reference material after the training has been completed.

Table 1 Course Title	Minimum Course Length (days per session)	Personnel (Estimated Number of Students)	Minimum Number of Sessions
SCADA, HMI, PLC Software	1	5	1

3. Training Course Requirements:
   a. Software Training:
      1) Furnish training on software and on related systems, including operation alarms, control, recording, reporting, etc.
      2) Furnish training on features, operation, troubleshooting, and maintenance.
   b. HMI Training:
      1) Provide the following:
         a) Overview of firmware, including starting, stopping, and PLC interface.
         b) Troubleshooting.

   c. Follow-up Training:
      1) Provide on-site follow-up training class beginning after startup of the SCADA system. The intent for these classes is to provide the OWNER's personnel the opportunity for a review and "refresher" of the training topics and material after they have had some experience using the system.
      2) Mutually schedule and develop the content of these classes with the OWNER no later than 1 month before the beginning of the first session:
         a) Schedule at the OWNER's discretion on non-consecutive days spaced out over the start-up and warranty period.

END OF SECTION

SECTION 40 11 00 – PROGRAMMABLE LOGIC CONTROLLER

PART 1 - GENERAL

1.1 SCOPE

A. Furnish all labor, material, equipment, appliances, and perform all operations in connection with providing a complete and operable programmable logic controller (PLC) system in accordance with this section of the specifications and applicable drawings and subject to the terms and conditions of the Contract.

B. The SUPPLIER shall furnish a PLC control system utilizing Allen Bradley CompactLogix 5069 PLC family of hardware as specified herein. No like, equal, or equivalent products will be considered.

C. The OWNER shall furnish PLC programming software.

E. The OWNERS programmer shall work in conjunction with the CONTRACTOR to train the owner's staff on the PLC system. The contractor shall train the owner on all hardware. The programmer shall train on PLC programming, SCADA programming, operations, fault clearing, start-up and shutdown procedures, etc.

1.2 APPLICABLE SECTIONS

A. The General Conditions, Supplementary General Conditions, Special Conditions, alternates and Addenda, applicable drawings and the technical specification herein shall apply to work under this Section.

1.3 APPLICABLE REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI X3.64 (1979) Additional Controls for Use with American National Standard Code for Information Interchange

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA232-D (Jan. 1987) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

EIA RS-485 (1983) Standard for Electrical Characteristics of Generators and Receivers for Use in Balanced Multipoint System

FEDERAL COMMUNICATION COMMISSION (FCC)

FCC Part 68 (July 1986) Connection of Terminal Equipment to the Telephone Network

THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

IEEE No. 100 (1988) IEEE Standard Dictionary of Electrical and Electronic Terms

IEEE C57.13 (1978) Instrument Transformers

IEEE C62.41 (1980) Surge Voltages in Low-Voltage AC Power Circuits

IEEE 802.3 Carrier Sense Multiple Access/Collision Detection (CSMA/CD)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1985; Incl. Rev. I and 2; ICS-6) Enclosures for Electrical Equipment

NEMA ICS 1 (1988) General Standards for Industrial Controls and Systems

UNDERWRITERS LABORATORIES, Inc. (UL)

UL 50 Enclosures for Electrical Equipment

UL 508 Industrial Control Equipment

1.4 SUBMITTALS

A. Provide complete submittal information for the PLC system as specified in Sections 01 34 00 and 26 05 00. Include manufacturer's data for each part, Bill of Materials, panel fabrication drawings including elevations and complete wiring diagrams with wire and terminal numbers for local and remote terminations. Remote terminations may be submitted with the operational and maintenance information in lieu of the initial equipment submittals.

B. Provide operational and maintenance information as specified in Section 26 05 00.

1.5 RELATED SECTIONS

A. Section 26 33 00 - Static Un-Interruptible Power Supply

B. Section 26 09 13 – Control Devices

PART 2 - PRODUCTS

2.1 PROGRAMMABLE LOGIC CONTROLLER SYSTEM

A. The PLC system shall be Allen Bradley Micrologix 1400 Series. Provide hardware types as necessary to operate the system according to the design intent of the drawings.

2.2 PLC ENCLOSURE AND ACCESSORIES

A. PLC Enclosure and Accessories: The PLC enclosure shall house the power supplies, PLC processor, analog input and output modules, discrete input and output modules, communication module, operator interface terminal (OIT), UPS, thermostatically controlled vent fan and louvers, heater with thermostat, light with integral door switch, relays, terminal blocks, and ancillary components. In addition, provide 25% spare back panel space and space for additional cards as indicated. The PLC shall be equipped with the following accessories, at a minimum:

1. Enclosure: The PLC shall be housed in a NEMA type 12 enclosure with a lockable 3-point latch.
2. Redundant Power Supplies: Power supply hardware shall include a PLC power supply and redundant 24VDC power supplies as required for Inputs and Outputs (I/O). The redundant power supplies shall be 100 watt, minimum.
3. Fusing: Individual I/O loops shall be individually fused. Fuse holders shall be indicating type.

4. I/O Terminal Blocks: Field wiring DIN rail type terminal blocks. 25% spare terminal blocks shall be provided. Discrete and analog I/O terminals shall be segregated by I/O type.
5. Plastic Snap-On Cover Wire Management Systems: These shall be sized to accommodate all wiring with 25% spare capacity.
6. UPS System: A panel mounted UPS shall be included in each PLC cabinet. The UPS's shall be sized to provide at least 30 minutes of run time for the PLC and all system I/O. UPS systems shall be as specified elsewhere.
7. Transient Voltage Surge Suppression (TVSS): The TVSS system shall protect all power wiring within the PLC enclosure.
8. Outlet: A 20 amp, 120 volt duplex grounded power outlet shall be mounted within the PLC enclosure.
9. Ground Terminals: A screw type bonding terminal strip to which all ground bonding shall take place for all signal reference, TVSS, safety bonding etc. This grounding terminal shall accept a #6 copper ground bonding conductor. 25% spare terminals shall be provided.
10. Enclosure Labeling: The enclosure shall carry a phonetic label indicating the enclosure name, label all pilot devices on the swing out panel, and label all I/O termination modules, relays, power supplies, etc. Internal wiring shall be labeled at each terminal and each terminal shall be labeled, all labeling names and/or numbers shall be reflected on the panel fabrication drawings.
11. Separate Power Warning Signs: The enclosure shall receive power from external sources and shall be labeled with the source of where the external power is derived. Each circuit providing power to the cabinet shall be indicated.

B. Operator Interface Terminal (OIT): The OIT is owner-provided.

2.3 INPUT/OUTPUT MODULES

A. Analog transmitters and receivers have 4 to 20 mA signals. Discrete (on/off) inputs (DI) originate from dry contacts. For discrete outputs (DO), provide interposing relays with dry contacts. Refer to the PLC Input / Output Point List, Appendix A, for required inputs and outputs.

B. The discrete input modules shall be 24VDC.

C. The discrete output modules shall be isolated relay contacts suitable for operating interposing relays. Each discrete output module shall include fuses and fuse blown indicators.

D. The analog input (AI) modules shall be suitable for accepting 4 to 20 mA from 2, 3, or 4 wire transmitters. The input power shall be from an internal or external 24-volt dc power supply. The analog to digital converter shall have a 10-bit minimum resolution with an overall accuracy of + .5% at 60ºC.

E. The analog output (AO) modules shall be 4 to 20 mA signals suitable for driving into a 0 to 600 ohm load without load adjustments. The digital to analog converter shall have a 10 bit minimum resolution with an overall accuracy of + 2% to 60ºC. The output power shall be from an internal or external, 24 volt dc power supply provided by the SUPPLIER. If the PLC processor fails, the analog outputs shall drop to zero-scale (4mA).

F. Discrete PLC I/O modules shall have individual LED status lights for each I/O point. All discrete and analog modules shall have terminal blocks for termination of the I/O wires. Individual I/O points shall be capable of withstanding low energy common mode transients to 1,500 volts.

2.6 PLC START-UP

A. Each PLC shall have start-up software that causes automatic commencement of operation without human intervention, including start-up of all connected I/O functions. A restart program based on detection of power failure shall be included in the software. Upon restoration of power, the program shall prepare the plant to run according to current inputs. If in auto, those processes will restart if current states permit restarting. The start-up software shall initiate operation of self-test diagnostic routines. If the data base and application software are no longer resident or if the clock cannot be read, the PLC shall not restart and systems shall remain in the failure mode indicated until the necessary repairs are made.

B. Programming software for the PLC shall be provided by the CONTRACTOR. The programming of the PLC shall be performed by the CONTRACTOR. All loop testing and debugging shall be performed by the Contractor and electrician.

PART 3 - EXECUTION

3.1 PANEL FABRICATION

A. Install each item in accordance with manufacturer's recommendations and in accordance with the Contract Documents.

B. The panel shall be fabricated and UL Listed as an assembly by a qualified panel shop.

3.2 OWNER TRAINING

A. Provide the services of a factory trained, manufacturer’s representative for instruction of the OWNER’s personnel. The training shall include basic PLC and OIT operation overview, I/O module normal and fault condition indications, and equipment maintenance, troubleshooting, and replacement.

B. The operation and maintenance manuals shall be included as a part of the instruction to the OWNER’s personnel. Refer to Section 01 34 00 for operation and maintenance data requirements.

C. Refer to Section 01 34 00 for additional training requirements.

END OF SECTION

SECTION 40 12 50 - PRESSURE TRANSMITTER

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall install the pressure transmitters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 40 10 00 – Process Control and Information Systems

B. Section 40 20 00 – Instruments, General

PART 2 - PRODUCTS

2.1 PRESSURE TRANSMITTERS

A. Gauge Pressure Transmitters

1. Contractor shall provide Rosemount 2088 Pressure Transducer No. 2088G2S22A1B4M5DW (which is 0 to 150 psi rating).
2. Power supply will be 24VDC, powered from PLC panel power supply. Process connection shall be 1/2-inch female NPT flange adapter. Signal output will be 4 to 20 mA.

PART 3 - EXECUTION

3.1 REQUIREMENTS

A. Refer to Section 40 20 00.

END OF SECTION

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. This section includes the process control strategies for this Contract. Together with the process input/output schedule, the equipment specifications (including control strategies for local equipment control panels), and the Drawings, the process control strategies describe the required operation, monitoring, and control of the facilities included in this Contract. The Contractor shall provide all equipment, and services necessary to implement all functions described herein.

B. The Contractor shall be responsible for furnishing functioning systems as described herein. The functional descriptions contain requirements for furnishing and installing labor and materials that may not appear elsewhere in the contract documents.

1.2 GENERAL DESIGN INFORMATION

A. Indicator lights on all MCCs, control panels, starter enclosures, interfaces, etc. shall conform to the following color convention:

Condition	Color
Running/Open	Green
Auto	White
Ready / Stopped / Off / Closed	Red
Fail	Amber
Alarm	Amber
Generic Status	Blue or White

B. Running status shall be provided from auxiliary contacts provided with the motor starter. Auto status shall be defined as HOA or OA switch in Auto position. Ready status shall be defined as in remote or auto mode with all interlocks satisfied (no failure conditions present). Stopped and Off status shall be defined as all interlocks satisfied (no failure conditions present), except for no remote or auto mode. Failed status shall be defined as motor overload and/or any other shutdown mode such as over torque, over temperature, low oil pressure, high vibration, etc.

C. A discrepancy failure shall be indicated through the control system for any drive, motor, instrument, etc. that should be running or providing a reading but for which the PLC is not receiving a run status signal or valid reading. An example is a motor which is commanded to run by the control system but is not subsequently detected as running. An adjustable time delay shall be provided for each motor to allow time for the motor to start and satisfy all interlocks.

D. Manual start/stop, open/close, speed/position adjustment, etc., from the Operator work stations shall be provided for all equipment controlled by the control system.

E. Where devices such as temperature, moisture, and/or vibration sensors, over- or under-pressure protection, space heaters, etc. are provided with process equipment and their associated motors under the various sections of Division 11, the Contractor shall provided all required interconnecting wiring between those devices and their

associated MCCs, motor starters, VFDs, local control panels, etc.

F. Where setpoints, operating limits, and other control settings are provided by the process control strategies, these settings shall be initial settings only and shall be used for assistance in the initial startup of the plant. All such settings shall be fully adjustable, and based on actual operating conditions, the Contractor shall make all necessary adjustments to provide smooth, stable operation.

G. The control system shall be capable of receiving inputs of initial run-times for existing and proposed equipment. Initial run-time shall not automatically assumed to be zero.

H. All PLC control strategies shall return to a normal control mode upon restoration of power.

I. All setpoint control shall be by PID control algorithms. Where only proportional control is specified, tuning constants shall be used to reduce the integral and derivative functions to zero. All PLC-controlled variable speed equipment shall be provided with individual speed control PID modules in the PLC which shall be cascaded with the overall setpoint PID modules as required. All setpoints, sequence timers, sequence orders, dead bands, PID tuning parameters, PLC delay timers, variable speed operating range limits, and similar control constants shall be accessible and alterable from the Operator work stations.

J. All setpoints, alarms, etc. based upon an analog input signal or field variable shall be provided with time delays and dead bands to prevent nuisance tripping of controls and alarms.

K. Elapsed run time shall be determined through an auxiliary contract on the starter which is an input to the PLC.

1. Elapsed run time shall be displayed at the SCADA level for each and every motor controlled through the PLC system.

2. Individual elapsed run time accumulation may be reset by the operator after entering a password if the proper security level is associated with said password.

3. Elapsed run time shall be displayed as 99,999.9 hours after which the elapsed run time registers shall recycle to 0.0 hours.

4. Provisions shall be made to allow the operator to enter a start value for runtime accumulation.

5. Elapsed run time shall be accumulated and stored in PLC registers and not in the SCADA system.

L. PID control algorithms.

1. PID control algorithms shall have operator selectable slew rates for setpoints that will allow the setpoint to slowly ramp to its final value in order to minimize system disturbance.

    a. Individual setpoint slew rates shall be set at a local HMI if available as well as through the SCADA system.

2. Each PID control algorithm shall have a face plate associated with the individual PID control algorithm that shall be displayed at its associated HMI and at the SCADA terminal. Said face plate shall have the following functions:

    a. Display Output, CV.

b. Display Setpoint, SP.

c. Display Process Variable, PV.

d. Allow for operator selection of Automatic or Manual control of Output.

e. Under manual control of output allow the Operator to enter the desired output value.

f. Allow for input of the three PID tuning parameters.

M. Programmable settling and proving timers shall be provided in all control sequences for starting and stopping of pumps, in order to let the process settle down before proceeding with any additional control functions.

1. These timers shall be imbedded in the PLC logic, tuned in the field, and listed separately as part of the software submittal and O & M manual.

N. Status indication:

1. The associated pilot light, HMI display, and SCADA display for each valve and pump shall indicate valve or slide gate position if available by constantly illuminating the corresponding status indication and report this condition to the SCADA system.

2. As previously described a fault condition shall flash the associated status indicator and alarm within the SCADA system.

3. When a valve is in transition, not fully closed and not fully opened, then the valve open and valve closed status indicator shall:

a. For HMI and graphic displays state that the valve is in transition.

b. For pilot lights shall alternately flash on and off the valve fully opened and fully closed pilot lights.

O. When setpoints or actions are identified to occur on more than one HMI, or both the HMIs and SCADA, the last action or setpoint shall override the current condition, unless otherwise noted.

P. Control software and/or hardware shall be so configured and designed as to monitor for loss of analog signal (signal <4 mA), analog signal too large (signal > 20 mA), or rate of signal change too fast (individual rate parameter for each analog input signal to be imbedded in software), when any of these conditions are detected the control system shall alarm this condition, and close the appropriate valve and or stop the appropriate motor in order to prevent the process from running away.

Q. The manual control mode shall be completely manual and under the operator control, there shall be no programmed interlocks requiring completion of a previous step before operating a device, unless specifically identified in the individual loop descriptions as occurring in the manual mode.

R. Number of starts shall be accumulated for each motor.

1. The number of starts for the current day shall be moved into a register and held as the previous day's number of starts at 0:01 hours each day.

2. The number of starts for the current day shall be entered into the historical data base time and date stamped at 0:01 hours each day.

3. The current day number of starts shall be reset at 0:01 hours each day.

S. Alarm/Fault Indication/Acknowledgement

1. Furnish an alarm acknowledgement pushbutton at each VCP, HMI, or LCP that shall signal the PLC that an alarm or fail condition has been acknowledged. This device shall only affect the alarms that are present on the panel where the device is located.

2. In general any fault condition shall flash the appropriate pilot light and/or graphic at a rate of on for 0.5 seconds and then off for 0.5 seconds.

3. The individual alarm acknowledgement pushbutton or action shall function as follows:

    a. Shall change the flashing alarm indication to continuously ON if the alarm or fail condition persists after the acknowledgement button or action has been depressed.

    b. Shall turn OFF the alarm indication if the alarm or fail condition has been corrected and the alarming system has returned to normal.

4. An alarm beacon and horn shall be located as needed.

    a. The alarm silence pushbutton or HMI command shall silence the horn but continue to show the visual alarm.

5. All alarm and fail conditions shall flash their respective pilot lights, indicators, HMI, or SCADA graphics, until the condition is acknowledged by the operator.

    a. Once the operator acknowledges the alarm or fail condition the pilot light, indicator, HMI, or SCADA graphic shall remain ON in a steady condition.

    b. Once the alarm has been cleared and the operator again acknowledges the alarm or fail condition the pilot light, indicator, HMI, or SCADA graphic shall turn OFF.

6. All valves, pumps, motors, and other process equipment shall have fail alarms displayed and reported at the HMI and SCADA level.

T. Tank and vessel levels.

1. All tank and vessels levels shall be displayed both in feet (XX.XX) and gallons, whether or not specifically identified in the P & IDs or Loop descriptions.

2. All identified tanks and/or vessels that have a level measurement shall include, whether or not identified, the following minimum functions that shall be displayed on the associated HMI and SCADA System.

    a. Numerical readout of process material level in the tank.

    b. Setpoint for high level and high level alarm

    c. Setpoint for low level and low level alarm.

    d. Setpoints for high level and low level shall be entered as a level or volume as directed by the ENGINEER.

U. Power failure.

1. The control system upon sensing a power failure shall store, within, the

PLC memory the current accumulation of all time records and flow totals and as necessary, the status of all devices, i.e. ON or OFF, to allow a return to normal operating condition.

V. PLC System Status

1. There shall be a minimum of one screen that shall include the status of all PLCs in the system and the status of the PLC communications LAN.
2. The PLC shall monitor communications status with equipment including with heartbeat status and alarm on communications failure.

W. Analog device calibration override.

1. Provide a SCADA screen for each and every analog input that allows the Operator to access said analog input to:
    a. Disable the analog input in the PLC control system.
    b. Enter a value for the analog input from the SCADA system to the PLC.
    c. Hold the last analog input value while the actual analog input is disabled.
2. Provide a SCADA screen for each and every analog output that allows the Operator to access said analog input to:
    a. Force an output value entered from the SCADA system to the PLC.
    b. Hold the last analog output value while the programmed output is disabled.

PART 2 – PRODUCTS

2.1 CONTROL DESCRIPTION

The drinking water system for the purposes of this project consists of a well pump that draws water from a well into a tank, and a booster pump that pumps water from the tank at line pressure to the drinking water system. There is a chlorination generation skid that generates sodium hypochlorite and correctly doses the right amount of chlorine into the egress line. Not within the scope of this project is an existing fluoride injection station that will continue to run unchanged.

Under normal operation, the well pump controls to a desired flow setpoint, and the booster pump controls to maintain constant level in the tank.

WELL STARTUP SEQUENCE
The Well startup sequence begins when the control switch is set to Auto. The pre-lube water solenoid opens the solenoid and upon detection of flow from both the flow switch and the lube water flow meter, begins a 10 minute timer. If there is no flow detected within a set time, an alarm is generated. Note that the pre-lube water solenoid is fail open on loss of power or signal.

During the pre-lube cycle, the system prepares for a flush by closing the tank valve and opening the flush valve.

Once the 10 minute pre-lube cycle is complete and the valves are detected to be in the correct

position for a flush, the VFD to the Well Pump is commanded to run. The VFD and controller shall be set to deliver a water at a speed of 2 ft/minute within the first 2 seconds of starting. The pre-lube water continues to be delivered for the first 1 minute of runtime.

The flow valve is used to modulate the VFD speed to maintain the Flushing Flow Setpoint. The controller will be designed to prevent wind-up of the controller until the flow rate can be detected. There may be a process delay from the point in time the pump starts to the time the flow is sensed in the flow meter. During that time, the controller will command a speed equal to the anticipated speed necessary to obtain the flushing flow setpoint. Standard PID control will be resumed when a flow is detected in the meter. If no flow is detected within a time delay, there will be an alarm and shutdown of the well pump.

The flushing cycle will continue for 10 minutes, at which time, the flow setpoint will be changed to the normal water delivery flow setpoint. The flushing valve will begin to close and the tank valve will begin to open at the same time. The VFD speed will be adjusted by the controller to maintain the normal water delivery flow setpoint.

The controller speed setpoint to the VFD will be calibrated in the VFD so that 4mA will correspond to the minimum acceptable VFD speed, and 20mA will be the maximum acceptable VFD speed. This will be field-verified as to the minimum and maximum speeds. The VFD will not interpret 4mA as a zero speed, and 20mA as a maximum speed, but will rather function as aforementioned.

WELL PERMISSIVES

The Well Pump will shut down and/or not allow startup for any of the following conditions:

- High discharge pressure as detected by the high discharge pressure switch, or the discharge pressure transmitter reading a high signal. The discharge pressure transmitter alarm will have a time delay adjustable in the system. The high discharge pressure switch will either be selected by hardware to be properly delayed and debounced for momentary high pressures during startup, or if it does not have the capability, then the controller will provide the appropriate debounce delay. This condition will lock in the shutdown and require a reset to resume operation of the pump.
- Low-Low well level will shut down the pump. This condition will lock in the shutdown and require a reset to resume operation of the pump. An alarm will register for a Low well level.
- High motor temperature will shut down the pump. This condition will lock in the shutdown and require a reset to resume operation of the pump.
- VFD Failure will shut down the pump. This condition will lock in the shutdown and require a reset to resume operation of the pump.
- Low water flow as measured by the well pump discharge flowmeter will shut down the pump.
- Pre-lube failure will prevent startup of the pump. This condition will lock out the permissive and require a reset to resume operation of the pump. Upon resuming, the startup sequence restarts from the beginning requiring the full 10 minute timer to elapse before starting the pumps.
- Failure of the valves to be in the correct position for the current cycle (flushing or normal) will on a time delay prevent startup or cause a shutdown of the pump. This condition will lock out the permissive and/or lock in the shutdown and require a reset to resume operation of the pump.
- The operator places the control hand switch in the OFF position. This switch will electrically drop the run command to the VFD. The controller will also detect that the hand switch is not in AUTO and drop the run command in the controller.
- The HMI will have the capability to cause an Emergency Stop or a stop command.

WELL SHUTDOWN SEQUENCE
The run command to the VFD will simply drop and cut power to the pump which will stop on its own with mechanical ratcheting. All tank valves will remain in their current position.

WELL COOLDOWN SEQUENCE
The Well pump shall not be permitted to restart until 10 minutes have gone by following a shutdown, with a maximum number of starts being limited to 4 per hour.

CHLORINE DOSING
The Chlorine dosing enable will be off until the flow rate sensed by the booster pump flow meter is above a minimum flow, and the pump is commanded to run and is sensed running and the system valve is commanded to be open and is sensed to not be in the closed position.

The Chlorine dosing rate from the PLC will be calculated from the Flow rate of the flow meter. Any case causing the dosing enable to drop will also set the dosing rate analog command to a zero dosing rate.

END OF SECTION

SECTION 40 20 00 - INSTRUMENTS GENERAL

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and place in operation process instrumentation (flow elements, level transmitters, etc.) as scheduled herein together with all signal converters, transmitters, isolators, amplifiers, etc. to interface with all instrumentation, panels, controls, and process equipment control panels with the process control system as shown on the Drawings and as specified. Mounting of associated transmitters, indicators, power supplies, brackets, and appurtenances shall be provided as specified herein and shown on the Drawings.

B. It is the intent of this Specification and the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of the process instrumentation on process lines shall be provided under this Contract.

C. Taps and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. It is the Contractor's responsibility to ensure that the location, supports, orientation, and dimensions of the connections and taps for instrumentation as such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage, and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 40 10 00 – Process Control and Instrumentation Systems

B. Division 26.

1.3 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
API RP550	Manual on Installation of Refinery Instruments and Control Systems, Part I – Sections 1 Through 13
ISA S20	Specification Forms for Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ISA S51.1	Process Instrumentation Terminology

1.4 GENERAL INFORMATION AND DESCRIPTION

A. These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment furnished. They are, however, intended to cover the furnishing, the shop testing, the delivery, and complete installation and field testing of all instruments and appurtenances

whether specifically mentioned in the Specification or not.

B. The instruments shall be furnished and installed with all necessary accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not. The installations shall incorporate the highest standards for the type of service shown on the Drawings including loop testing of the entire installation and instruction of operating personnel in the care, operation, calibration, and maintenance of all instrumentation.

C. All instrumentation shall be of first class workmanship and shall be entirely designed and suitable for the intended services. All materials used in fabricating the equipment shall be new and undamaged.

PART 2 - PRODUCTS

2.1 GENERAL

A. All instrumentation supplied shall be the manufacturer's latest design. Unless otherwise specified, all instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings or as required.

B. Equipment installed in hazardous areas shall meet Class, Group, and Division as shown on the Drawings, to comply with the National Electric Code.

C. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure.

D. Unless otherwise shown or specified, local indicators shall be provided for all instruments. Where instruments are located in inaccessible locations, local indicators shall be provided and shall be mounted as specified in paragraph 3.1.B. All indicator readouts shall be linear in process units. Readouts of 0-100% shall not be acceptable, except for speed and valve position. Floating outputs shall be provided for all transmitters.

E. Unless otherwise specified, field instrument and power supply enclosures in corrosive environments shall be 316 stainless steel, fiberglass, or PVC coated copper free cast aluminum NEMA 4X construction.

F. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.

G. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture, and fungus. Solid-state components shall be conservatively rated for long term performance and dependability over ambient atmospheric fluctuations. Ambient conditions shall be –15 to 50 degrees C and 10 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid, and corrosive service conditions.

H. All devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models which are currently in production. All equipment provided, where applicable, shall be of modular construction and shall be capable of field expansion.

I. All non-loop powered instruments and equipment shall be designed to operate on a 60 Hz alternating current power source at a nominal 117 V, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with

the above shall be provided. Where equipment requires voltage reduction, constant voltage transformers shall be supplied.

J. All analog transmitter and controller outputs shall be isolated, 4-20 milliamps into a load of 0-750 ohms, unless specifically noted otherwise. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless specified otherwise.

K. Materials and equipment used shall be U.L. approved wherever such approved equipment and materials is available.

2.2 ACCESSORIES

A. Isolation Valves – Valves shall be full port ball valves with ASTM A276, Type 316 stainless steel trim and body and with Teflon seats and packing. Valves shall be Parker CPI, Whitey, Hoke, or equal.

B. Gage Valves – Gage valves shall be machined from ASTM A276 bar stock and shall be provided with 1/2-inch NPT connections and integral bleed valve. Valves shall be Anderson, Greenwood & Company M9530, Hoke 6801L8Y, or equal.

C. Root Valves – Root valves shall be ASTM A276, Type 316 stainless steel bar stock with 1/2-inch NPT male process connection and three 1/2-inch NPT female instrument connections. One instrument connection shall be provided with an ASTM A276, Type 316 stainless steel bleed valve. ASTM A276, Type 316 stainless steel plugs shall be provided for unused ports. Lagging type units shall be provided for insulated vessels and pipes. Root valves shall be Anderson, Greenwood & Company M5 AVS-44, Hoke 6802L8Y, or equal.

D. Manifolds – Manifolds shall be three-valve bar-stock type. Manifold body shall be machined from 316 stainless steel bar stock. Valves shall be globe configuration with 316 stainless steel ball seats and Teflon stem packing. Manifolds shall be designed for direct mounting to differential pressure transmitters in place of the flanges normally furnished. Fabricated manifolds or manifolds employing needle or soft seat valves are not acceptable. Purge taps, 1/8-inch NPT shall be furnished on manifolds where water purge is specified. Manifolds shall be Anderson Greenwood M4TVS, Hoke 8123F8Y, or equal.

E. Tubing – Instrument tubing between the process connection and instruments shall be 1/2-inch x 0.065-inch seamless annealed ASTM A269, Type 316 stainless steel. Tubing fittings shall be Type 316 stainless steel. Fittings shall be of the swage ferrule design and shall have components (nut, body and ferrule system) interchangeable with those of at least one other manufacturer. Flare and ball sleeve compression type are not acceptable. Fittings shall be Parker CPI, Crawford Swagelok, Hoke Gyrolok, or equal.

F. Chemical Seals

1. Diaphragm – Seal shall be the diaphragm type with flushing connection, Type 316 stainless steel body and Type 316L diaphragm unless otherwise specified. Seal shall be Mansfield and Green Type SG, Ashcroft Type 101, or equal.

2. Annular Ring – Seal shall be the in-line full stream captive sensing liquid type. Metallic wetted parts shall be Type 316 stainless steel. Flexible cylinder shall be Buna-N unless otherwise specified. Seals shall be rated 200 psig with not more than 5-inch WC hysteresis. Seals shall be Ronningen-Petter Iso-Ring, Red Valve series 40, or equal.

3. Fill Fluid – Chemical seals and associated instruments shall be factory filled as follows: Instrument side of seal, capillary tubing, and instrument shall be evacuated to an absolute pressure of 1.0 Torr or less; filled; and sealed. Unless otherwise specified, fill fluid shall be silicone oil, Dow Corning DC200, Syltherm 800, or equal.

G. Bushings and Thermowells – Bushings or thermowells shall comply with SAMA PMC17-10. Temperature taps shall be 1/2-inch NPT, and lagging extensions shall be provided on insulated vessels or pipes. Thermowells and bushings shall be machined from Type 316 stainless steel bar stock unless otherwise specified.

H. Purge Assemblies

1. Air – Air purge assembly shall consist of a constant-differential relay, needle valve, check valve and 0.2 to 2.0 scfh rotameter. Assembly shall be Moore Products 62VA, Fischer & Porter 10A3137N-3BR2110, or equal.

2. Water – Water purge assembly shall consist of a strainer, constant-differential regulator, needle valve, check valve, and 20 to 200 cc/m rotameter. Assembly shall be Moore Products 63BD4A, Fischer & Porter 10A3137N-53BR2110, or equal. Strainer shall be 155 micron wye-type, ASCO 8600A2, Crane, or equal.

2.3 POWERED INSTRUMENTS GENERAL REQUIREMENTS

A. Powered instruments are those instruments which require power (120 VAC or 24 VDC loop power) to operate. Each instrument includes an element or analyzer and a transmitter/controller.

B. Transmitters shall be 4 to 20 milliampere output two-wire type with operating power derived from the transmission circuit. Transmitter shall support an external load of 0 to 600 ohms or greater without requiring trimming resistors with a transmission circuit power supply of 24 volts. Transmitter output shall be galvanically isolated from the process and the transmitter case. Time constant of transmitters used for flow or pressure measurement, including level transmitters used for flow measurement, shall be adjustable from 0.5 to 5.0 seconds. Transmitter output shall increase with increasing measurement except where "reverse action" is specified in the instrument schedule.

C. Electrical parts of transmitter and/or primary element mechanisms shall, as a minimum be housed in enclosures meeting NEMA 250, Type 4 requirements. Where electrical mechanisms are located outdoors or in areas specified as corrosive, enclosures shall meet NEMA 250, Type 4X requirements.

D. Transmitters located outdoors shall be provided with surge protectors: Rosemount Model 470A, Taylor 1020FP, or equal.

E. Where two-wire transmitter is located in an area classified as hazardous, it shall be made safe by means of an intrinsic safety barrier. Intrinsic safety barriers for two-wire transmitters shall be of the active, isolating, loop powered type. Barrier shall be Measurement Technology LTD. type MT3042, Stahl 9005/01-252/100/00, or equal.

F. Where four-wire transmitters are permitted, they shall be provided with a loop powered signal current isolator connected in the output signal circuit. Isolator shall provide galvanic isolation of milliampere transmission signals from transmitters with inadequately isolated output circuits. Isolator shall be housed in a NEMA 250, type 4/7 conduit body and shall derive its operating power from the signal input circuit. Input and output signals shall be 4 to 20 milliamperes, and error shall not exceed 0.1 percent of span. Input resistance shall not exceed 550 ohms with an output load of 250 ohms. Isolator shall be Moore Industries SCX/4-20MA/ 4-20/MA/6.5DC/-RF(EX).

2.4 PROCESS SWITCHES GENERAL REQUIREMENTS

A. Contact outputs used for alarm actuation shall be ordinarily closed and shall open to initiate the alarm. Contact outputs used to control equipment shall be ordinarily open and shall close to start the equipment. Contacts monitored by solid state equipment such as

programmable controllers or annunciators shall be hermetically sealed and designed for switching currents from 20 to 100 mA at 24 volts DC. Contacts monitored by electromagnetic devices such as mechanical relays shall be rated NEMA ICS 2, designation B300. Double barriers shall be provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures. Switch electrical enclosures shall be rated NEMA 250, type 4 minimum. Contacts in Class 1, Division 1 areas and monitored by solid-state circuits shall be made safe by suitable intrinsic safety barriers as specified in Section 26 09 13.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General – Equipment shall be located so that it is accessible for operation and maintenance. Electrical work shall be performed in compliance with all applicable local codes and practices. Where these specifications and the Drawings do not delineate precise installation procedures, API RP550 shall be used as a guide to installation procedures.

B. Equipment Mounting and Support

1. Field equipment shall be wall mounted or mounted on two-inch diameter aluminum pipe stands welded to a 10-inch square, ½-inch thick aluminum steel baseplate. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than ½-inch by use of phenolic spacers. Expansion shields in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.
2. Embedded pipe supports and sleeves shall be schedule 40, 304 stainless steel pipe, with stainless steel blind flange for equipment mounting as shown on the Drawings.
3. Materials for miscellaneous mounting brackets and supports shall be 304 stainless steel.
4. Pipe stands, mounting brackets, and supports shall comply with the requirements of Division 5.
5. Where transmitters are supported from process piping, leveling saddles shall be provided. Transmitters shall be oriented such that output indicators are readily visible.

C. Control and Signal Wiring – Electrical, control, and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid-tight flexible conduit. Conduit seals shall be provided where conduits pass from classified to unclassified areas.

3.2 CLEANING AND ADJUSTMENT

A. General

1. The Contractor shall comply with the requirements of Division 1 and all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation and controls provided under this Contract and specified herein. The Engineer, or his designated representative(s), reserve the right to witness any test, inspection, calibration, or start-up activity. Acceptance by the Engineer of any plan, report, or documentation relating to any testing or commissioning activity specified herein shall not relieve the Contractor of his responsibility for meeting all specified requirements.

. The Contractor shall provide the services of factory trained technicians, tools, and equipment to field calibrate, test, inspect, and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provided all personnel, equipment, and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

B. Field Instrument Calibration Requirements

1. Each instrument shall be calibrated at 0, 25, 50, 75, and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracies as set forth by the National Bureau of Standards.
2. The Contractor shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures, name of person performing the calibration, listing of published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required, and corrections made.
3. If doubt exists as to the correct method for calibrating or checking calibration of an instrument, the manufacturer's recommendations shall be used as an acceptable standard, subject to approval of the Engineer.
4. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices being subjected to overvoltages, incorrect voltages, overpressures, or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.
5. Upon completion of instrumentation installation, the Contractor shall perform a loop check. The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.

END OF SECTION

SECTION 40 21 20 - MAGNETIC FLOW METERS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall install the magnetic flowmeter systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 40 10 00 - Process Control and Information Systems
B. Section 40 91 23 - Misc Properties Measurement Devices (paragraphs 2.2, 2.3)
C. Section 46 31 12 - Fluoride Chemical Process System (paragraph 2.10)
D. See Sht C-8, Equipment Schedule Item 258, meter required upstream of chlorine pump

PART 2 - PRODUCTS

2.1 MAGNETIC FLOWMETERS

A. Contractor shall provide flow meters and flow transmitters.

PART 3 - EXECUTION

3.1 REQUIREMENTS

A. Refer to Section 40 20 00.

END OF SECTION

SECTION 40 24 10 - ULTRASONIC LEVEL MEASUREMENT

PART 1 -

1.1 REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the

Ultrasonic level sensor and transmitter systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 40 10 00-Process Control and Information Systems

B. Section 40 20 00-Instruments, General

PART 2 - PRODUCTS

2.1 ULTRASONIC LEVEL SENSORS/WITH REMOTE DISPLAY/TRANSMITTERS

A. The ultrasonic level transmitter shall be of the non-contact microprocessor based type for the continuous measurement of liquid levels.

B. The unit shall be a two piece transmitter/display meter and transducer with interconnecting cables.

C. The transmitter shall store the ultrasonic profile in the computer memory and moment by moment, analyze the profile to determine the actual liquid level.

D. All program data shall be safeguarded internally in non-volatile EEPROM memory.

E. The transducer shall be encapsulated and shall be capable of:

1. Accuracy of ± 0.25% of range.
2. Range 0.8 to 26.2 feet.
3. Provide for flange mounting, or provide wall mounted mounting bracket as detailed on the drawings.
4. With integral temperature compensation.
5. The unit shall utilize a narrow beam ultrasonic transducer which is rated Class 1 Division 1, explosion proof. The unit shall be provided with factory fabricated lead cable integral to sensor unit and shall extend to the meter unit within the electrical room.

F. The control transmitter shall be in a NEMA 4X enclosure with an integral from panel

mounted meter indicating in scaled engineering units.

1. The unit shall provide a 4-20 mA analog output signal directly proportional to level, driven from the PLC and its associated power supplies.

2. The unit shall be capable of displaying by software selection:
    a. Distance to liquid surface from transmitter.
3. The unit shall contain four relays for use as programmable alarm points.

4. Power requirements shall be 120 VAC
5. 4-20 mA output into 750 Ohms at 24 VDC.
6. Selectable damping 1 to 10 m/min.
7. 4 button HMI, wall mounted controller allowing for programming from the panel face, including blanking distances and obstruction blanking.

G. The programming unit shall be incorporated into the body of the instrument.

H. Operating temperature range -40º to 60° C.

I. Mount transducer with non-metallic mounting only.

J. Hart Protocol.

K. Three wire extended range.

L. As manufactured by:

1. The system shall be Siemens Hydroranger LT500 with LR100 or LR110 level transducer. The Hyrdroranger shall include accessories for ethernet communication.

PART 3 -

3.1 REQUIREMENTS

A. Refer to section 40 20 00.

B. Transducers shall be provided with flange mounting options. Mount to flanged support rigidly attached to wall or concrete square and plumb to building. Sensor shall be mounted to avoid all signal interferences.

END OF SECTION

SECTION 40 27 60 - PRESSURE SWITCHES AND SEALS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the pressure switches and seals with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 MANUFACTURERS

A. Section 40 10 00 – Process Control and information Systems

B. Section 40 20 00 – Instruments, General

PART 2 - PRODUCTS

2.1 Pressure Instrumentation

A. Seals

1. All pressure switches and/or transmitters need not be provided with seals.
2. Pressure switches, gages, and/or transmitters and seals shall be assembled and oil filled at the factory prior to shipment. Filling fluid shall be compatible with piping contents and temperature.
3. Pressure switches and/or transducers attached to systems involving chemical solutions, corrosive fluids, or other liquids containing one percent or more of solids, shall be equipped with diaphragm or annular seals whether shown or not on the drawings, or equal protective pressure sensing devices, as follows:

a) Clear process water applications:

1. Type 316 stainless steel for pressures over 15 psi.
2. Elastomer for pressures of 15 psi and below.
3. Type 316 stainless steel nuts and bolts, fill connection and valved flush port size of ¼-inch NPT, capable of disassembly without loss of filler fluid.
4. As manufactured by:
   a) Ashcroft Type 101
   b) Or prior approved equal.

b) For chemical solutions, sludge, etc., where breakage does not create major shutdown:

1. Seals with PVC body for removable mounting rated at 200 psi.
2. Type 316 stainless steel bolts and nuts
3. ½-inch inlet

4. ¼-inch outlet

5. Liquid-filled with Teflon diaphragm for pressure.

6. Elastomer diaphragm for vacuum service.

c) For sludge, liquids containing solids, pulsating flow:

1. Pressure instrument protectors shall be of the isolation ring type seal with integral instrument removal device.

2. Construction

a. Unit consists of a body, 360 degree flexible elastomeric cylinder with positive O-ring type sealing arrangement, captive fill fluid and two assembly flanges.

b. Includes integral instrument removal device to remove instrumentation without interrupting process flow. The isolation ring I.D. shall match the pipeline I.D. The isolation ring O.D. shall not exceed the I.D. of the piping flange bolt circle. Units are designed to fit 135#, 150# and 300# ANSI piping flanges.

3. Materials

a) Body is 316 Stainless Steel unless otherwise required. Two assembly flanges are 316 S.S. Flexible elastomeric cylinder is Silicone. Captive sensing liquid is glycerin, Silicone or Halocarbon as required for the piped fluid.

4. As manufactured by:

a) Ashcroft Type 80, 81.

b) Prior Approved Equal.

2.2 Pressure Switches High

a) General:

1) Enclosure NEMA 4X

2) Manual Reset trip on increasing pressure

3) DPDT

4) Actuator Seal: Teflon

5) Each pressure switch shall have visible scale and contact operation.

b) Pressure switches shall have a contact rating of 10 amperes at 125 VAC.

c) Pressure switches shall be snap-action switches and shall be in general-purpose enclosures at indoor installations, or weatherproof enclosures at outdoor installations.

d) Diaphragm seals shall be provided and included at the locations shown.

e) Automatic reset

g) Standard Ranges:

1) 10” H20, Proof psi 20, Burst psi 35

2) 30” H20, Proof psi 20, Burst psi 35

3) 60” H20, Proof psi 20, Burst psi 35

4) 100” H20, Proof psi 20, Burst psi 35

5) 150” H20, Proof psi 20, Burst psi 35

6) 15” H20, Proof psi 500, Burst psi 1000

7) 30” H20, Proof psi 500, Burst psi 1500

8) 60” H20, Proof psi 500, Burst psi 1500

9) 100” H20, Proof psi 1000, Burst psi 3000

10) 200” H20, Proof psi 1000, Burst psi 3000

11) 400” H20, Proof psi 2400, Burst psi 3000

12) 600” H20, Proof psi 2400, Burst psi 3000

h) As manufactured by:

13) Mercoid.

14) Or approved equal.

PART 3 - EXECUTION

3.1 REQUIREMENTS

A. See Section 40 20 00.

END OF SECTION

SECTION 40 91 20 - PRESSURE GAUGES

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place into satisfactory operation the pressure gauges and seals with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.2 RELATED SPECIFICATION SECTIONS

A. Section 40 10 00 – Process Control and information Systems

B. Section 40 20 00 – Instruments, General

C. Section 40 27 60 – Pressure Switches and Seals

1.3 SUBMITTALS

A. Furnish complete submittals in accordance with Section 01 30 00.

B. Product Data

1. Complete manufacturer's brochures; identify instrument construction, accuracy, ranges, materials and options.

2. Complete instrument data sheets, including catalog number and source for determining catalog number for all gauges and seals.

PART 1 - PRODUCTS

2.1 PRESSURE GAUGES MANUFACTURED UNITS

A. Pressure, Vacuum, Compound Gauges.

1. General

a. Furnish and install pressure and vacuum gauges as specified; complete, including all fittings, connections, gaskets, supports and accessories in the locations shown or specified, in accordance with the Contract Documents.

b. Pressure gauges shall be provided whether or not shown on the plans:

1) On discharge connection to all pumps.

2) In other locations as shown on the P&IDs and/or mechanical plans.

c. Sleeve pressure gauges

1) Shall be provided where shown on the plans.

2) Pressure shall be sensed by a flexible sleeve contained in a flanged cast iron or steel spool or wafer body, and transmitted to the gauge through a captive fluid.

3) Sleeve shall be of BUNA A and fabricated so as to isolate the body from the process liquid.

4) Gauges shall be calibrated to read in applicable units.

5) Accuracy of ±1% to 150% of the working pressure of the system to which they are connected.

2. Construction

a. Gauges shall be industrial quality type with Type 316 stainless steel movement.

b. Phenolic case.

c. Liquid filled.

d. Unless otherwise shown or specified, gauges shall have:

1) A 4 ½ inch dial.

2) ½ inch threaded connection.

3) Type pulsation dampener adapter.

a) Pulsation Dampener as manufactured by:

b) Cajon Co.

c) Weksler Instruments, Corp.

d) Ashcroft.

e) No equals.

4) A block and bleed valve – ½ inch national pipe thread process connection and bleed/calibrate valve between block valve and outlet port.

e. Gauges shall be calibrated to read in applicable engineering units.

f. Accuracy of ±0.5% to 150% of the working pressure or vacuum of the pipe or vessel to which they are connected.

g. All gauges shall be vibration and shock resistant.

3. Gauges general as manufactured by:

a. Ashcroft Industrial Instruments (Dresser). With Plus Performance.

b. Forboro/Jordan, Inc. Equivalent model

4. Gauges sleeve pressure as manufactured by:

a. Red Valve Co., Inc.

b. Ronningen-Petter.

c. Onyx.

d. No Equal.

4. Pulsation dampeners as manufactured by:
    a. Cajon Co.
    b. Weksler Instruments, Corp.
    c. Ashcroft.
    d. No Equal.

2.2 ACCESSORIES

A. Gauges shall be liquid filled or have some equivalent technology.

2.3 SOURCE QUALITY CONTROL

A. All instruments and/or representative instruments shall be calibrated to in facilities and with instruments traceable to the National Bureau of Standards.
    1. Provide complete documentation covering the traceability of all calibration instruments.

PART 2 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures and temperatures and furnish instruments that are compatible with installed process condition.

3.2 PREPARATION

A. Coordinate the installation with all trades to ensure the mechanical system has all necessary appurtenances, weldolets, valves, orientation, etc. for proper installation of the instruments.

3.3 INSTALLATION

A. All instruments shall be installed in strict conformance with the manufacturer's recommendations.
    1. It is the CONTRACTOR's responsibility to install all instruments in conformance with manufacturer's recommendations.
    2. It is the CONTRACTOR's responsibility to notify the ENGINEER of any installation conditions that may be shown at variance with the manufacturer's recommendations.
3. Install two 2 –valve instrument manifolds for each gauge pressure transmitter.
4. Bolt 3 valve manifolds at non-flange diaphragm type differential pressure transmitters in place of standard flange adapters.
5. Install root valves at process taps except insertion elements.
6. Install gauge valves on process connections to instruments where multiple instruments are connected to one tap or where root valves are not readily accessible.
7. All gauges shall be installed with the face in the vertical position.
8. In strict accordance with the manufacturer's printed instructions.

9. At the locations shown on the drawings, when so shown.

10. Care shall be taken to minimize the effect of water hammer or vibrations on the gauges.

11. In extreme cases, and with the approval of the ENGINEER, gauges may be mounted independently, with flexible connectors.

3.4 FIELD QUALITY CONTROL

A. The Instrumentation and Control Systems Contractor shall calibrate all instruments in the field during the Calibration and Loop Validation Tests as identified in Section 40 10 00.

3.5 ADJUSTING

A. All instruments shall be field verified.

3.6 DEMONSTRATION

A. Performance of all instruments shall be demonstrated to the ENGINEER prior to commissioning.

3.7 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning.

The CONTRACTOR shall replace any instruments damaged prior to commissioning.

1. The ENGINEER shall be the sole party responsible for determining the corrective measures.

3.8 SCHEDULES

A. The following instrument data sheets are included as a guideline for the supply of the instruments. These sheets are not complete and the instrument selection shall be the CONTRACTOR's responsibility. Changes may be made to the instrument materials, ranges, etc. as part of the submittal review. The CONTRACTOR shall provide documented evidence for a differential, plus or minus, that results from these changes.

B. The CONTRACTOR shall supply complete instrument data sheets for each and every instrument and submit this information in accordance with paragraph 1.05 of this section.

1. Instrument data sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

SECTION 40 91 23
MISCELLANEOUS PROPERTIES MEASUREMENT DEVICES

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers the Work necessary to install a ready to use and tested process and analysis system. CONTRACTOR shall provide all components required for a complete and functional system.

1.2 RELATED WORK

A. Related Work in other sections includes, but is not limited to Section 01 33 00 Submittal Procedures. See also the following related Sections:

1. 40 10 00 Process Control and Instrumentation
2. 40 11 00 Programable Logic Controller
3. 40 12 50 Pressure Transmitter
4. 40 15 10 Process Control Strategies
5. 40 20 00 Instruments General
6. 40 21 20 Ultrasonic Level Measurement
7. 40 27 60 Pressure Switches and Seals
8. 40 91 20 Pressure Gauges

1.3 REFERENCES

A. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract. The publication is referred to in the text by basic designation only.

B. AMERICAN WATER WORKS ASSOCIATION (AWWA)

1. AWWA C 207 Steel Pipe Flanges for Waterworks Service—Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)
2. AWWA C 751 Magnetic Inductive Flowmeters

C. NSF INTERNATIONAL (NSF) / ANSI 61 Drinking Water System Components - Health Effects

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit catalog cuts on all process equipment including: switches, meters, sensors, or other items shown on Contract Drawings referencing each item by mark number. Information shall indicate manufacturer specification compliance and dimensional data.

C. CONTRACTOR shall supply operation and maintenance manuals for all process equipment.

1.5 WARRANTY

A. Manufacturer shall provide to OWNER written guarantee against defects in material or workmanship for a period of one (1) year.

1.6 DELIVERY AND STORAGE

A. All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants. Each system shall be factory calibrated and certified prior to delivery.

1.7 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for any systems. Full compensation for the system shall be considered as included in the contract unit or lump sum bid prices for the various items of the contract to which it relates.

1.8 QUALITY ASSURANCE

A. Equipment to be furnished under this section shall be the product of manufacturers regularly engaged in the design and manufacturing of this type of equipment. The manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving CONTRACTOR from responsibility for the proper installation and functionality of the work.

PART 2 PRODUCTS

2.1 GENERAL

A. Each process measurement system shall typically consist of a sensor and analyzer/transmitter. Where shown on the Contract Drawings, the analyzer/transmitter may be utilized for multiple sensors. When an analyzer/transmitter is used for multiple sensors, it shall be capable of displaying simultaneously each process measurement.

B. Each analyzer/transmitter shall be equipped with a means to transmit process measurement data to the plant SCADA system.

1. For hardwired signals, unless indicated otherwise on Contract Drawings, provide the following:
   a. 4-20 mA output signals for each process measurement (for up to 500 Ohm loads).
   b. Two programmable SPDT relay outputs, rated at 5A up to 230 VAC, for each process measurement.

2. Where shown on the Contract Drawings, provide the following digital communications to the plant SCADA system:

a. HART Protocol
b. PROFIBUS
c. MODBUS

C. Each analyzer/transmitter shall be powered by 115VAC (+/- 10%) at 60 Hz unless shown on Contract Drawings as being powered by 24 VDC (+/- 15%). Each analyzer/transmitter shall retain its programmable settings in non-volatile memory. Battery powered instruments, analyzer, or transmitters will not be accepted.

D. Each sensor and corresponding analyzer/transmitter shall be supplied as a complete and operable system. This includes all cabling, mounting hardware and fasteners. When installed outdoors, the analyzer/transmitter shall be protected from the sun such that direct sunlight will not shine on the display.

E. All analyzers/transmitters shall be waterproof and made from corrosion resistant materials.

F. All sensors to be immersed in liquids shall be rated for permanent submersion and shall be corrosion resistant.

2.2 MAGNETIC FLOW METERS

A. Magnetic flow meters shall be the low the low frequency induction type which produces a DC pulsed signal directly proportional to and linear with the flow rate. Liners shall be polyurethane. Flow meters shall be rated at 250 psi. Standard output shall be an analog 4-20 mA signal with a local indication from a liquid crystal display (LCD) reading in gallons per minute flow. The meter shall also have a totalizer (with pulsed output), and non-full pipe detection. Meters shall have a minimum of 2 self-cleaning electrodes. CONTRACTOR shall field verify length of cable for connection.

B. Flanged connections shall be constructed of Type 304 or Type 316 stainless steel with pressure ratings to match the connecting pipe.

C. Liner shall be polyurethane or PTFE and electrodes stainless steel suitable for potable water service. Liners and electrodes for service other than potable water shall be constructed of materials conforming to the manufacturer’s recommendation for the intended service.

D. Meter housing shall be rated for NEMA 6 for submersible operation.

E. Meters shall include grounding rings.

F. The transmitter shall have six digit LCD displays for flow rate, percent of span, and totalization; be capable of measuring flow in both directions; automatic range change; capability to convert DC pulse signal from the tube to a standardized 4 to 20 mA DC signal into a minimum of 700 ohms; self-diagnostics and automatic data checking, and a scaleable frequency output, 0 to 100 Hz.

G. The flow measuring system shall conform to the following:

1. Time constant: 0.5 to 1000 seconds; galvanic or optic isolation

2. Accuracy: 0.50 percent of flow rate from 10 to 100 percent full scale velocities over 3 feet per second.
3. Repeatability: 0.25 percent of full scale
4. Power consumption: 30 watts or less
5. Power requirements: 120 VAC, plus or minus 10 percent, unless indicated otherwise on the Contract Drawings. Battery powered flow meters will not be accepted.

H. Magnetic flow meters shall be **Proline Promag W400 by Endress+Hauser, or Engineer Approved equal by Siemens**, or approved equal.

2.3 FLUORIDE FLOW METER

A. See Section 46 31 12 Fluoride Chemical Process System.

2.4 HIGH PRESSURE SHUTOFF SWITCH

A. See Section 40 27 60, Pressure Switches and Seals. A high-pressure shutoff switch shall be installed on each pump discharge pipe as shown on Drawings, and shall be as specified in the Electrical Drawings. The switch setting shall be adjustable as specified on the drawings. The switch shall be rated for the pressure of the system where it is installed with a safety factor of 1.5.

2.5 PRESSURE TRANSMITTER

A. See Section 40 12 50, Pressure Transmitter. A pressure transmitter is required at well head. Other pressure transmitters are also shown on plans and / or called out in specified systems.

B. The pressure transmitter shall be an electronic pressure transducer tailored to the installation as shown on the drawings and suitable for the planned application. The system shall include a pressure transducer with integral diaphragm seal. The pressure transmitter shall operate on 24 VDC, and shall provide a 4-20 mA DC signal to the RTU panel. The loop signal shall measure the water pressure and have a 4-20 mA signal output. The pressure transmitter shall have a LCD display showing the pressure in “psi”. The pressure transmitter shall be coded “DW” for NSF drinking water certification. Pressure transmitters shall be **Rosemount Series 2088**, or approved equal.

2.6 PRESSURE GAGE

A. See Section 40 91 20, Pressure Gauges. Pressure gage shall be Ashcroft 1279 with Performance Plus and these features:

1. Engineered dampening media (EDM)
2. 1106 pulsation dampener
3. Range -15 psi to +200 psi

PART 3 EXECUTION

3.1 INSTALLATION

A. All equipment shall be mounted and installed as per manufacturer recommendations. Coordinate final location with ENGINEER.

3.2 FLOW METER FIELD CALIBRATION AND QUALITY CONTROL

A. Each instrument shall be tested before commissioning and ENGINEER shall witness the interface capability in the PLC control system and associated registers.

1. Each instrument shall provide direct programming capability through the PLC
2. Each instrument shall provide direct control of totalizer reset functions through PLC
3. Each instrument shall be supported with a device profile permitting direct integration in the PLC

B. ENGINEER shall witness all instrument verifications in the field.

C. Manufacturers Field Services shall be provided for start-up and commissioning by a Factory field service representative or a manufacturer's authorized service provider (ASP).

1. Manufacturer representative shall verify installation of all installed flow tubes and transmitters.
2. Manufacturer representative shall notify ENGINEER in writing of any problems or discrepancies and proposed solutions.
3. Manufacturer representative shall perform field verification at the time of installation for long-term analysis of device linearity, repeatability and electronics health. A comparative report shall be generated for each meter tested.
4. Manufacturer representative shall generate a configuration report for each meter
5. Meters shall be field calibrated to verify proper operation within the expected flow ranges for the project.

3.3 TESTING

A. After installation of the equipment is complete, operating tests shall be carried out to assure that the equipment operates properly. All piping shall be tested hydrostatically and for leaks. If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests shall be reconducted.

- END OF SECTION –

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SECTION 46 31 12
FLUORIDE CHEMICAL PROCESS SYSTEM

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers work to provide a complete, tested, and ready-to-use fluoride chemical process system. Provide all components required for a complete and functional system. Fluoride chemical process system shall comply with current US and international standards for fluoride chemical processes for drinking water systems.

1.2 RELATED WORK

A. Related Work in other Sections includes, but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 33 05 07.1 PVC Pressure Pipe ASTM D 1785
3. Section 33 05 11 HDPE Pressure Pipe C901, C906
4. Section 33 12 00 Mechanical Appurtenances
5. Section 40 91 23 Miscellaneous Properties Measurement Devices

1.3 REFERENCES

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only. Work covered by this Specification shall meet or exceed the provisions of the latest editions of the following Codes and Standards in effect at the time of award of the Contract.

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM B 16.3 Malleable Iron Threaded Fittings, Classes 150 and 300
2. ASTM B 88 Seamless Copper Water Tube
3. ASTM D 1784 Standard Specification for Rigid Polyvinyl Chloride Compound (PVC) Chlorinated Polyvinyl Chloride (CPVC) Compounds.
4. ASTM D 1785 Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
5. ASTM D 1998 Standard Specification for Polyethylene Upright Storage Tanks
6. ASTM D 2466 Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40
7. ASTM D 2564 Standard Specification for Solvent Cements for Polyvinyl Chloride (PVC) Plastic Piping Systems
8. ASTM F 441 Standard Specification For Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe, Schedules 40 And 80

C. AMERICAN WATER WORKS ASSOCIATION

1. AWWA B703 Standard for Fluorosilicic Acid
2. AWWA C800 Standard for Underground Service Line Valves and Fittings
3. AWWA C900 Standard for Polyvinyl Chloride (PVC) Pressure Pipe & Fabricated Fittings, 4 In. to 12 In., for Waster Distribution

4. AWWA C901 Polyethylene (PE) Pressure Pipe and Tubing, 3/4 in to 3 in for Water Service
5. AWWA M4 Water Fluoridation Principles & Practices
6. AWWA M23 PVC Pipe - Design and Installation
7. AWWD M55 PE Pipe - Design and Installation

D. INTERNATIONAL ASSOCIATION OF PLUMBING & MECHANICAL OFFICIALS (IAPMO)

E. INTERNATIONAL MECHANICAL CODE (IMC)

F. INTERNATION PLUMBING COED (IPC)

1.4 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit manufacturer's literature, installation instructions, product test reports and technical data. Submit manufacturer's certification that the proposed materials and equipment comply with this Section, including each applicable referenced standard.

C. Submit operation and maintenance manuals for all fluoride equipment.

1.5 WARRANTEE

A. Provide to OWNER written guarantee against defects in material or workmanship for a period of two (2) years.

1.6 DELIVERY AND STORAGE

A. Materials and equipment be delivered and stored in areas protected from the weather, sun, rain, snow, wind, humidity, heat, cold, temperature variation, dirt and dust, and shall not be allowed to become wet, soiled, or otherwise damaged.

B. Manufacturer's recommendations for handling storage and protection shall be strictly followed.

1.7 MEASUREMENT AND PAYMENT

A. There shall be no separate measurement and payment for the fluoride chemical system. Full compensation for the fluoride chemical system shall be considered as included in the contract unit or lump sum bid prices for the various items of the contract to which it relates.

PART 2 PRODUCTS

2.1 FLUORIDE SYSTEM

A. The fluoride system shall be complete with all piping and fittings as recommended by the manufacturer and as shown on the Drawings. Supply fire extinguishers designed for the plastics and chemicals in the fluoride system.

2.2 STORAGE TANKS: BULK AND DAY TANK

A. Tanks shall be of the manufacturer, type and size indicate in the Drawings.

B. The storage tank systems shall consist of a primary tank and a secondary containment tank. Manways and covers in the tank tops shall be made of crosslinked polyethylene and shall be fume tight. Tanks shall meet the requirements of ASTM D 1998, Type I: Tanks molded from cross linkable polyethylene. Tanks may be either dome or flat top

C. Resin Type

1. Resin used shall be 100% virgin, UV-stabilized, 35 mesh crosslinkable high density polyethylene.
2. Tanks shall have weatherability equal to that of PAXON grade 7004 natural.
3. Resins shall meet or exceed the following properties listed in Table 1, below.

TABLE 1 - RESIN PROPERTIES

Classification	ASTM Test	Nominal Value
Density	D1505	0.944 g/cm^3
Tensile strength at yeild	D638	3,000 psi
Elongation at Break	D638	400%
Tensile modulus of elasticity	D638	80,000 psi
Flexural modulus	D790	100,000 psi
Heat deflection temperature, 66 psi load	D648	138° F
Vicat softening temperature	D1525	248° F
Impact brittleness temperature	D746	<-180° F
Dart Impact (-40°F)	ARM Std.	120 ft. lb
Environmental stress crack Resistence	D1693	>1,000 hrs

D. Tank Design: Tank design standards shall meet the requirements of ASTM D 1998. Molded part lines shall be located above the lower 1/3 of the straight side wall of the tank. The inner tank wall shall yield gel test results of no less than 65%; entire wall thickness must be more than 80% gelled. Rotationally molded crosslinked polyethylene tanks shall have an uninterrupted bottom knuckle radius for maximum strength per design requirements in ASTM 1998.

E. Fittings shall be provided as shown on referenced drawings. All fittings shall be located away from the bottom knuckle radius. Fittings and gaskets must be chemically compatible with the materials to br handled in the tanks. All fittings shall terminate in socket, threaded or flanged connections. Flanges shall match 150 lb ANSI, all threaded plumbing

connections shall be standard American Pipe thread cut. Any fittings used on upper tank sidewall or top of tank may be PVC Bulkhead Fittings

F. Tanks shall have a leak detection system between the primary and secondary tank walls. The detection sensor shall be a DC Optic Leak Detection device as manufactured by Intellitank (or equal), capable of being connected to a PLC input.

G. Seismic restraint shall be supplied and the design for same certified by a licensed Structural Engineer. Design shall conform to the latest edition of the Uniform Building Code. Detailed instructions for installation shall be provided, along with all necessary hardware including anchor bolts. All components of the restraint system shall be protected against the chemical stored in the tank.

H. Tanks shall have a warranty for five (5) years to be free of defects in material and workmanship. The warranty shall fully cover the tank during the first 3 years of service and be prorated during the remaining two years of warranty period.

I. A appropriate height ladder if required shall be provided to access the top of the tank

J. Manufactures shall be one who is regularly engaged in the business of designing and fabricating crosslinked polyethylene storage tanks. Tanks shall be manufactured by Central California Container Mfg., Inc., Polyprocessing, or approved equal.

2.3 DOSING PUMPS – *POSITIVE DISPLACEMENT TYPE*

A. The chemical dosing pump shall be a chemical electronic metering pump designed for fluoridation. Pumps shall be rated for an maximun feed rate as noted on the drawings or specified herein. Pumps shall be capable of manual adjustment and instrument responsive external control for an automatic system. Pumps shall be capable of injection to a system pressure of 250 psi or as noted on the drawings. Pumps shall have anti-siphon valves and pressure relief.

B. Pumps shall be rated for 120 VAC, with a non standard plug (twist lock) for electrical service. Duty cycle shall be continuous.

C. Pumps shall be *positive displacement, Liquifram type pumps wit NEMA 4X/IP-65 enclosure, and meet IP-68 standards with max capacity of 0.25 GPH (6.0 GPD), and capable of injecting fluoride solutions into piping with up to 250 psi pressure.* Pump “liquid end” materials shall be as follows: housing (glass fiber reinforced thermoplastic); head (acrylic); fittings (PVDF); balls (Teflon); seats and o-rings (polyprel); head screws (stainless steel). Provide petroleum jelly to cover stainless steel screws so they don’t corrode in fluorine gas.

D. *Pump shall be LMI* AD21 1919SI, or approved equal.

2.4 DOSING PUMPS – PERISTALTIC TYPE (not used)

A. The chemical dosing pump - peristaltic type shall be a chemical electronic metering pump designed for fluoridation. Pumps shall be rated for an maximum feed rate as noted on the drawings or specified herein. Pumps shall be capable of manual adjustment and instrument responsive external control for an automatic system. Pumps shall be capable of injection to a system pressure of 100 or 75 psi as noted. Pumps shall be capable of a

minimum suction lift of 30 feet of water. Pumps shall have anti-siphon valves.

B. Pumps shall be rated for 120 VAC, with a non standard plug (twist lock) for electrical service. Duty cycle shall be rated continuous.

C. Pumps shall be Blue-White Model A-100N with Option-E.

2.5 TRANSFER PUMP

A. Mount the transpher pump atop of the tank.

B. The transfer pump shall be a Diaphragm Pump designed for fluoridation. Pumps shall be capable of lifts up to 20 feet, system pressures of 10 psi, and flows of 20 gpm minimum.

C. Pumps shall be Lutz (barrel pump) or Engineer approved equal.

D. A compressor shall be supplied with the transfer pump rated for the pump operation. The compressor and air supply piping shall include a regular, desiccant dryer (10 scfm minimum), flow control valve, solenoid valve, and isolation valve.

E. The compressor shall be 1 hp, 1700 rpm, 120 vac, 60 hz, with a 4.5 gallon tank, Rol-Air model no. D1000LPV5 or approved equal.

2.6 CALIBRATION COLUMN

A. Calibration columns shall be 100ml capacity with ½" NPT(F) threads bottom connection with dust cover top. They shall be made of PVC with Mylar polyester-film shroud. Columns shall be Accudraw PV#3-100, Cole-Parmer P-74600-01 or approved equal.

2.7 ELECTRONIC DRUM SCALE

A. The Contractor shall furnish and install one (1) electronic drum scale of 0-400 lbs. capacity. Scale shall be of the digital readout/electronic load cell type. Platform height shall be no more than 2" to permit easy loading and unloading of drums. Platform shall be epoxy powder coated steel. The unit shall be designed and fully warranted for continuous operation, and shall use 115 VAC, 60 hertz.

B. The scale shall include a wall mounted backlit digital indicator. Indicator shall output net weight via a 4-20 mA signal for remote monitoring. All indicator operations shall be menu prompted for ease of operation. Operator shall be able to monitor chemical by weight, volume or percent full. An “Auto Load” function shall automatically compensate for tank tare weight during tank change. A data log function shall store the “Daily Usage” for each of the previous 10 days. Full-scale accuracy shall be better than 1/4 of 1% and display to 0.1 lbs. The unit shall have a set of alarm relays for a low condition. The scales and indicator shall be Models No. 27-DR4DS and Solo 1000, respectively, as manufactured by Force Flow/Floquip, or approved equal.

2.8 RADAR LEVEL SENSOR

A. Radar level sensors shall be suitable for measurement of fluoridation liquids. The gauge shall operate on the Frequency Modulated Continuous Wave (FMCW) principle with an output signal directly proportional to process level, distance or volume.

B. The sensor assembly and signal converter shall be an integral, compact unit. Converter shall be capable of operation with wave stick antenna which shall mount directly to standard 2 inch ANSI flange.

C. The unit shall be powered by the A 4-20mA current loop. The maximum loop resistance shall be 750 Ohms. The output shall provide a continuous analog output of signal directly proportional to volume. The gauge shall be capable of local and remote interrogation and/or configuration.

D. On-site startup assistance and operator training shall be required.

E. The radar level sensor shall be Krohne Model BM702 or approved equal.

2.9 LEVEL SENSOR - MILLTRONICS

A. Level sensors shall be suitable for measurement of fluoridation liquids. The gauge shall be operated on the ultrasonic principle with an output signal directly proportional to process level, distance or volume

B. The level transmitter shall be immune to corrosive and harsh environments. The transducer shall have an integral temperature sensor to compensate fro temperature changes. The transducer shall mount directly to standard 2 inch ANSI flange. Transducers shall be Milltronics or ABB Model No. ST-H.

C. The Level Instrumentation Ultrasonic Interface Unit shall be Milltronics Miniranger or ABB Datum UI/1000 or approved equal. The unit shall have a volume conversion feature for measurement of the Bulk Storage Tank in gallons.

2.10 ELECTRONIC FLOW METER – ULTRASONIC METER

A. The electronic flow meter shall measure flow of the acid solution. The meter shall be 1/12" in size with ½" flange PVC coupling ends. The accuracy shall be ± 0.2%. and be able to read in units of gallons. Supply voltage shall be 85 to 260 VAC, 45 to 65 Hz and have the output/input option of Current / HART, frequency.

B. The unit shall be Keyence ultrasonic clamp on flow meter (3 parts): FD-XS20 (sensor) + FD-XC20R4 (bracket) + FD-XA1 (controller) as called out on the Drawings.

C. Provide an Ethernet connection to Owner’s (WBWCD) system for Owner to continuously monitor metered fluoride flows.

2.11 EMERGENCY EYE WASH AND SHOWER

A. Emergency eye wash and showers shall meet ANSI Standards. Showers shall be floor mounted combination eye/face wash station. Inlet piping shall be 1" and have a 150 psi rating. Showers shall be Speakman Company, Emergency Station, Northern # 108-1217 or approved equal.

B. Benches in shower rooms shall be preformed fiberglass with stainless steel supports.

C. Provide a minimum of four wall hooks for installation in the shower room.

2.12 EMERGENCY SHOWER WATER SUPPLY LINE AND TEMPERING TANK

A. The Contractor shall furnish and install the water supply line as shown on the drawings including all tubing, valves, air release valve, couplings, and any other accessories necessary to have a complete and ready-to-use system

B. The eye wash and shower shall have a minimum 80 gallon capacity tempering tank mounted as recommended by the manufacturer and shown on the drawings. The tank shall be glass lined per ASME HLW procedures using NSF approved glass lining compound. The tank shall have replaceable magnesium anodes, threaded openings on each end, and be rated for 150 psi minimum.

C. Tanks shall be A.O. Smith Water Products or approved equal.

2.13 PIPING AND TUBING

A. Piping and tubing shall be suitable to handle the materials carried as recommended by the manufacturer.

B. PVC piping and fittings shall be schedule 80 unless otherwise noted. Only Teflon tape shall be use for joint gaskets.

C. Tubing shall be Teflon PFA with a 3/64" wall for 1/4" and 1/16" wall for larger sizes. Fittings for tubing shall be “O” Ring & Grab Ring type as manufactured by Parker or approved equal.

D. Hose fittings shall be nylon with double hose clamps.

E. Hose shall be reinforced clear PVC.

2.14 MULTI-POINT TOXIC GAS DETECTION SYSTEM

A. A multi-point gas detector shall be supplied for monitoring the concentration of Fluorine and Hydrogen Fluoride in the Well House. The system shall consist of a NEMA 4X alarm module and a remote mounted gas sensor/transmitter for each specified gas. A sensor/transmitter shall provide the gas measurement function for the system. The sensor/transmitters shall consist of a stable electrochemical gas sensor that shall generate a signal linearly proportional to gas concentration. The entire assembly shall be coated to minimize RFI interference. Each sensor/transmitter shall be supplied with an electrochemical gas generator closely coupled to the sensor which shall automatically generate a small concentration of gas every 24 hours to verify sensor operation. During the verification test, alarm relays shall be inhibited. A battery backup module shall be supplied to provide standby power to the gas detector. The battery backup module shall be housed in a NEMA 4X enclosure and shall be suitable for operating the detector for at least 4 hours.

B. Two programmable alarm setpoints shall be provided for warning personnel of differing levels of leakage. Gas leak alarms shall be indicated by flashing LED indicators on the alarm receiver and activation of the SCADA system. The concentration of the gas shall be displayed directly in PPM units. Three alarm relays shall be provided for external alarming functions. Each alarm relay shall be independently assignable to either the low or the high alarm setpoint, and shall be provided on each receiver to indicate the loss of

signal from the sensor/transmitter, or to alarm the loss of sensitivity of the gas sensor. Each receiver shall provide an isolated 4-20 mA output signal proportional to gas concentration, and shall also contain remote reset input terminals to allow alarm acknowledge from a remote location.

C. The gas detection system shall be ATI Series A14 or approved equal.

2.15 SAFETY EQUIPMENT

A. Contractor shall furnish the Safety Equipment listed below in Table 2 -Safety Equipment.

TABLE 2 - SAFETY EQUIPMENT (NIOSH approved where applicable)

Description	Quantity (per site)	Notes
Cartridge Respirator with Full-Face Shield	2 ea	Northern #152-4340
Chemical Cartridges	5 sets (10)	Northern #153-7253
Gauntlet neoprene gloves (12" glove minimum length)	6 pair	Northern #121-9934
Full-Face Shield (8" min.)	2 ea	Northern #107-1283
Heavy Duty acid type neoprene aprons	2 ea	Northern #136-1372
12" latex Hazmat Boot Covers	4 pair (Owner to select sizes)	Northern #145-1473
Spill Containment Drum	5 ea	Northern #195-9877
Spill Containment Pallets	Sets of 1x2 and 2x3 drum pallets. Including link locks	Northern #195-9882 Northern #195-9884 Northern #195-9886
Combination Emergency Station (Shower/eyewash)	1 ea	Northern # 108-1217
Tempering Water Storage Tank - 80 gallons	1ea	See paragraph 2.06 B
Wash down Hose with nozzle (Connect to combination emergency station)	1 ea	Northern #108-1219
Spill control pillows (foamed-sand type) or Maintenance Sorbents	Capacity: 50 Gal.	Northern #200-17817
Disposable Towels w/ Dispenser	1 dispenser w/ 6 towel rolls	Northern #109-6628
Hazardous Material Identification Signs	1 sign ea door (10" x 10") and storage tank (4 ½" x 4 ½")	Northern #233-5321R Northern #233-5319P

PART 3 EXECUTION

3.1 INSTALLATION

A. All equipment shall be installed as per manufacturers directions. Weight of valves, hoses and equipment must not be carried by the fittings themselves. Proper support for all equipment shall be provided.

B. The fluoride dosing pump shall not be mounted higher than 4 feet above the highest liquid level of the day tank. Fluoride injection points shall have anti-siphon valves and diffuser piping as required mounted on a 45 degree angle off of vertical from the floor.

C. If noted on the drawings, the bulk fluoride storage tank shall be installed with a 6" high curb around the perimeter. The floor within the berm area shall slope to a low point at which a leak sensor shall be mounted. Vents shall extend to the outside of structures and be turned down and be equipped with a non-corrodible screen.

3.2 START UP AND TESTING

A. Contractor and Fluoride Equipment Supplier (FES) shall verify that structures, equipment, pumps and motors are compatible for an efficient system.

B. Contractor and FES shall make equipment adjustments required to place system in proper operating condition.

C. Contractor and FES shall test the Fluoride feed system for proper operation in the presence of the Owner and Engineer.

D. The FES shall furnish all testing equipment and devices required.

E. If the Fluoride feed system fails to meet any of the specified performance requirements, Contractor and/or FES shall modify and/or replace defective equipment until it meets specified requirements. Re-test system to verify satisfactory operation.

F. Demonstrate the accuracy of each dosing pump using job supplied calibration column.

G. The Contractor shall, after installation of storage tanks is complete but before piping connections are made, block all outlets and fill each tank with water to again check for leaks. No leakage will be permitted.

H. The FES field services:

1. Retain, for a period of not less than one (1) day per site for installation of fluoride system factory trained representatives. For installation, the representative shall perform the services listed below:
    a. Inspect the completed installation and prepare an inspection report.
    b. Test, calibrate and adjust all components for optimum performance.
    c. Assist in initial start-up and field testing.
    d. Instruct Owner's personnel in the operation and user maintenance of all components. Conduct a training seminar at the site.
    e. Supervise the correction of any defective or faulty work before and after acceptance by Owner.

I. The Contractor shall be responsible to supply all chemicals required for testing.

J. All piping shall be tested hydrostatically for leaks. If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests shall be reconducted.

- END OF SECTION -

SECTION 46 33 13
ON-SITE HYPOCHLORITE GENERATION SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Scope

1. The On-Site Sodium Hypochlorite Generation System shall be installed by the On-Site Sodium Hypochlorite Generation System Supplier (SUPPLIER) under subcontract to and with specific support from CONTRACTOR. The Equipment and installation shall be complete and operational. This requirement includes delivery of the On-Site Sodium Hypochlorite Generation System equipment; the installation of SUPPLIER's equipment; startup of the complete system; and training of OWNER's personnel.
2. SUPPLIER shall furnish all materials; equipment; above ground piping and valves shown on the sodium hypochlorite generation and feed system schematic shown on the drawings; and other appurtenances required to furnish, test and place into satisfactory operation the complete sodium hypochlorite generator feed system indicated on the drawing, and as specified herein.
3. CONTRACTOR shall perform all other work not performed by SUPPLER concurrent to the work provided by SUPPLIER, in order to provide a fully functional and operating system.

B. General

1. The On-Site Sodium Hypochlorite Generation System SUPPLIER shall warrant and support all of the components of the On-Site Sodium Hypochlorite Generation System as if they were components of its own manufacture regardless of the source. SUPPLIER shall supply all component pieces and shall maintain all overall "single source responsibility" for the complete system. As is practical, SUPPLIER shall take responsibility for the design and implementation of the equipment at the Breeze Tank Site and will immediately bring to ENGINEER's attention any portion of the design which may have a negative impact to the performance of the On-Site Sodium Hypochlorite Generation System.
2. SUPPLIER shall certify within 5 days of contract award that the proposed plans and specifications are complete and adequate to support acceptable system operation.
3. Drawings show a layout of the generation system, various components and the system's overall relationships. Not all items incidental to the On-Site Sodium Hypochlorite Generation System are shown or specified. It is the intent of these specifications that SUPPLIER is to provide a complete and workable system whether or not any specific component is shown or specified.

C. Related work specified in other sections includes but is not limited to:

1. Section 01 33 00 Submittal Procedures
2. Section 01 60 00 Product Requirements
3. Section 05 45 00 Mechanical Metal Supports (Pipe Supports)
4. Section 22 10 10 Plumbing and Piping Specialties
5. Section 33 05 07 PVC Pressure Pipe (ASTM D1785)
6. Section 33 12 00 Mechanical Appurtenances

1.2 CONTRACTOR SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings:

1. Make and Model of each equipment assembly.
2. Provide a plan view layout showing equipment location at the site to scale.
3. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
4. Outside utility requirements: ie air, water, power, drain, etc. - for each component.
5. Functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled, or alarmed.
6. Provide power and control wiring diagrams including terminals and numbers.
7. Submit design for seismic bracing of tank, equipment, and piping signed by a professional engineer licensed in the State of Utah.

C. Quality Control Submittals:

1. Factory functional and performance test reports and log.
2. Manufacturer's Certification of Compliance that the factory finish system is in accordance with the requirements specified herein.
3. System shipping, storage, protection, and handling instructions.
4. Manufacturer's written/printed installation instructions.
5. Manufacturer's Certificate of Proper Installation.
6. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
7. Operation and Maintenance Manuals.

1.3 SPARE PARTS

A. Furnish, tag and box for shipment and long-term storage the following spare parts and special tools:

1. Two replacement bellows cups (one for brine pump and one for fresh water).
2. Two replacement pop-it check valves (one for brine pump and one for fresh water).

1.4 WARRANTY

A. Prior to acceptance of the On-Site Sodium Hypochlorite Generation System, provide written warranty from the system manufacturer that includes the following statements:

1. SUPPLIER has inspected the installation during and after completion and the On-Site Sodium Hypochlorite Generation System is free from faults and defects and is in conformance with the Contract Documents.
2. The On-Site Sodium Hypochlorite Generation System will remain free of defects for a period of one (1) year from the date of final acceptance.
3. If the equipment requires repair or replacement as a result of ordinary wear and tear under normal conditions, the system manufacturer will repair or replace such equipment as required without cost to OWNER.
4. System manufacturer will provide a seven (7) year guarantee for replacement of the cell pack; 0-2 years full replacement, 3-7 years prorated straight line.

5. System manufacturer will provide a two (2) year parts and labor guarantee for the power supply.

1.5 EQUIPMENT DELIVER, STORAGE AND HANDLING

A. All equipment and materials shall be inspected against approved Shop Drawings at time of deliver. Equipment and materials damaged or not meeting requirements of the approved Shop Drawings shall be immediately returned to the system manufacturer for replacement or repair.

B. Equipment and materials shall be stored in a dry location and protected from the elements according to the system manufacturer's instruction.

C. Equipment and materials shall be handled in an approved manner according to the system manufacturer's instructions.

1.6 MEASUREMENT AND PAYMENT

A. Full compensation for the On-Site Sodium Hypochlorite Generation System shall be considered as included in the contract lump sum bid price as shown on the bid schedule for the On-Site Sodium Hypochlorite Generation System.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. The On-Site Sodium Hypochlorite Generation System manufacturer shall be **a 75 lbs per day system, by ClorTec or PSI**, no other equal.

2.2 SYSTEM DESCRIPTION

A. Furnish On-Site Sodium Hypochlorite Generation System capable of generating 75 pounds per day of chlorine equivalent sodium hypochlorite at 0.8% concentration.

B. Raw materials per day include the following:

1. Power: 2 kilowatt-hours (per each lb FAC)
2. Salt: 75 pounds.
3. Water: 1128 gallons.

C. Electrical and water requirements include the following:

1. Chlorine Generator Power Supply: 480 volts, 3-phase, 60 Hz, 20A.
2. Chlorine Generator Control Panel Power Supply: 120 volts, 1-phase, 60 Hz, 20A.
3. Water Pressure: 30 to 80 psig.

D. The On-Site Sodium Hypochlorite Generation System equipment shall consist of the following:

1. Brine mixing and storage tank.
2. Brine proportioning pump.
3. Provide complete Clortec or PSI Minichlor system.
4. Sodium hypochlorite storage tank.
5. Sodium hypochlorite generation control panel.

6. Hydrogen vents.
7. Assorted piping, filters and water softener.

2.3 EQUIPMENT DESCRIPTION

A. Brine Mixing and Storage Tank:

1.	Manufacturer:	**BrineMaker** or approved equal
2.	Salt:	Water softener salt (99.7% pure)
3.	Salt Quantity:	11,500 pounds
4.	Tank Material:	Rigid high-impact nontoxic polyethylene
5.	Capacity:	1090 gallons
6.	Dimensions:	Cylindrical with 8-foot diameter and 6-feet 9-inch height
7.	Salt Level:	**BinMaster SBR II** unit to measure salt level
8.	Brine Level:	Pressure transducer manufactured by **Flowline, model LD30** to measure water/brine solution level
9.	Controller:	Salt concentration monitor / controller made by **BrineMaker, model BCMS01**
10.	Conductivity Analyzer:	ATI Q46C67 4E, **Kuntze Neon EC Conductivity Analyzer**

B. Provide complete 75 lb per day Clortec or 80 lb per day PSI Minichlor system.

C. Sodium Hypochlorite Storage Tanks:

1.	Material:	Crosslink polyethylene
2.	Capacity:	710 Gallons (approximately 3 day's storage)
3.	Dimensions:	Cylindrical with 7.5-foot diameter by 7.3-foot height
4.	Type:	Storage tanks shall be a vertical closed top tank
5.	Manufacturer:	**Snyder Industries, Central California Container Mfg, Inc, Poly Processing**, or approved equal

6. Tanks shall be UL classified to ANSI/NSI Standard 61 Drinking Water System Components - Health Effects.
7. The system shall be controlled by ultrasonic level transmitters. One located in a 2-inch threaded port on the top of each tank.
8. The ultrasonic level transmitters shall be **USonic Series by Drexelbrook, Siemens HydroRanger 200 with XRS-5 Ultrasonic, Siemens LT500 with LR100 Radar,** or approved equal.

D. Sodium Hypochlorite General Control Panel:

1. The system shall consist of a singular power supply control cabinet capable of supporting one power supply module, capable of continuous output up to 1.50 amps draw, 120 VAC, single phase, 60 Hz, 10 Amp. service.
2. The control system shall be PLC based with a LCD digital interface for control and monitoring statuses.
3. The control cabinet shall be stainless steel with a NEMA 12 enclosure.
4. The power supply will incorporate the following features and operating parameters:
   a. Constant Current Operation: The device will monitor cell current and concurrently correct cell voltage to maintain constant current.
   b. Soft Start Operation: Upon startup, the device will gradually ramp up to full current over the first 5 seconds of operation.
5. The interfacing PLC will incorporate the following features and operating parameters:

a. Touch Control: The PLC will allow the operator to start, stop, engage, disengage, and reset alarms, cell fill, and display history.
b. Status Display: The display will show amperage, voltage, running hours, standby, alarm and type, disabled and cell fill.
c. Alarm Status: Upon an alarm condition, the display will acknowledge the alarm type, cell level, cell temperature, rectifier alarm, and tank limit alarms.
d. Automatic Restart: When an alarm condition occurs, the system shall try to automatically restart four times before initiating a shutdown condition.
e. Alarm History: the PLC shall contain a history of the last 10 events and their alarm types.

6. External Interface:
a. Provide system ON and TROUBLE outputs from the sodium hypochlorite generation control panel, for remote indication.
b. Discrete outputs shall be SPDT contacts rated 5A at 120 V ac, minimum: On, Off, Failed.

E. Hydrogen Vents and Dilution Fan:

1. There shall be a 2-inch diameter clear PVC schedule 80 pipe from tank to contain hydrogen gases and serve as a hydrogen vent. The 2-inch pipe will be routed to the hypochlorite solution tank where the pipe will connect to a 4-inch diameter clear PVC schedule 80 pipe venting outside the building directly to atmosphere.
2. The hydrogen dilution fan shall be 1 HP, 204 V, single-phase, 60 hz blower, capable of producing at least 406 ACFM. The fan shall be manufactured by **Cincinnati Fan,** or approved equal.
3. Flow switch shall be **Model ProSense FTS200-1001 by AutomationDirect**, or approved equal.

F. Water and Brine Filters:

1. 50 micron melt blown cartridges shall be used as shown on the Contract Drawings.
2. Filter housings shall be **Pentek Traditional Standard Series by Pentair,** or approved equal.
3. The housings shall be sized to accommodate filters recommended by the chlorine generator supplier.

G. Miscellaneous Piping:

1. There are several ball valves located at points in the system to allow for easy shutdown and maintenance. Ball valves shall be in accordance with Section 33 12 00 – Mechanical Appurtenances.
2. All piping and fittings shall be Polyvinyl Chloride (PVC), Schedule 80, unless otherwise specified.
3. All tubing shall be clear reinforced PVC rated for a minimum of 275 psi. Tubing shall be connected to PVC barbed fittings with SS 316 clamps.

H. Alternate Equipment:

1. A supplier proposing to furnish equipment other than what is specified herein, must provide verifiable performance data of the proposed alternative in accordance with Specification Section 01 60 00.
2. The manufacturer of the proposed alternate equipment must have a minimum of 3 years' experience and five installations of the same type equipment.

3. OWNER reserves the right to determine whether the alternate equipment is acceptable.
4. Supplier of the alternate equipment must guarantee that the State Health Department has approved the product.
5. If at any time within the warranty period the system fails approval by the Utah State Health Department, CONTRACTOR agrees to replace the system with the Micro-Clor System as specified herein at no additional cost to OWNER.

2.4 ACCESSORIES

A. Water Softener:

1. Provide a water softener to condition the influent water prior to entering the salt saturator tank.
2. Soft Water System shall be a dual tank type water softener and manufactured by **CP 208S Kinetico,** or approved equal.
3. Pertinent specifications include the following:
   a. Tank size: 8” x 40”
   b. System size (width x depth x height): 17” x 8” x 46”
   c. Resin Volume per Tank: 0.70 cubic feet
   d. Regeneration Time/Volume: 45 min / 35 gal
   e. Flow Range (15/30 psig): 11.5 – 18 gpm
   f. Maximum Hardness: 66 gpg
4. CONTRACTOR may supply alternate equipment provided that the performance specifications are similar to those listed herein.

B. Dosing Pump:

1. Provide a digital dosing pump suitable for pumping a hypochlorite solution from the storage tank to the influent nozzle of the pipeline.
2. Stainless steel pump housing and ceramic valve ball.
3. Flowrate: 3 to 16 gph
4. Maximum operating pressure 145 psi.
5. Turndown ratio: 800:1
6. Inlet diameter: Threaded NPT 3/4-inch, or equal
7. Outlet diameter: Threaded NPT 3/4-inch, or equal
8. Dosing pump shall be **Grundfos Model Number DME 60-10 AR**, no equal.

C. Injection Unit:

1. Injection quill shall be a high corrosion resistant, retractable injection quill rated for 250 psi with an integrated check valve. Process connection size shall be 1-inch with 1/2-inch inlet connection. Solution tube size shall be 1/2-inch. Injection quill insertion length shall be 18 inches with 45-degree beveled end. Valve and solution tube material shall be Type 316 stainless steel. Check valve seal shall be FKM (fluorocarbon rubber).
2. Provide a flexible hose assembly for flexibility maintaining and installing the injection quill. Assembly shall have a true union ball valve inlet, clear braided PVC reinforced vinyl hose, stainless steel clamps, and either FNPT or MNPT coupler outlet.
3. Manufacturer shall be **Saf-T-Flo Water Services, Inc. (Injection Quill - Model EB-155-S-H-18-B-V, with alloy C276 solution tube; Hose Assembly FHA or FHB Series),** or approved equal.

4. CONTRACTOR may supply alternate equipment provided that the performance specifications are similar to those listed herein.

D. Mixer:

1. Provide a static mixer downstream of injection unit to thoroughly mix injected hypochlorite solution.
2. Static mixer model and manufacturer shall be **Series 650 by Statiflo**, no equal.
3. Pertinent specifications include the following:
   a. Static mixer shall contain 2.5 fixed elements to provide 95% mixing.
   b. Mixing elements shall have a 1.5:1 Pitch Ratio.
   c. Housing material: Carbon steel coated with NSF61 approved coating
   d. Mixing element material: 316L stainless steel.
   e. Injection connection: 1-inch threaded
   f. Sample connection: 1-inch threaded

E. Chlorine Analyzer:

1. Provide an amperometric chlorine analyzer upstream of the injection unit and downstream of the static mixer.
2. Chlorine analyzer shall be **Kuntze Krypton DIS with Argon StabiFlow**, no equal.
3. Pertinent specifications include the following:
   a. Inlet size: 1/2-inch
   b. Drain size: 1/2-inch
   c. Analysis method: Amperometric
   d. Minimum pressure: 2.5 psi
   e. Power requirements: 110 VAC, 60 Hz

PART 3 EXECUTION

3.1 INSTALLATION

A. All equipment shall be installed in strict accordance with the manufacturer's written instructions and as shown on the Contract Drawings.

B. Install piping as shown on the Contract Drawings and in accordance with manufacturer's piping diagrams.

C. Provide tank and pipe supports in accordance with Section 05 45 00 – Mechanical Metal Supports.

D. Tank and equipment drains shall be routed to the nearest floor drain, hub drain, or trench drain and shall not be allowed to drain across the floor.

3.2 FIELD QUALITY CONTROL

A. Functional Test:

1. Perform on all complete assemblies prior to startup. Inspect and test installed equipment for proper alignment and connection, quiet operation, and satisfactory specified performance.
2. Leakage Test: A test with units installed as under maximum operation.

B. Performance Test:

1. Conduct pumps and electrolytic cells assisted by manufacturer's representative.
2. Perform under maximum operating conditions.
3. Test for continuous 3-hour period without malfunction.
4. Performance tests shall be conducted in the presence of ENGINEER and OWNER. Test completed without ENGINEER or OWNER will not be accepted.

3.3 TRAINING

A. SUPPLIER shall provide on-site training and startup assistance for OWNER. Training shall be a minimum of 4 hours not including travel time. Training shall be provided by a factory authorized representative.

B. SUPPLIER shall provide a minimum of 4 hours on-site training or assistance during the first year after final acceptance. Additional assistance may be on multiple visits.

- END OF SECTION –

SECTION 46 34 00
FILTER TECH FILTER SYSTEM, GREEN ROAD WELL

PART 1 GENERAL

1.1 GENERAL

A. Contractor shall provide, install, functionally test all components and process of, and operationally start up and help the District to operate - for the first month of testing and operation, the:

"Filter Tech Systems 600 gpm AquaSand Pressure Vessel System for Green Road Well Water Treatment"

according to Contract Drawings and Specifications including this system which is presented by the Manufacturer in the End of (Appendix to) this Section as follows:

1. Filter Tech Systems Inc
   Proposal No 20-1235d (4 pages Summary of Work with Cost and Schedule)
   21 March 2023
   Weber Basin – Green Road Well
   600 gpm Aqua Sand Filter Skid
   Proposal details are shown in original proposal: Sections 1 thru 4 (which follow)

2. Section 1: Design Criteria
   a. 00 Table of Contents - pg 1
   b. 01 AquaSand Data Sheets - pgs 1-5 (Iron & Manganese Removal Calcs)
   c. 02 Greensand Plus Data Sheet - pgs 6-9
   d. 03 AquaSand Operating Instructions - pgs 10-11
   e. 04 Aquasand Backwash Cycle Operating Instructions – pg 12

3. Section 2: Mechanical Drawings Binder
   a. 00 Table of Contents - pg 1
   b. 1A-0 Item List – pgs 2-3
   c. 1A-1 Process Flow Schematic – pg 4
   d. 2A-1 Filter Orientation – pg 5
   e. 2B-1 Filter Media Schedule – pg 6
   f. 3A-1 Skid Elevation – pg 7
   g. 3A-2 Skid Plan View – pg 8
   h. 3A-3 Piping Side View – pg 9
   i. 4A-1 Filter Underdrain Assembly – pg 10
   j. 4A-2 Filter Inlet Installation – pg 11
   k. 4B-1 Filter Underdrain Assembly – pg 12
   l. 4B-2 Filter Underdrain Installation – pg 13
   m. 5A-1 Air Release Assembly – pg 14
   n. 6A-1 Skid Mounting Details – pg 15

4. Section 3: Mechanical Equipment Binder

a. Table of Contents – pg 1
b. Apollo – Isolation Valves – pg 2
c. Ashcroft-WIKA – Pressure Gauges – pg 3
d. Bray – Butterfly Valves – pgs 4-19
e. Dwyer – Pressure Transmitters – pgs 20-21
f. Matco-Norca – Hose Bibb – pg 22
g. McCrometer – Flow Meter – pgs 24-32
h. Valmatic – Combination Air / Vacuum Breaker Valve – pgs 33-41

For Installation of Equipment and Filter Media see paragraph 3.1.

1.2 RELATED WORK DESCRIBED ELSEWHERE

A. Related work is also found in these Sections:

1. Section 01 33 00, Submittal Procedures
2. Section 01 60 00 Product Requirements
3. Section 01 78 00 Operation and Maintenance Manuals
4. Section 01 78 20 Project Closeout
5. Section 09 90 00 Painting and Finishes
6. Section 33 05 13 Precast Concrete Manholes and Structures
7. Section 33 12 00 Mechanical Appurtenances
8. Section 33 13 00 Pipeline Testing and Disinfection
9. Section 33 14 13 Drainage System
10. All Division 40 Specs – Process Control and Instrumentation

1.3 MEASUREMENT AND PAYMENT

A. This system will be paid for when it is complete, operationally tested and proven that it is ready to go into continuous automated service.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 INSTALLATION OF EQUIPMENT AND FILTER MEDIA

A. The Manufacturer (Filter Tech's) Installation Instructions are found at the End of (Appendix to) this Section, including:

1. Delivery – pg 1
2. Filter and Project Information – pg 2
3. Media Depths & Layers, Filter Preparation, Gravel Installation – pg 3
4. Sand and Anthracite Installation pgs 4-5
5. Conditioning & Disinfecting Manganese Greensand & GreensandPlus – pgs 6-7

3.2 TESTING, STARTUP AND AUTOMATED OPERATION OF SYSTEM

A. Manufacturer (Filter Tech) and Contractor shall jointly participate in well startup and testing including, system automation testing and operational running of filtration system and backwash system until it is proven to be fully automated to District (Owner) and

Engineer. Assume two weeks of successful automated operation of system. Comply with Section 01 78 50, Project Closeout.

3.3 OPERATION AND MAINTENANCE MANAUALS

A. Manufacturer (Filter Tech) and Contractor shall jointly provide, along with all other operation and maintenance manuals for project, the most detailed operation and maintenance manuals, and portions of manuals, which are published by Manufacturer, all organized with tables of contents and appendices. Comply with Section 01 78 20, Operation and Maintenance Manuals.

3.4 TRAINING OF OWNER TO OPERATE AND MAINTAIN SYSTEM

A. Manufacturer (Filter Tech) and Contractor shall jointly participate in training of Owner staff to operate and maintain system. Assume two weeks of operational and maintenance training.

- END OF SECTION TEXT -

FILTER TECH APPENDICES

- Proposal Update Summary March 21, 2023 (with Cost and Schedule)..... 4 pages
- Section 1 - Design Criteria Binder..... 12 pages
- Section 2 - Mechanical Drawings Binder ..... 16 pages
- Section 3 - Mechanical Equipment Binder ..... 41 pages
- Installation Instructions for Equipment and Filter Media ..... 7 pages

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Filter Tech Systems, Inc.
Designers & Manufacturers of AquaSand Filters
2844 Chipeta Avenue Grand Junction, CO 81501
(888) 287-8292 Local (970) 254-2855 Fax (970) 254-2858

Proposal No. 20-1235d1
21 March 2023

Weber Basin - Green Road Well
600 gpm AquaSand Filter Skid

We are pleased to provide a revised proposal for a pressure filter skid capable of treating 600 gpm of groundwater.

The system will consist of Three (3) AquaSand+ 84" diameter Vertical Pressure Filters to remove iron and manganese.

Included in our quotation are the following items as noted below and as shown on our Process Flow Schematic and Item List.

AquaSand+ Iron & Manganese Removal Filter Skid

Three (3) AquaSand+ Vertical Pressure Filters fabricated of steel; epoxy coated. Mounted on epoxy-coated steel frame

Three (3) 84" diameter x 72" Side Shell Vertical Pressure Vessels
175 psi Operating Pressure
Sch 80 PVC Inlet Distribution Header
Sch 80 PVC Header/Lateral Underdrains
One (1) 14" x 18" Manway per filter
Lifting Eyes and Support Legs

Air/Vac Valve, Isolation Valve and Vent Piping to drain

8" Epoxy-Coated, Welded Steel Face Piping
8" Flanged Filter Inlet

8" Flanged Backwash Outlet
8" Flanged Filter Effluent

One Lot — Filter Media in bags and palletized.
AquaSand+ filter media will include 12" Anthracite, 18" Manganese Dioxide Media for the removal of oxidized (precipitated) iron & manganese and 20" graded support gravel.

Includes an additional 5% over theoretical to allow for conditioning losses.

One (1) — Backwash Flow Control Valve
8" Lug-Style Butterfly Valve with Positioner

One (1) — Backwash Supply Flow Meter
Flanged Tube Magnetic Flow Meter with Remote Readout
Includes Flow Rate, Flow Total and 4-20 mA Signal Output

Two (2) — Pressure Transmitters
For Feed and Effluent of filter skid to determine differential pressure

Two (2) — Pressure Gauges
0-200 psi for influent & effluent of each filter for individual filter monitoring. Pressure Taps integral with filter stubs.

Indicator-gauge mounted in the face of the enclosure.

One Lot — 1/2" Sample Taps
For Raw and Filtered Water from each filter skid
See Flow Schematic for locations

One (1) — Filter Control Panel
Allen Bradley Compact Logix PLC-Based automated controls
With Ignition Edge Operator Interface
Automatic Filter Backwash

Battery-Backed Up 24V DC Power Supply
15" Full-Color Panel-Mounted Touch Screen
3-Position Lighted HOA switch for every valve

Freight, Start Up & Training

One Lot — Freight to accessible jobsite, on truck. Unloading by others.

One Lot — Days Start-Up Assistance and Operator Training

As required or as requested.

In addition to any requirements in the specifications, Filter Tech Systems will provide any additional trips as needed or as requested for the first one year of operation at no charge.

Includes 24/7 free telephone technical support for the life of the plant.

Four (4) — Operation and Maintenance Manuals

Includes plant operating instructions, mechanical and electrical drawings and equipment cut-sheets, installation, operating and maintenance instructions.

AquaSand Equipment Proposal .....$ 541,179

Includes all equipment listed above and Start Up and Operator Training

Items **NOT** included in this quotation (but not limited to):

- Overall Plant Design, Construction, Installation
- Excavation and Site Work, Concrete, Building, Utilities
- Unloading and Setting Equipment
- Mechanical Installation of Equipment
- Electrical Installation of Equipment
- Interconnecting Piping to and from pressure filter systems
- Electrical cabling to equipment
- MCCs and Motor Starters
- Facility Management and Operating Staff
- Sales Taxes, Licenses, Permits

Delivery — 30 - 32 Weeks after receipt of approved submittals

Freight — FOB Ship Point, Full Freight Allowed

Terms

10%	of the contract amount with Purchase Order or Signed Contract
15%	of the contract amount upon receipt of equipment submittals
65%	of the contract amount as material is shipped or ready to ship on a pro-rata basis, net 30 days
10%	Upon completion of start up

Quotation Valid for Sixty Days

Filter Tech Systems
600 gpm AquaSand
Pressure Vessel System
Green Road Well Water Treatment

Section 1 Design Criteria

Document	Description
00	Table of Contents
01	AquaSand Data Sheets
02	Greensand Plus Data Sheet
03	AquaSand Operating Instructions
04	AquaSand Backwash Cycle Operating Instructions

Filter Tech Systems

600 gpm AquaSand Filtration System

Weber Basin - Green Road Well

Process Design Calculations

This process is designed to remove iron and manganese from a ground water source.

Raw water quality design data:

Iron	0.0900	ppm Max
Manganese	0.2030	ppm Max
pH	7.2000	S.U.

The mechanisms for removal are:

Step 1 Oxidation of iron and manganese.

The chlorine demand to oxidize iron is 1.0 mg/l of chlorine per 1.0mg/l of iron.

The chlorine demand to oxidize manganese is 2.0 mg/l of chlorine per 1.0mg/l of manganese.

Estimated Dosage

Iron	0.0900	ppm	x	1.00	ppm	=	0.0900
Manganese	0.2030	ppm	x	2.00	ppm	=	0.4060
				Total chlorine demand, ppm		=	0.4960

Step 2 Filtration for removal of particulates

The greensand filtration process will remove 100% of the oxidized material

AquaSand Filter Effluent Quality Treatment Goal

Iron	< 0.30	ppm
Manganese	< 0.05	ppm

Filter Tech Systems

600 gpm AquaSand Filtration System

Weber Basin - Green Road Well

AquaSand Iron & Manganese Removal Filters
Design Criteria

Source	Ground Water		
	Pump Capacity	600	gpm
	Design Maximum	600	gpm
	Inlet Pressure	135	psi

Model Number	AquaSand Model 8472	
Number of Filters	3	
Diameter of Filter	84	inches
Area per Filter	38.48	ft^2
System Capacity	600	gpm Design Flow to Filters
Service Flow Rate	5.20	gpm/ft^2
Service Rate w/two filters	7.80	gpm/ft^2
(One Filter in Backwash)		
Backwash Flow Required	461.8	gpm
(12 gpm/ft2)		
Filter Pressure Drop	10	psid at backwash maximum
Inlet Pressure Required	15	psi

Filter Tech Systems

600 gpm AquaSand Filtration System

Weber Basin - Green Road Well

AquaSand Iron & Manganese Removal Filters
Media Composition

Anthracite	12	In.	1.0 - 1.1 mm	Effective Size; UC 1.5 Max
GreenSand Plus	18	In.	0.30 - 0.35 mm	Effective Size; UC 1.6 Max
Underbed	22	In.	2.0 - 3.0 mm	Torpedo Sand

Area per Filter 38.48 ft^2

Media Quantities (per filter includes 5% extra):

Anthracite	41 Cubic Feet
GreenSand Plus	61 Cubic Feet
Underbed	75 Cubic Feet

Filter Tech Systems

600 gpm AquaSand Filtration System

Weber Basin - Green Road Well

AquaSand Iron & Manganese Removal Filters
Backwash Requirements

Area per Filter	38.48	ft^2
Backwash Design	12.0	gpm / square foot
Backwash Flow Rate	461.8	gpm/ft^2
Backwash Cycle Time	8.0	Minutes
Backwash Volume	3694.5	Gallons
Rinse Flow Rate	5.0	gpm / square foot
Rinse Cycle Time	4.0	Minutes
Rinse Volume	769.7	Gallons
Backwash & Rinse Volume	4464.2	Gallons per Filter
Total Backwash Volume	13392.6	Gallons per Skid

Inversand Company
SINCE 1925
226 Atlantic Avenue, P.O. 650 • Clayton, NJ 08312
Phone 856-881-2345 Fax 856-881-6859
Email: info@inversand.com • www.inversand.com

GREENSAND plus™

Performance Media for Water Filtration

Removes iron, manganese, hydrogen sulfide, arsenic and radium.

GreensandPlus™ is a black filter media used for removing soluble iron, manganese, hydrogen sulfide, arsenic and radium from groundwater supplies.

The manganese dioxide coated surface of GreensandPlus acts as a catalyst in the oxidation reduction reaction of iron and manganese.

The silica sand core of GreensandPlus allows it to withstand waters that are low in silica, TDS and hardness without breakdown.

GreensandPlus is effective at higher operating temperatures and higher differential pressures than standard manganese greensand. Tolerance to higher differential pressure can provide for longer run times between backwashes and a greater margin of safety.

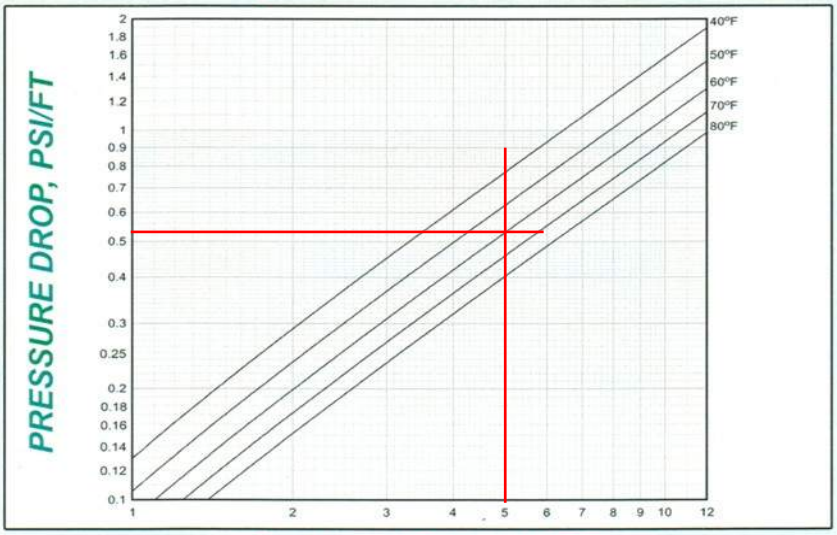
Systems may be designed using either vertical or horizontal pressure filters, as well as gravity filters.

GreensandPlus is a proven technology for iron, manganese, hydrogen sulfide, arsenic and radium removal. Unlike other media, there is no need for extensive preconditioning of filter media or lengthy startup periods during which required water quality may not be met.

GreensandPlus is an exact replacement for manganese greensand. It can be used in CO or IR applications and requires no changes in backwash rate or times or chemical feeds.

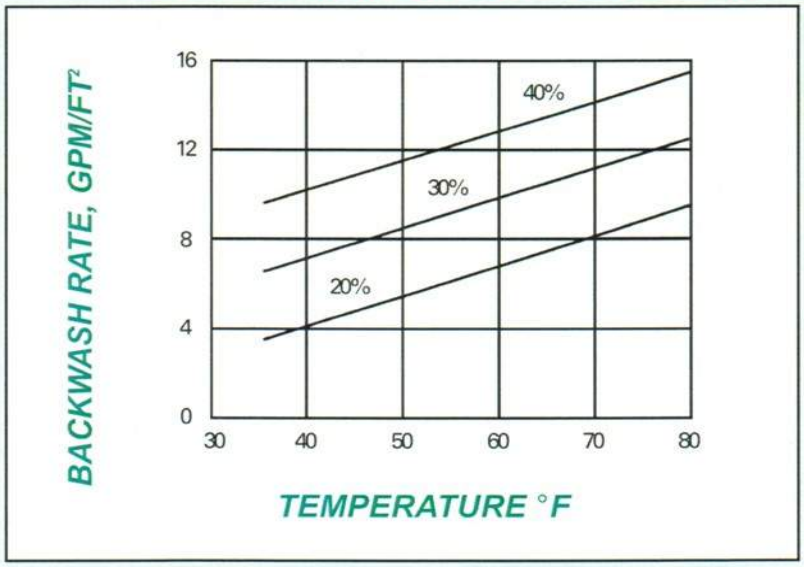
GreensandPlus has the WQA Gold Seal Certification for compliance with NSF/ANSI 61. Packaging is available in 1/2 cubic foot bags or 1 metric ton (2,205 lbs) bulk sacks.

GREENSANDPLUS PRESSURE DROP (CLEAN BED)



0.5 psi/ft x 1.5 feet = 0.75 psi total pressure drop

BED EXPANSION DURING BACKWASHING



PHYSICAL CHARACTERISTICS

Physical Form
Black, nodular granules shipped in a dry form

Apparent Density
88 pounds per cubic foot net (1410.26 kg/m3)

Shipping Weight
90 pounds per cubic foot gross (1442.31 kg/m3)

Specific Gravity
Approximately 2.4

Porosity
Approximately 0.45

Screen Grading (dry)
18 X 60 mesh

Effective Size
0.30 to 0.35 mm

Uniformity Coefficient
Less than 1.60

pH Range
6.2-8.5 (see General Notes)

Maximum Temperature
No limit

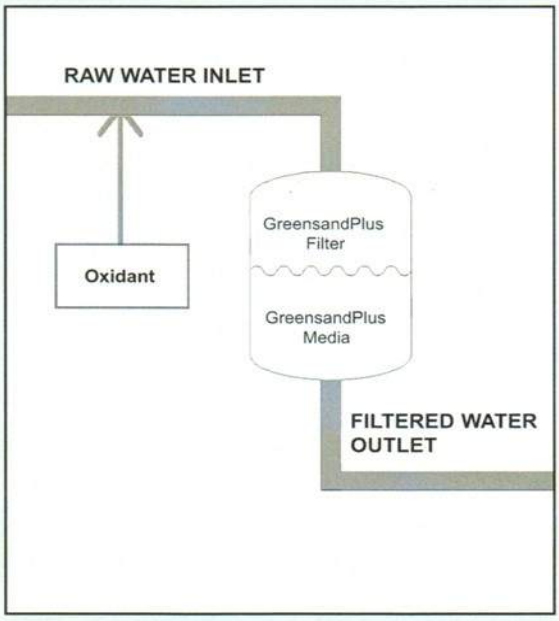
Backwash Rate
Minimum 12 gpm/sq. ft. at 55*F
(29.4 m/hr @ 12.78*C) (see expansion chart)

Service Flow Rate
2 -12 gpm/sq. ft. (4.9 m/hr - 29.4 m/hr)

Minimum Bed Depth
15 inches (381 mm) of each media for dual media beds or 30 inches (762 mm) of GreensandPlus alone.

METHOD OF OPERATION CO

GreensandPlus: Catalytic Oxidation (CO)



Catalytic Oxidation (CO) operation is recommended in applications where iron removal is the main objective in well waters with or without the presence of manganese. This method involves the feeding of a predetermined amount of chlorine (Cl_2) or other strong oxidant directly to the raw water before the GreensandPlus Filter.

Chlorine should be fed at least 10-20 seconds upstream of the filter, or as far upstream of the filter as possible to insure adequate contact time. A free chlorine residual carried through the filter will maintain GreensandPlus in a continuously regenerated condition.

For operation using chlorine, the demand can be estimated as follows:

mg/L Cl_2 = (1 x mg/L Fe) + (3 x mg/L Mn) + (6x mg/L H_2S) + (8 x mg/L NH_3)

SUGGESTED OPERATING CONDITIONS

Bed Type

Dual media; anthracite 15-18 in. (381 mm - 457 mm) and GreensandPlus 15-24 in. (381 mm - 610 mm)

Capacity

700-1200 grains of oxidized iron and manganese/sq.ft. of bed area based on oxidant demand and operation to iron break through or dp limitations.

Backwash

Sufficient rate using treated water to produce 40% bed expansion for 10 minutes or until waste water is clear.

Air/Water Scour

Optional using 0.8-2.0 cfm/sq. ft (15 m/hr - 37 m/hr) with a simultaneous treated water backwash at 4.0-4.5 gpm/sq. ft. (9.8 m/hr - 11.03 m/hr)

Raw Water Rinse

At normal service flow rate for 3 minutes or until effluent is acceptable.

Flow Rate

Recommended flow rates with CO operation are 2-12 gpm/sq. ft. (4.9 m/hr - 29.4 m/hr) Extremely high concentrations of iron and manganese usually require lower flow rates for equivalent run lengths. Higher flow rates can be considered with very low concentrations of iron and manganese. For optimizing design parameters, pilot plant testing is recommended.The run length between backwashes can be estimated as follows:

What is the run length for a water containing 1.7 mg/L iron and 0.3 mg/L manganese at a 4 gpm/sq. ft. service rate:

Contaminant loading

= (1 x mg/L Fe) + (2 x mg/L Mn)
= (1 x 1.7) + (2 x 0.3)
= (2.3 mg/L or 2.3/17.1 = 0.13 grains/gal. (gpg)

At 1,200 grains / sq. ft. loading ÷ 0.13 gpg = 9,230 gal./sq. ft.

At 4 gpm / sq. ft. service rate 9,230/4 = 2,307 min.

The backwash frequency is approximately every 32-38 hours of actual operation.

The Intermittent regeneration (IR) operation is available for certain applications. Contact your Inversand representative for additional information.

GENERAL NOTES

pH

Raw waters having natural pH of 6.2 or above can be filtered through GreensandPlus without pH correction. Raw waters with a pH lower than 6.2 should be pH-corrected to 6.5-6.8 before filtration. Additional alkali should be added following the filters if a pH higher than 6.5-6.8 is desired in the treated water. This prevents the possible adverse reaction and formation of a colloidal precipitate that sometimes occurs with iron and alkali at a pH above 6.8.

Initial Conditioning of GreensandPlus

GreensandPlus media must be backwashed prior to adding the anthracite cap. The GreensandPlus backwash rate must be a minimum of 12 gpm/sq. ft. @ 55 °F.

This initial backwash could last for up to 60 minutes to thoroughly remove the fine dust. After backwashing is complete, the GreensandPlus must be conditioned. Mix 0.5 gal. (1.9 L) of 6% household bleach or

Initial Conditioning of GreensandPlus

0.2 gal (0.75 L) of 12% sodium hypochlorite for every 1 cu. ft. (28.3 L cu. m) of GreensandPlus into 6.5 gallons (25 L) of water.

Drain the filter enough to add the diluted chlorine mix. Apply the diluted chlorine to the filter being sure to allow the solution to contact the GreensandPlus media. Let soak for a minimum of 4 hours, then rinse to waste until the "free" chlorine residual is less than 0.2 mg/L. The GreensandPlus is now ready for service.

Radium and Arsenic Removal Using GreensandPlus

The GreensandPlus CO process has been found to be successful in removing radium and arsenic from well water. This occurs via adsorption onto the manganese and/or iron precipitates that are formed. For radium removal, soluble manganese must be present in or added to the raw water for removal to occur. Arsenic removal requires iron to be present in or added to the raw water to accomplish removal. Pilot plant testing is recommended in either case.

REFERENCES

USA

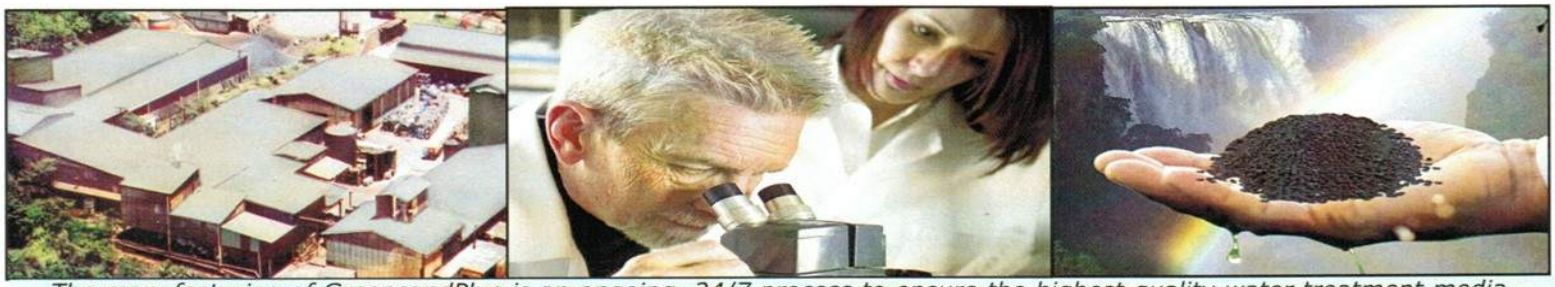
American Water Company, CA
San Jacinto, CA
City of Tallahassee, FL
Adedge Technologies, Inc., Buford, GA
City of Mason City, IL
City of Goshen, IN
City of Hutchinson, KS
City of Burlington, MA
Dedham Water Co., MA
Raynham Center, MA
Northbrook Farms, MD
Sykesville, MD
Tonka Equipment Company, Plymouth, MN
City of New Bern, NC
Onslow County, NC
Hungerford & Terry, Inc., Clayton, NJ
Fort Dix, NJ
Jackson Twsp. MUA, NJ

USA

Churchill County, NV
Suffolk County Water Authority, NY
City of Urbana, OH
Roberts Filter Group, Darby, PA

International

Watergroup, Saskatoon, SK Canada
BI Pure Water, Surrey, BC Canada
Sydney, Nova Scotia, Canada
PT Besflo Prima, Jakarta, Indonesia
Eurotrol, Milanese, Italy
Gargon Industrial, Mexico City, Mexico
Filtration Tech, Auckland, New Zealand
Alamo Water Poland, Izabelin, Poland
Aquatrol Company, Moscow, Russia
Impulse Group, St. Petersburg, Russia
Brenntag Nordic, Taby, Sweden
Nema Kimya, Istanbul, Turkey
Minh Tam, Ho Chi Minh City, Vietnam



The manufacturing of GreensandPlus is an ongoing, 24/7 process to ensure the highest quality water treatment media.

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Disclaimer: The information and recommendations in this publication are true and reliable to the best of our knowledge. These recommendations are offered in good faith but without warranty or liability for consequential damage as conditions and method of use of our products are varied and beyond our control. We suggest the user determine the suitability and performance of our products before they are adopted on a commercial scale.

AquaSand Filters
Operating Instructions for Iron, Manganese Removal Filters

Filter Tech Systems

1. Automatic Operation

The AquaSand iron and manganese removal filters have been designed for full automatic operation, with the backwash cycle being initiated by a differential pressure switch or filtration run time. The pressure differential set point is set at 7.5 psi differential and must be maintained no higher than 10 psid.

2. Backwash Cycle

The instrumentation is designed so the filters may also be placed into a backwash cycle at any time by use of a semi-automatic graphic start button. When the selector switch is in the semi-automatic position the pressure differential switch will not start the filters into a backwash cycle. Care should be taken so that the backwash switch is maintained in the automatic position unless a manual operation is to be performed with an operator in attendance.

The chemical feed pump will cycle off and on with the well pumps, provided that the switches on the control panel for the chemical feed pumps are in the auto position.

When the loss of the head across the filters reaches 7.5 - 10 psi and the DP set point is reached, a backwash time delay timer is started. The time delay relay should be set for approximately 30 seconds so a sudden surge will not initiate a backwash before the pressure loss has built up to the DP set point.

The backwash selector switch must be in the full automatic position for the differential pressure switch to start a backwash cycle. If the selector switch is in semi-automatic position the push button must pressed to start a backwash cycle.

Approximately 30 seconds after the time delay relay is pulled in the programmed timer is started into operation.

Programmed timer contacts will energize the pilot solenoids for the pneumatic valves for the filter selected for operation. Operation of the valves will be in the manner described in the following backwash cycle.

3. Protect Filters and Filter Beds

The filter tanks have been designed for a maximum working pressure of 135 psi. Do not allow the pressure to exceed this figure. All surges and/or water hammers must be prevented from reaching the filters to prevent damage occurring due to surges or water hammer. The AquaSand manganese greensand filters must not be allowed to operate past a pressure loss of 12 psi. If the filters are

allowed to exceed an excess of 12 psi, pressure loss across the bed will damage the AquaSand manganese greensand.

4. Chemical Feed

a. The chemical feed pumps must run whenever the well pump(s) is on and water is flowing through the filter.

b. ADJUST the chlorine feed pump so that the minimum residual is maintained at the minimum of 0.3 ppm at the effluent of the filters.

5. Operation Record (Log) Sheets

Complete the record sheets EACH DAY so that a history of operation is developed. Record in the "operator's notes or comments" section any items that cannot be fit into the labeled sections of the log sheets, particularly those that would be useful to others diagnosing problems that may develop. Use record sheets as a diary.

Send one good copy of the record sheets to Filter Tech Systems Inc. at the close of each month.

6. Loss of Media

During operation of the filters, it is inevitable that the larger particles of anthracite and AQUASAND manganese greensand may break into smaller particles and are lost out the backwash. Within limits, this attrition is normal. After a period of time, it may be necessary to add AQUASAND manganese greensand and/or AQUAKOL anthracite medias.

7. Trouble Shooting

Troubles may develop - - - for a variety of reasons. When they do - - - consult first the following trouble shooting guide for possible explanations and suggestions for remedial actions to be taken.

If following the suggested remedies does not "solve" the problem, consult Filter Tech Systems Inc.

Filter Tech Systems, Inc.
2844 Chipeta Avenue Grand Junction, CO 81501
Tel: 970-254-2855 or 888.287.8292 Fax: 970-254-2858
www. FilterTechSystems.com

AquaSand Filters
Backwash Cycle

Filter Tech Systems

1. Filters can be backwashed automatically or manually.

2. In automatic mode, filters can be backwashed based on differential pressure or filter run time or either.

3. START Backwash when the differential-pressure across the filters reaches 7.5 psi or the filtration run time has been reached.

4. CLOSE Well Water Inlet Valve (leaving open the Filter Effluent/Backwash Inlet Valve).

5. OPEN Backwash Outlet Valve.

6. Backwash for the following:

TIME	RATE
8 minutes	462 gpm

7. CLOSE Filter Effluent Valve.
   CLOSE Backwash Outlet Valve.

8. OPEN Well Water In Valve.
   OPEN Rinse Valve
   Rinse for: 10 minutes @ 967 gpm.

9. OPEN Filter Effluent Valve.
   CLOSE Rinse Valve.

   Filter is now in Service Mode.

10. CHECK the chlorine level to ensure that the water leaving the filters is at the desired disinfection level.

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www. FilterTechSystems.com

Filter Tech Systems
600 gpm AquaSand
Pressure Vessel System
Green Road Well Water Treatment

Section 2 Mechanical Drawings

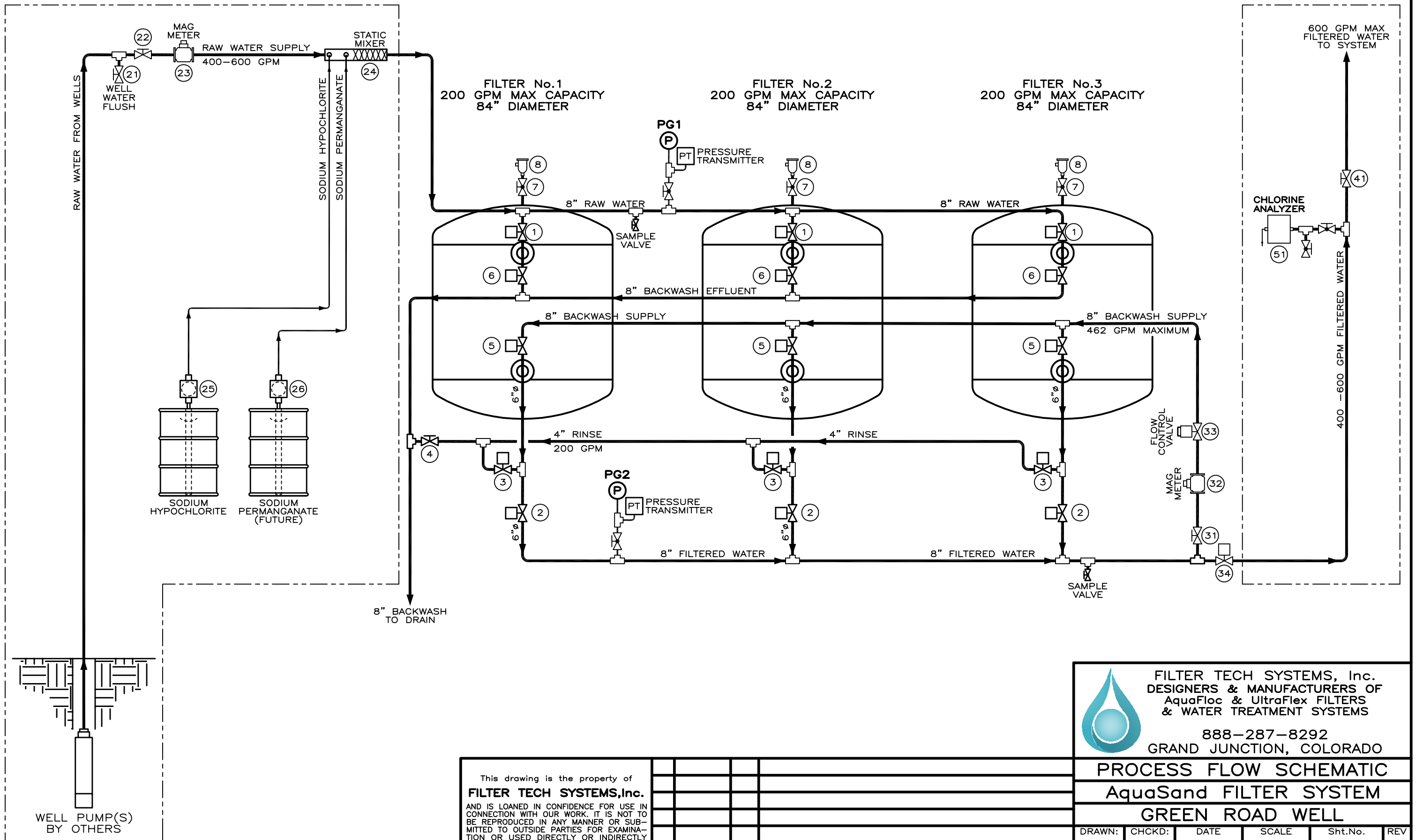
Document	Description
00	Table of Contents
1A-0	Item List
1A-1	Process Flow Schematic
2A-1	Filter Orientation
2B-1	Filter Media Schedule
3A-1	Skid Elevation
3A-2	Skid Plan View
3A-3	Piping Side View
4A-1	Filter Inlet Distribution Header
4A-2	Filter Inlet Installation
4B-1	Filter Underdrain Assembly
4B-2	Filter Underdrain Installation
5A-1	Air Release Assembly
6A-1	Skid Mounting Details

Filter Tech Systems, Inc.
600 gpm AquaSand Item List
Green Road Well Water Treatment Facility

Item#	Qty	Size	Item	Purpose	Manufacturer	Description
Filter Components						
1	3	6"	Lug-Style Butterfly Valve with Electric Actuator	Raw Water Influent	Bray	Bray Model 31-119 Lug-Style Butterfly Valve With Cast Iron Body, Nylon Coated disc, 416 SS Stem, EPDM Seat Series And Series 70/A 120V Single Phase Electric Actuator p/n 311200-11010119, C1 with p/n 700121-113D0536/A Electric Actuator
2	3	6"	Lug-Style Butterfly Valve with Electric Actuator	Filtered Water Effluent	Bray	Bray Model 31-119 Lug-Style Butterfly Valve With Cast Iron Body, Nylon Coated disc, 416 SS Stem, EPDM Seat Series And Series 70/A 120V Single Phase Electric Actuator p/n 311200-11010119, C1 with p/n 700121-113D0536/A Electric Actuator
3	3	4"	Lug-Style Butterfly Valve with Electric Actuator	Rinse Valve	Bray	Bray Model 31-119 Lug-Style Butterfly Valve With Cast Iron Body, Nylon Coated disc, 416 SS Stem, EPDM Seat Series And Series 70/A 120V Single Phase Electric Actuator p/n 311200-11010119, C1 with p/n 700121-113D0536/A Electric Actuator
4	1	4"	Lug-Style Butterfly Valve with Lever	Rinse Rate Control	Bray	Bray Model 31-119 Lug-Style Butterfly Valve With Cast Iron Body, Nylon Coated disc, 416 SS Stem, EPDM Seat Series And Series 70/A 120V Single Phase Electric Actuator p/n 311200-11010119, C1 with p/n 700121-113D0536/A Electric Actuator
5	3	8"	Lug-Style Butterfly Valve with Electric Actuator	Backwash Supply	Bray	Bray Model 31-119 Lug-Style Butterfly Valve With Cast Iron Body, Nylon Coated disc, 416 SS Stem, EPDM Seat Series And Series 70/A 120V Single Phase Electric Actuator p/n 311200-11010119, C1 with p/n 700121-113D0536/A Electric Actuator
6	3	8"	Lug-Style Butterfly Valve with Electric Actuator	Backwash Effluent	Bray	Bray Model 31-119 Lug-Style Butterfly Valve With Cast Iron Body, Nylon Coated disc, 416 SS Stem, EPDM Seat Series And Series 70/A 120V Single Phase Electric Actuator p/n 311200-11010119, C1 with p/n 700121-113D0536/A Electric Actuator
7	3	1"	Ball Valve w/ Lever	Manual Air Bleed	Apollo	
8	3	1"	Air Relief Valve	Pressure Filter Air Relief	ValMatic	
9						
Backwash Supply Components						

600 gpm AquaSand Item List
Green Road Well Water Treatment Facility

Item#	Qty	Size	Item	Purpose	Manufacturer	Description
31	1	8"	Lug-Style Butterfly Valve with Electric Actuator	Backwash Supply Isolation	Bray	Bray Model 31-119 Lug-Style Butterfly Valve With Cast Iron Body, Nylon Coated disc, 416 SS Stem, EPDM Seat Series With Gear Operator and Handwheel p/n 310800-11010119, D1, with 040300-21202002 Handwheel Assembly
32	1	8"	Magnetic Flow Meter	Backwash Supply Flow	McCrometer	McCrometer Ultra Mag UM06 Flanged-Tube Electromagnetic Flow Meter with Remote Mount Signal Converter and 25' of Cable; 0-300 gpm output range
33	1	8"	Lug-Style Butterfly Valve with Electric Actuator & Positioner	Backwash Supply Flow Control	Bray	Bray Model 31-119 Lug-Style Butterfly Valve With Cast Iron Body, Nylon Coated disc, 416 SS Stem, EPDM Seat Series And Series 70/B 120V Single Phase Electric Actuator with 4-20 mA Control p/n 310600-11010119, C1 with p/n 700121-113A0536/B Electric Actuator
34	1	8"	Lug-Style Butterfly Valve with Electric Actuator	Filtered Water Shut Off Valve	Bray	Bray Model 31-119 Lug-Style Butterfly Valve With Cast Iron Body, Nylon Coated disc, 416 SS Stem, EPDM Seat Series And Series 70/A 120V Single Phase Electric Actuator p/n 311200-11010119, C1 with p/n 700121-113D0536/A Electric Actuator
Instruments & Analyzers						
PGIV	2	1/4"	Brass Ball Valve	Pressure Gauge Isolation	Apollo	
PG1,2	2	1/4"	0-160 PSI Gauge	Influent & Effluent Pressure	Ashcroft	
PT1,2	2	1/4"	Pressure Transmitter	Influent & Effluent Pressure	Dwyer	
SV1,2	2	1/2"	Smooth-Nose Ball Valve	Sample Valve	Matco Norca	Smooth-nose Ball Valve



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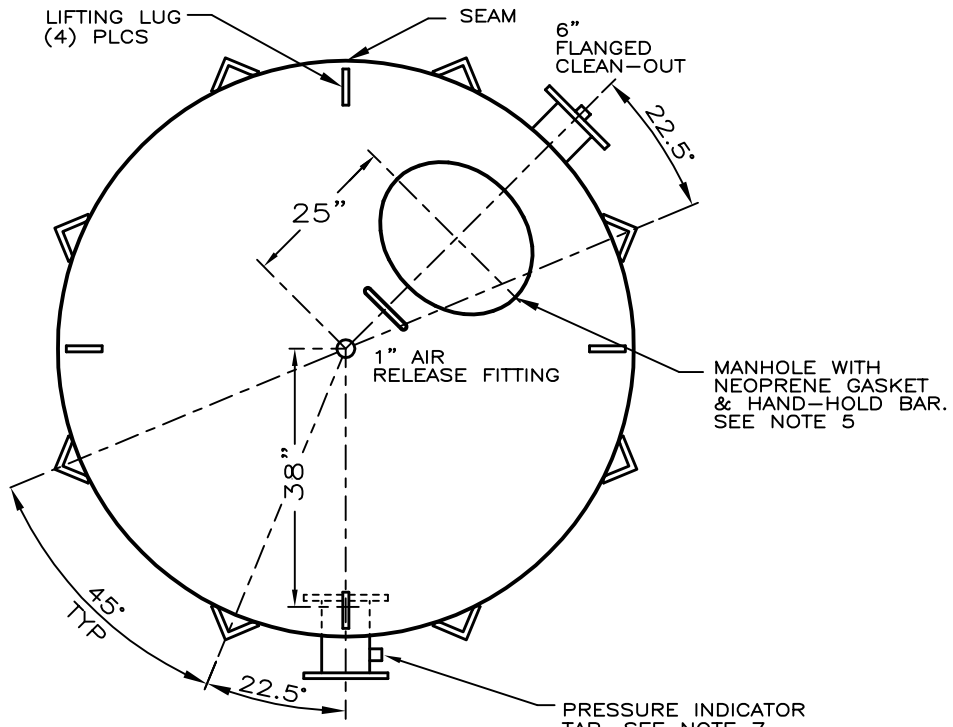
#	DATE	BY	DESCRIPTION

FILTER TECH SYSTEMS, Inc.
DESIGNERS & MANUFACTURERS OF
AquaFloc & UltraFlex FILTERS
& WATER TREATMENT SYSTEMS
888–287–8292
GRAND JUNCTION, COLORADO

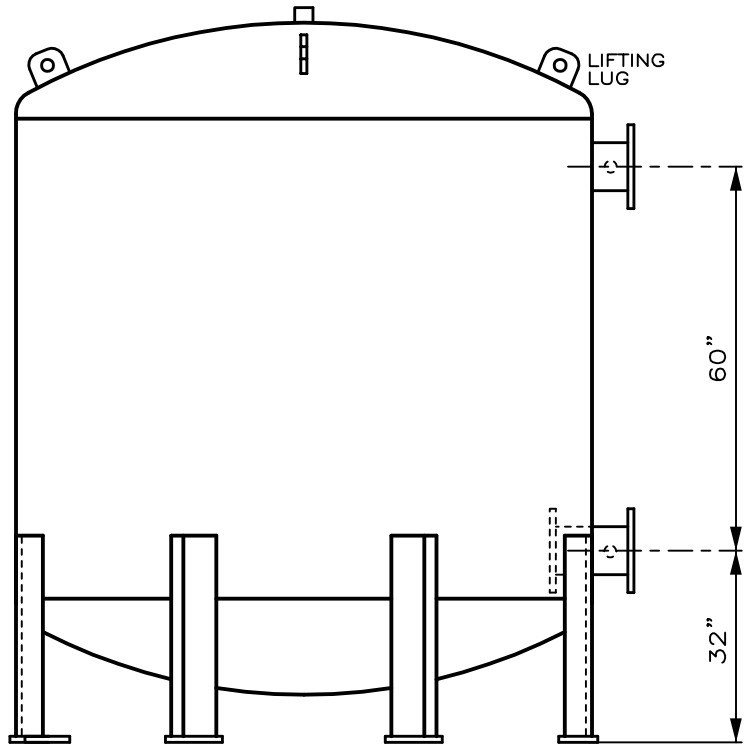
PROCESS FLOW SCHEMATIC
AquaSand FILTER SYSTEM
GREEN ROAD WELL

DRAWN:	CHCKD:	DATE	SCALE	Sht.No.	REV
DDJ		29 SEP'20	– NONE –	1A–1	0

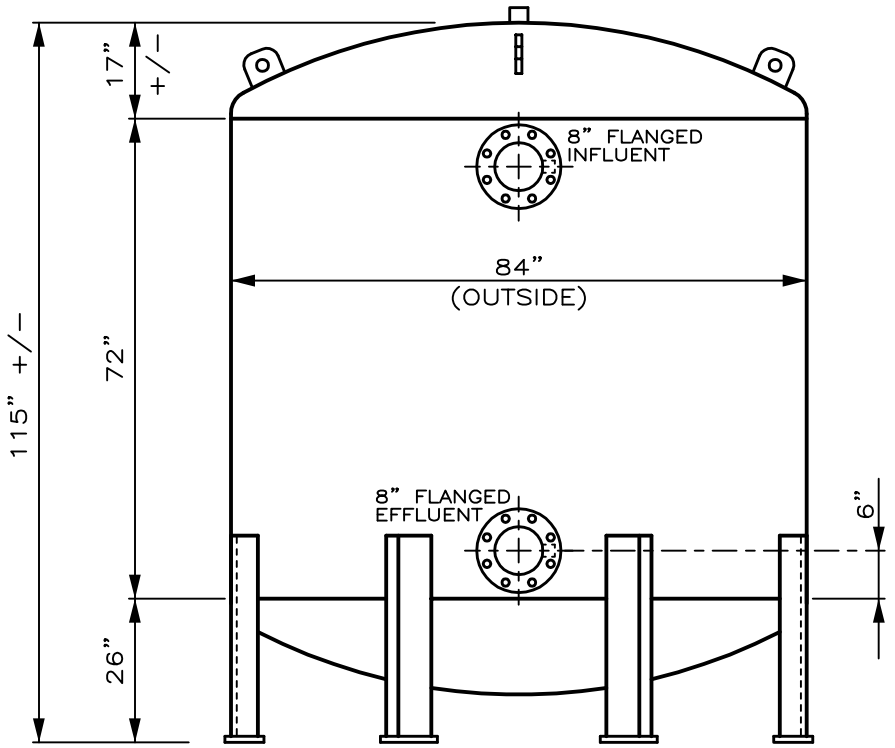
PROPOSAL No.	PROJECT No.
20–1235	4388–M



PLAN VIEW



SIDE VIEW



ELEVATION

NOTES:

1. WORKING PRESSURE: 135 PSI
   TEST PRESSURE: 180 PSI
2. CONSTRUCTION: ASME STAMPED
3. SURFACE COATING:
   INTERIOR:
   WHITE METAL BLAST
   (2)-COATS; 6-8 MILS PER COAT
   TNEMEC SERIES 20 POTA-POX
   EXTERIOR:
   COMMERCIAL BLAST
   ONE PRIME COAT; 4-6 MIL
   TNEMEC 66-1211 PRIMER
   TNEMEC SERIES 66 EPOXOLINE
   PIPING:
   TNEMEC SERIES 66 POXIPRIME
   TNEMEC SERIES 66 HI BUILD EPOXY
4. SHELL: 1/4" STEEL
   HEADS: 5/16" NOMINAL THICKNESS
5. MANWAY: 24" x 36"
6. INFLUENT: 8" 150# RF FLANGE
   EFFLUENT: 8" 150# RF FLANGE
7. PRESSURE PORTS: 1/4"
8. 1" AIR RELEASE VALVE

TYPICAL (3) FILTERS AS SHOWN

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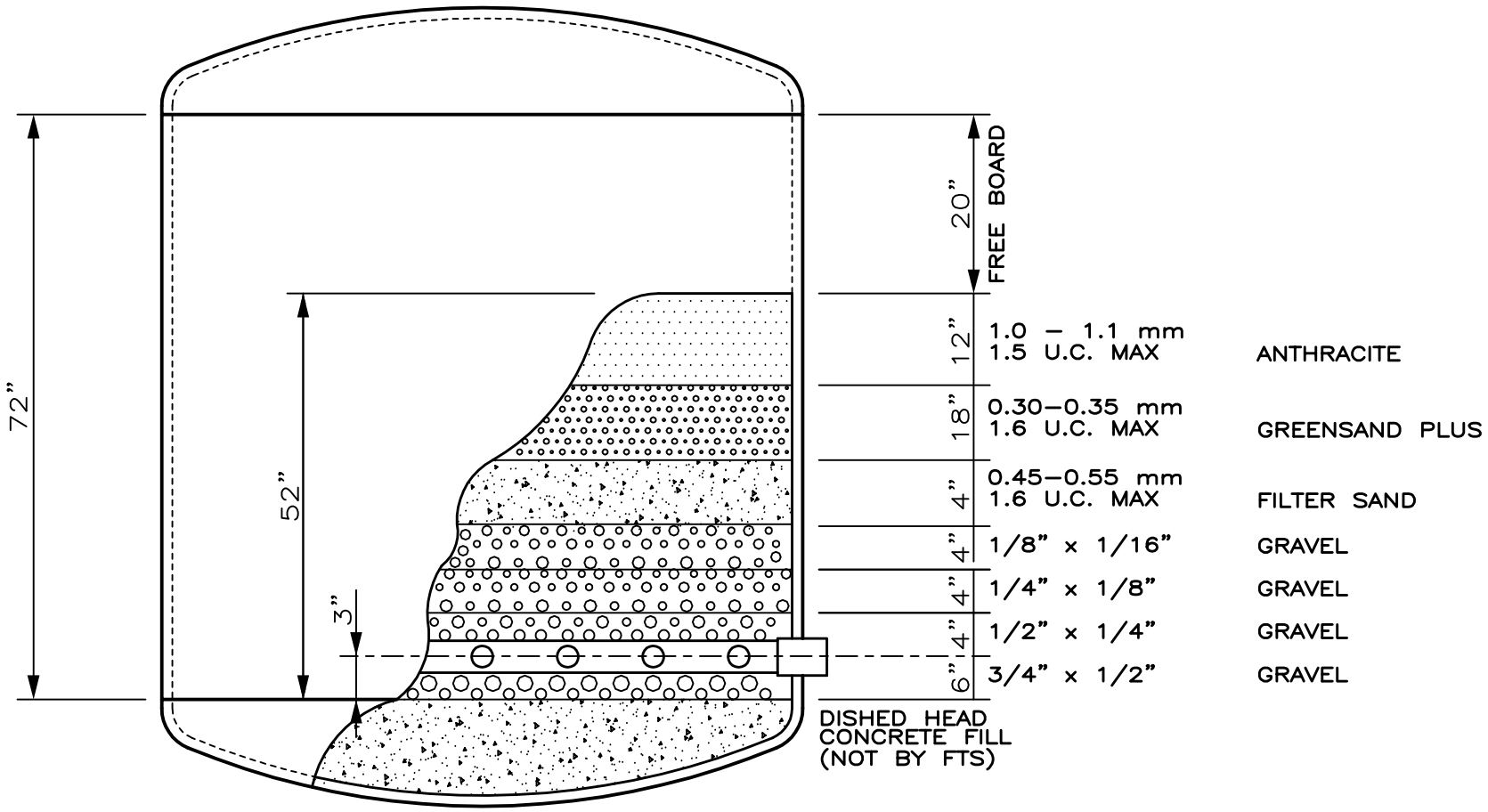
#	DATE	BY	DESCRIPTION

FILTER TECH SYSTEMS, Inc.
DESIGNERS & MANUFACTURERS OF
AquaFloc FILTERS
& WATER TREATMENT SYSTEMS
888-287-8292
GRAND JUNCTION, COLORADO

FILTER ORIENTATION
AquaSand FILTER SYSTEM
GREEN ROAD WELL

DRAWN:	CHCKD:	DATE	SCALE	Sht.No.	REV
TJB		03 FEB 21	- NONE -	2A-1	0

PROPOSAL No. 20-1335A
PROJECT No.



FILTER MEDIA

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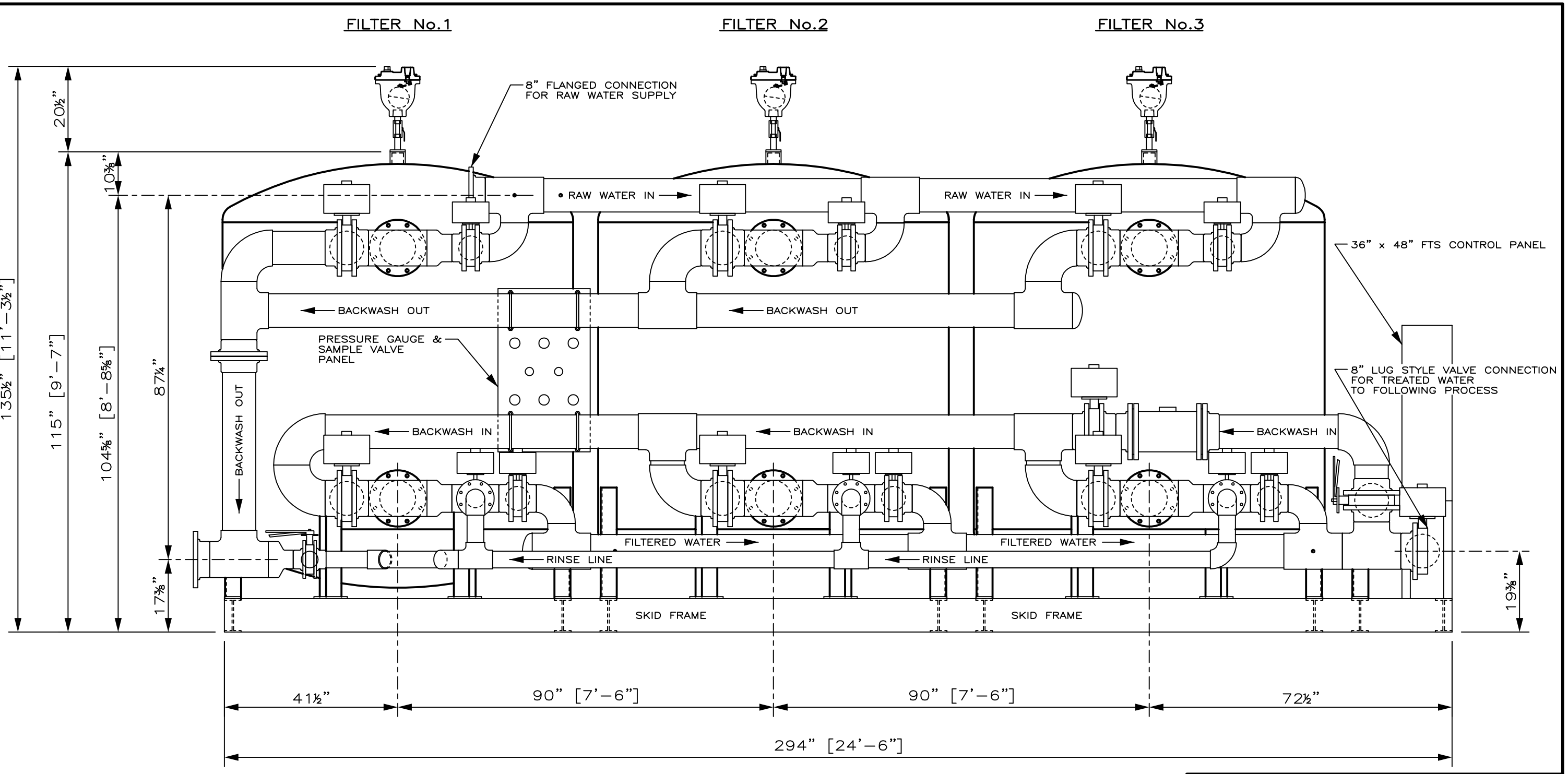
& WATER TREATMENT SYSTEMS
888–287–8292
GRAND JUNCTION, COLORADO

FILTER MEDIA SCHEDULE

AquaSand FILTER SYSTEM

GREEN ROAD WELL

DRAWN:	CHCKD:	DATE	SCALE	Sht.No.	REV
TJB		22 APR 21	– NONE –	2B–1	0
PROPOSAL No. 12–788D		PROJECT No. 3440–M			



AquaSand SKID ELEVATION

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#	DATE	BY	DESCRIPTION

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& WATER TREATMENT SYSTEMS
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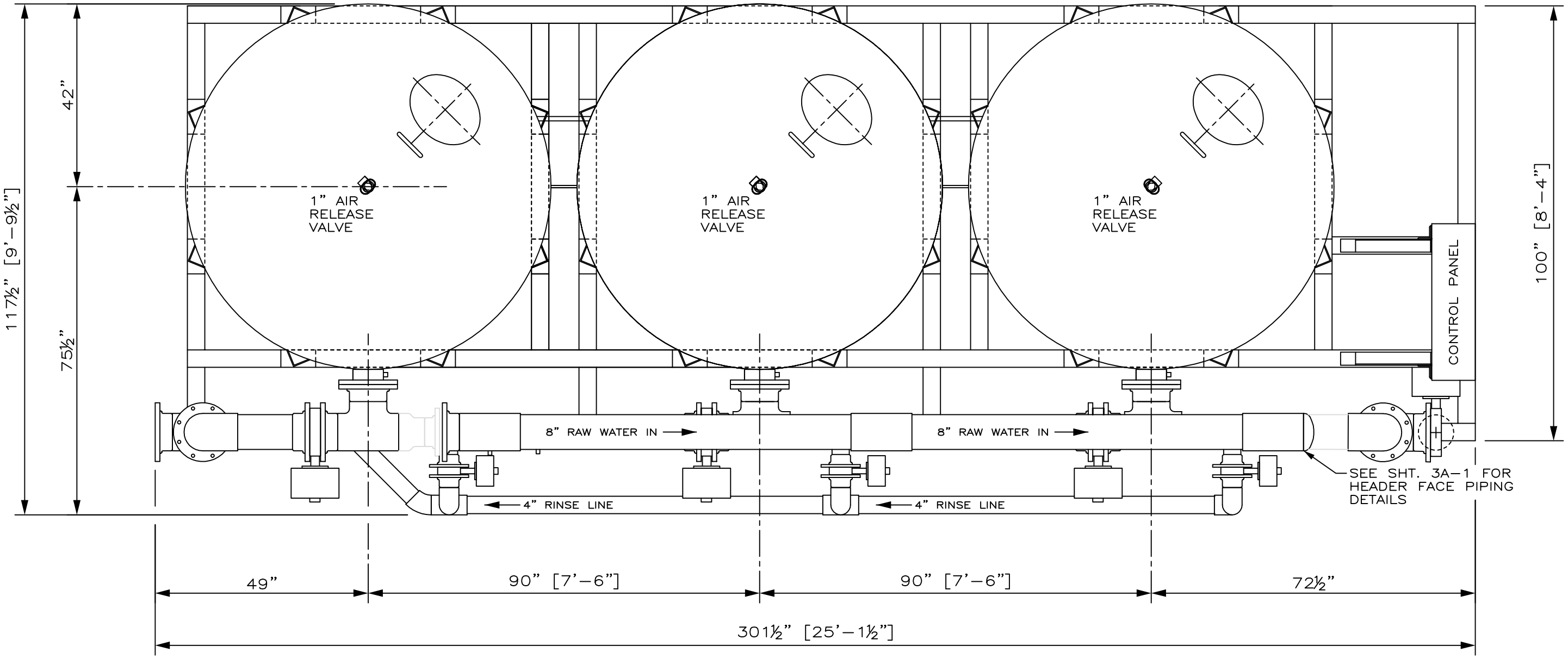
SKID ELEVATION

AquaSand FILTER SYSTEM

GREEN ROAD WELL

DRAWN:	CHCKD:	DATE	SCALE	Sht.No.	REV
TJB		06 MAY 21	1/2"=1'–0"	3A–1	0
PROPOSAL No. 20–1235		PROJECT No. 4388–M			



SKID PLAN VIEW

FILTER TECH SYSTEMS, Inc.
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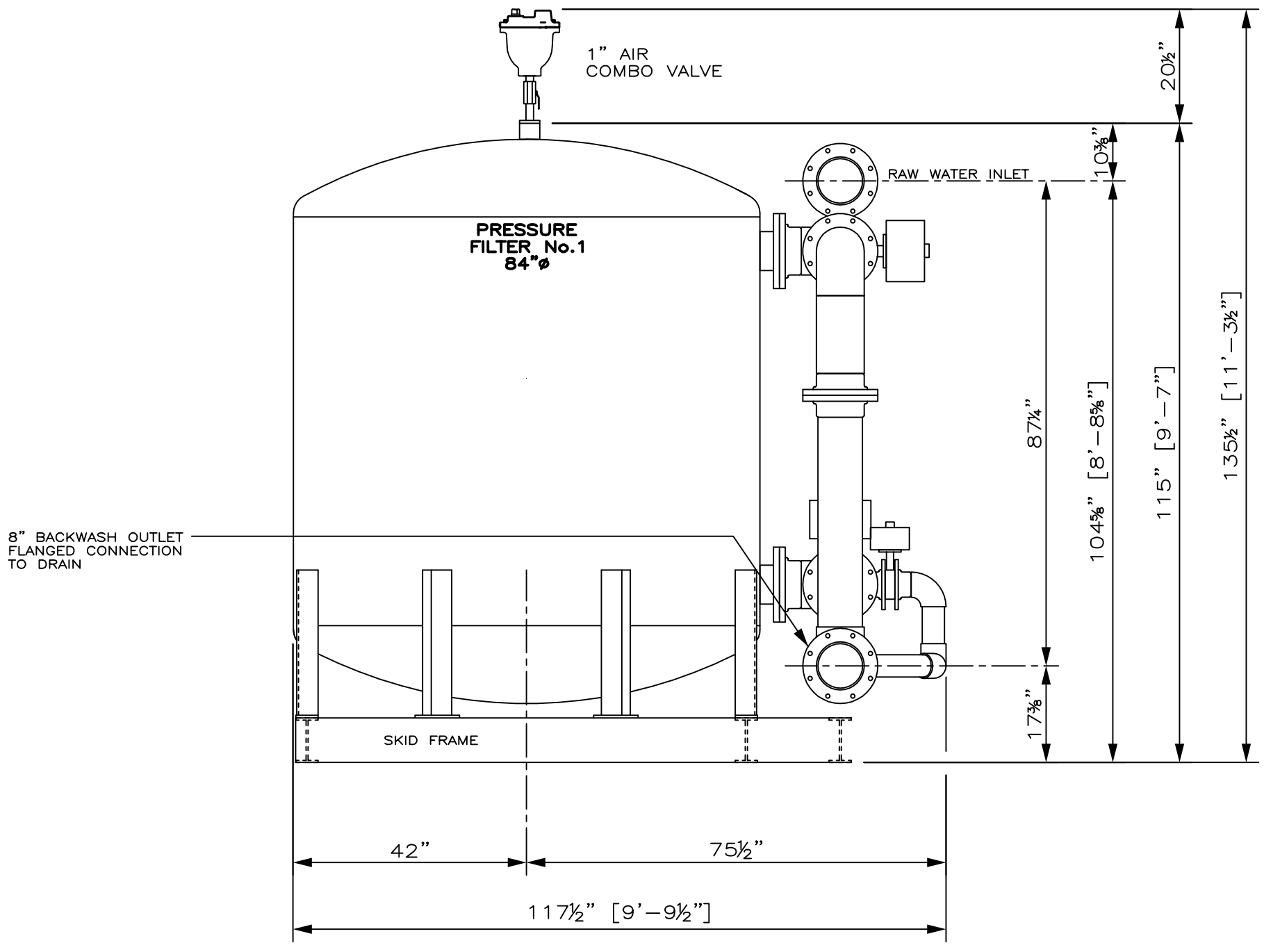
#	DATE	BY	DESCRIPTION

SKID PLAN VIEW
AquaSand FILTER SYSTEM
GREEN ROAD WELL

DRAWN:	CHCKD:	DATE	SCALE	Sht.No.	REV
TJB		06 MAY 21	1/2"=1'–0"	3A–2	0

PROPOSAL No. 20–1235
PROJECT No. 4388–M

FILTER No.1



AquaSand SKID
LEFT END VIEW

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#	DATE	BY	DESCRIPTION

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& WATER TREATMENT SYSTEMS
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GRAND JUNCTION, COLORADO

SKID LEFT END VIEW

AquaSand FILTER SYSTEM

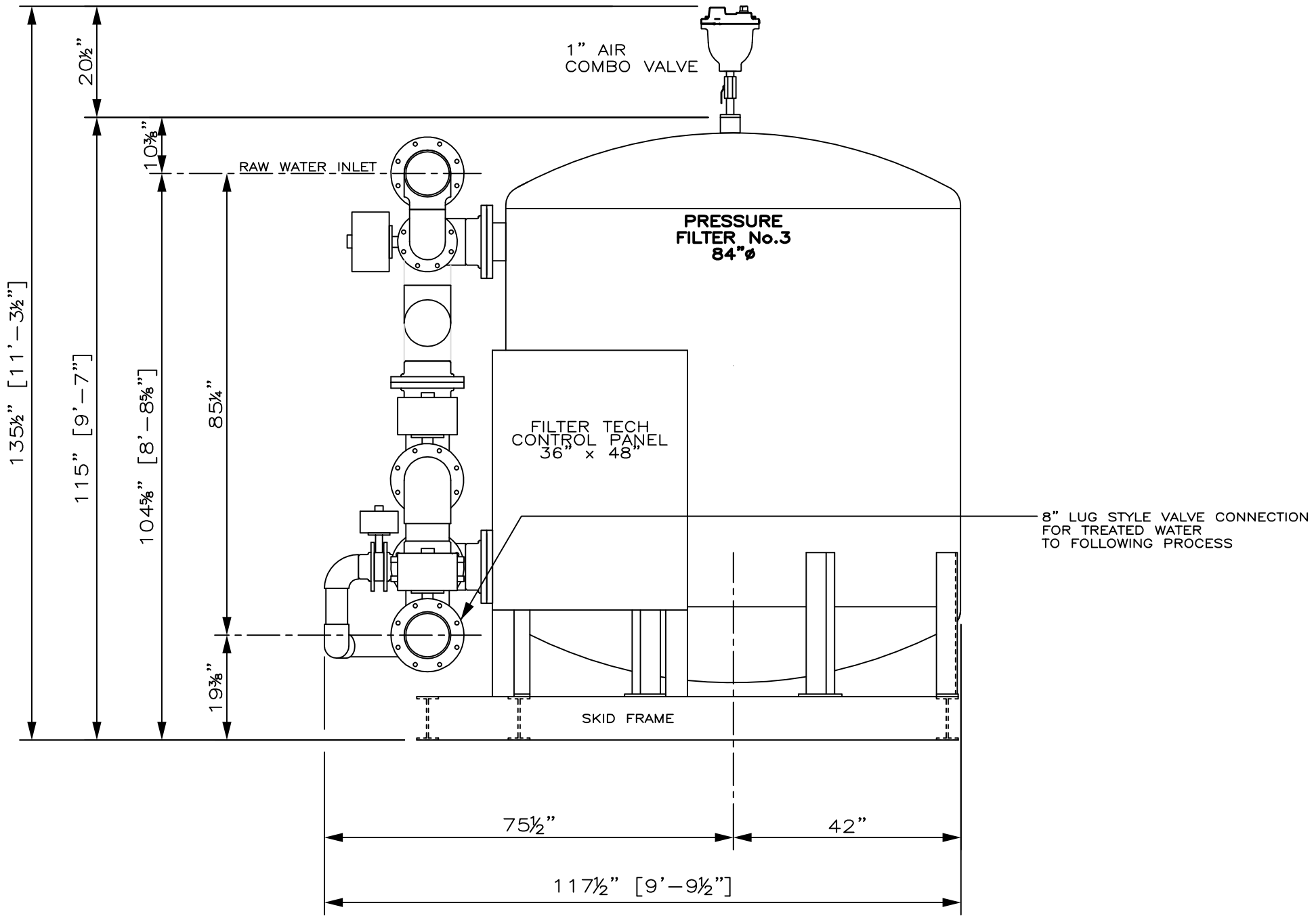
GREEN ROAD WELL

DRAWN:	CHCKD:	DATE	SCALE	Sht.No.	REV
TJB		06 MAY 21	1/2"=1'–0"	3A–3A	0

PROPOSAL No. 20–1235

PROJECT No. 4388–M

FILTER No.3



AquaSand SKID
RIGHT END VIEW

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#	DATE	BY	DESCRIPTION

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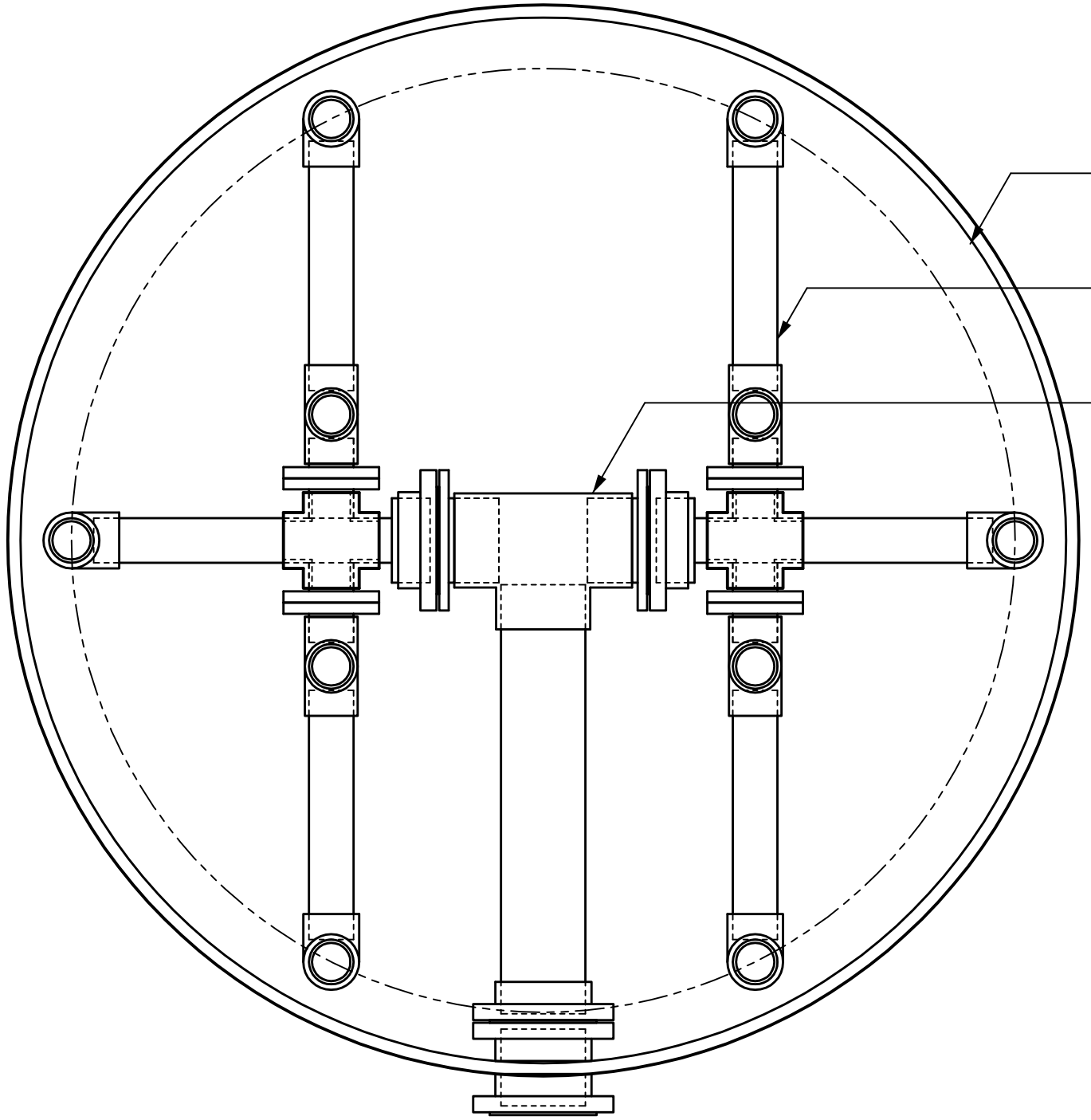
SKID RIGHT END VIEW

AquaSand FILTER SYSTEM

GREEN ROAD WELL

DRAWN:	CHCKD:	DATE	SCALE	Sht.No.	REV
TJB		06 MAY 21	1/2"=1'-0"	3A-3B	0

PROPOSAL No.	PROJECT No.
20-1235	4388-M



PLAN VIEW

SEE SHEET# 4A–2 FOR INSTALLATION
FILTER INLET ASSEMBLY
TYPICAL (3) PLACES

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#	DATE	BY	DESCRIPTION

FILTER TECH SYSTEMS, Inc.
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& WATER TREATMENT SYSTEMS
888–287–8292
GRAND JUNCTION, COLORADO

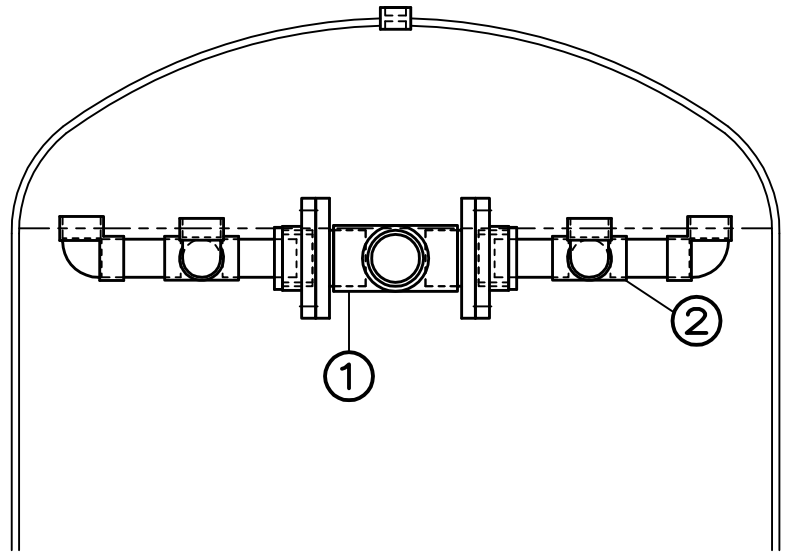
INLET HEADER ASSEMBLY

AquaSand FILTER SYSTEM

GREEN ROAD WELL

DRAWN:	CHCKD:	DATE	SCALE	Sht.No.	REV
TJB		23 APR 21	1" = 1'–0"	4A–1	0

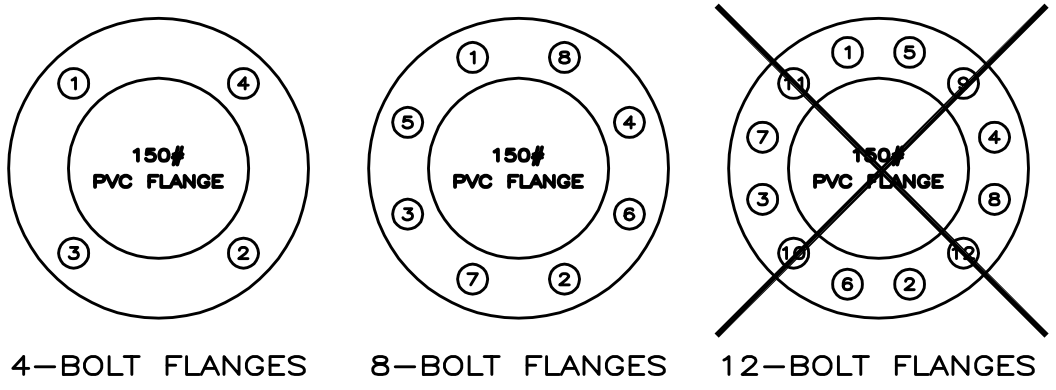
PROPOSAL No.	PROJECT No.
20–1235	4388–M



ELEVATION

FILTER INLET/BACKWASH OUTLET ASSEMBLY
TYPICAL (3) PLACES

1	6"	Sch80 PVC INLET HEADER
2	3"	Sch80 PVC LATERAL



4—BOLT FLANGES 8—BOLT FLANGES 12—BOLT FLANGES

FLANGE BOLT TIGHTENING PATTERN

TORQUE REQUIREMENTS

1/2"	THRU	1—1/2"	10—15 FT—LBS
2"	THRU	4"	20—30 FT—LBS
6"	THRU	8"	33—50 FT—LBS
10"			53—75 FT—LBS
12"			80—110 FT LBS

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#	DATE	BY	DESCRIPTION

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AquaFloc FILTERS
& WATER TREATMENT SYSTEMS
888—287—8292
GRAND JUNCTION, COLORADO

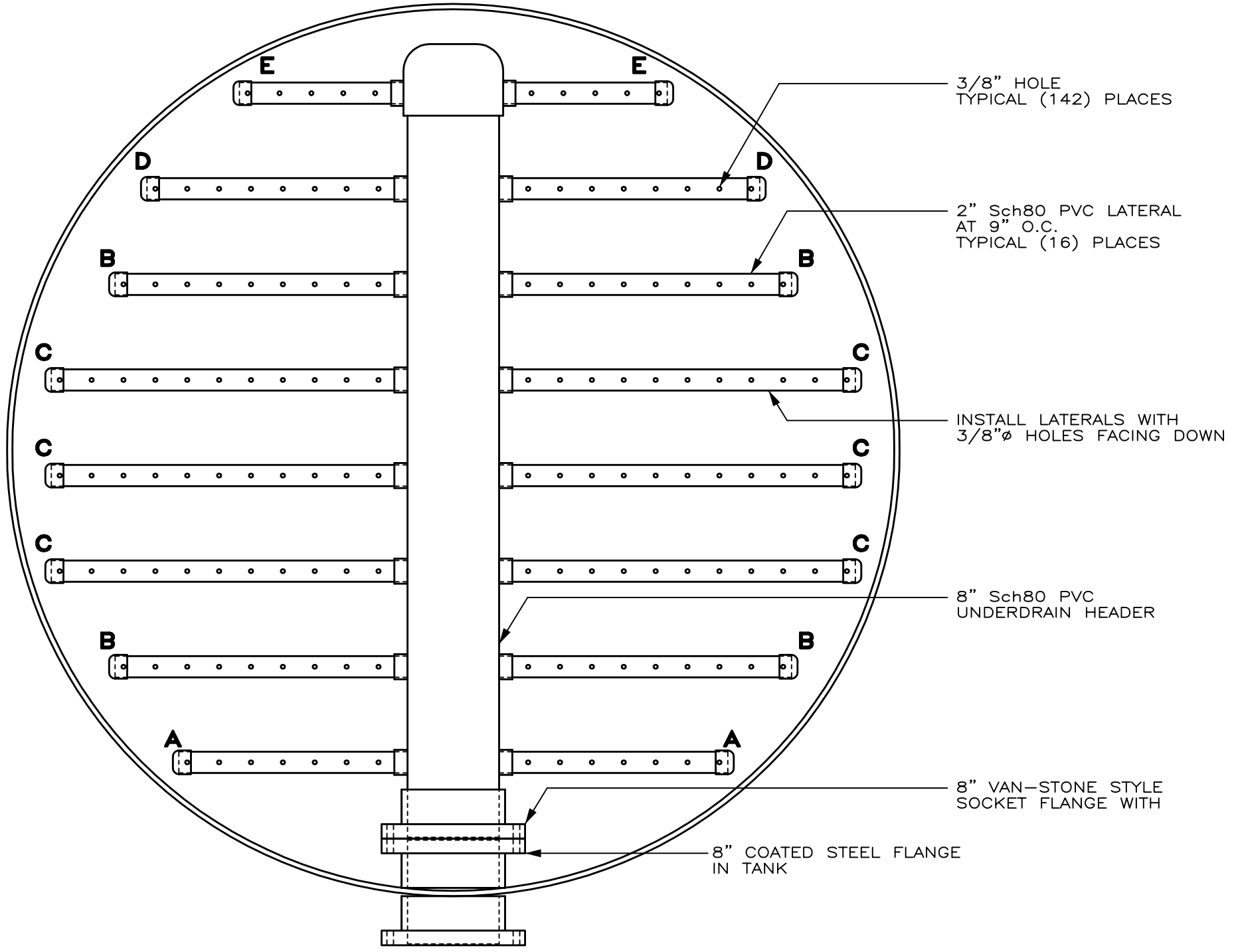
INLET HEADER INSTALLATION

AquaSand FILTER SYSTEM

GREEN ROAD WELL

DRAWN:	CHCKD:	DATE	SCALE	Sht.No.	REV
TJB		23 APR 21	— NONE —	4A—2	0

PROPOSAL No. 20—1235
PROJECT No. 4388—M



PLAN VIEW

FILTER UNDERDRAIN
TYPICAL (3) PLACES

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#	DATE	BY	DESCRIPTION

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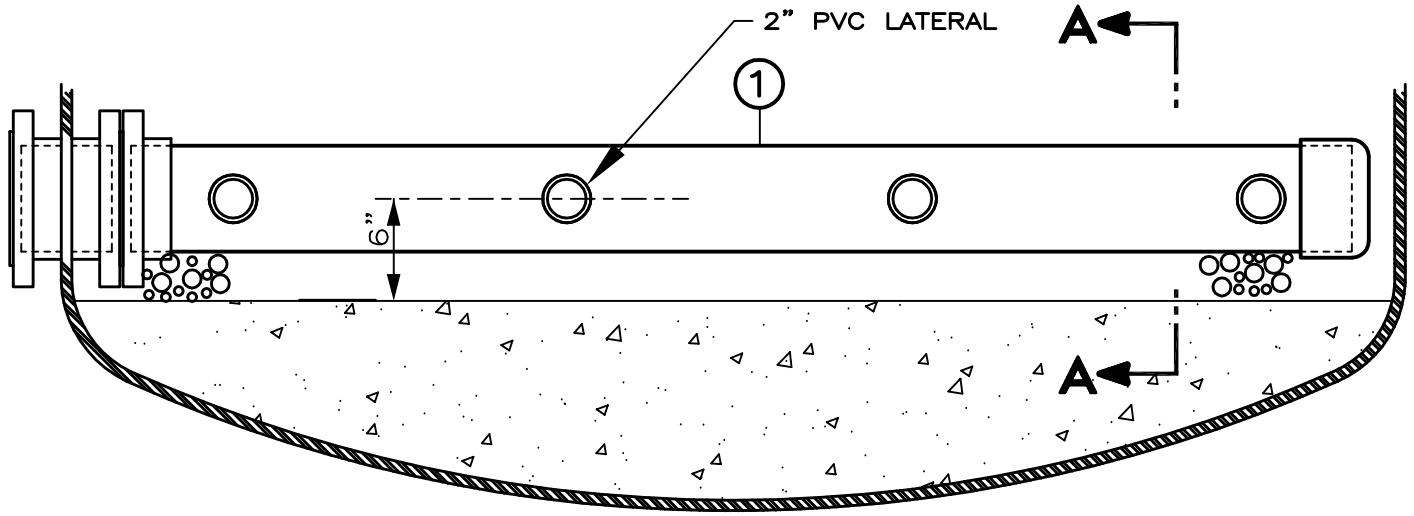
& WATER TREATMENT SYSTEMS
888-287-8292
GRAND JUNCTION, COLORADO

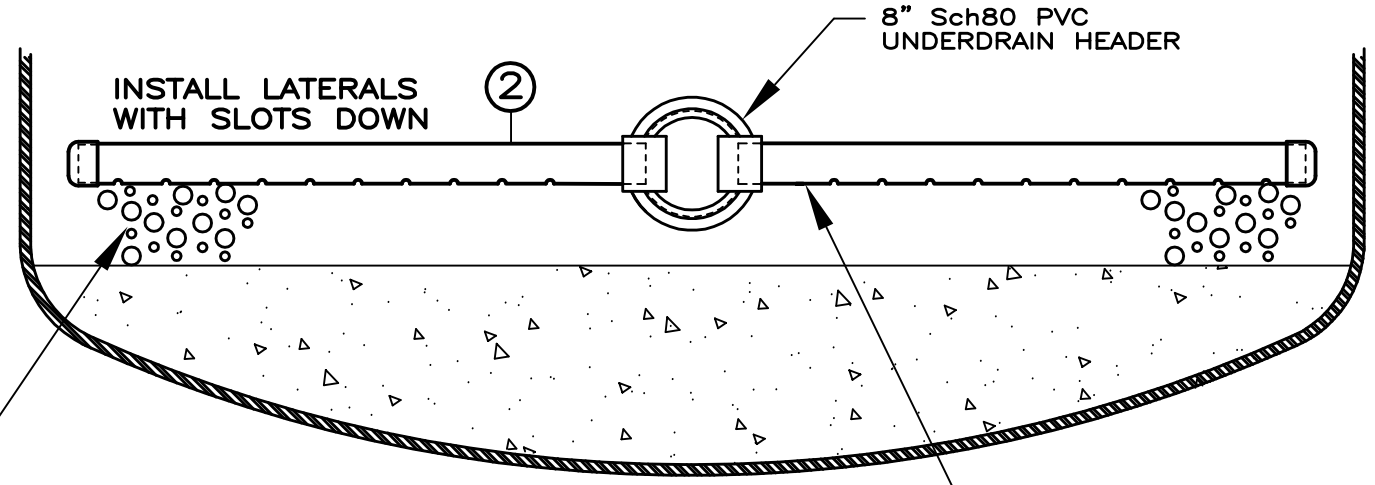
UNDERDRAIN ASSEMBLY
AquaSand FILTER SYSTEM
GREEN ROAD WELL

DRAWN:	CHCKD:	DATE	SCALE	Sht.No.	REV
TJB		23 APR 21	– NONE –	4B–1	0

PROPOSAL No.	PROJECT No.
20–1235	4388–M



ELEVATION



SECTION "A–A"

NOTE!

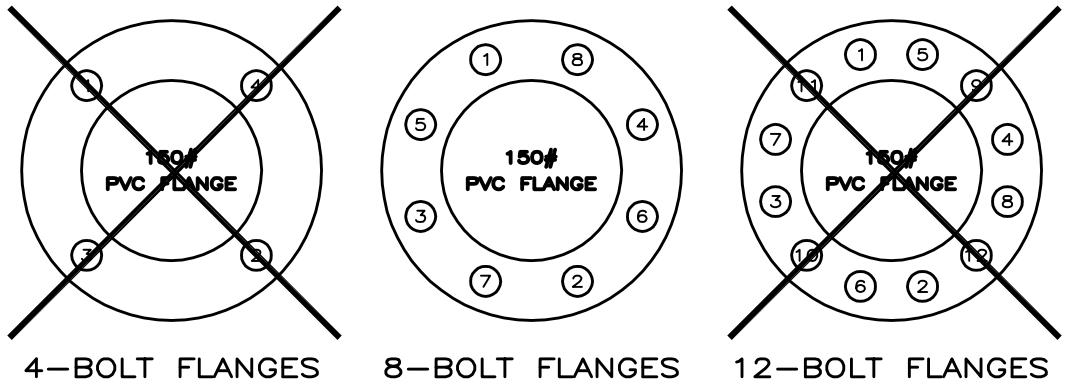
LATERALS MUST NOT BE LEFT UNSUPPORTED.

SUPPORT ENDS OF HEADERS AND LATERALS WITH PACKED GRAVEL DURING INSTALLATION

GRAVEL MUST BE HAND PACKED UNDER HEADER AND LATERAL TO FILL ALL VOIDS

① 8" Sch80 PVC OUTLET HEADER

② 2" Sch80 PVC LATERAL



4–BOLT FLANGES 8–BOLT FLANGES 12–BOLT FLANGES

FLANGE BOLT TIGHTENING PATTERN

TORQUE REQUIREMENTS

1/2"	THRU 1–1/2"	10–15	FT–LBS
2"	THRU 4"	20–30	FT–LBS
6"	THRU 8"	33–50	FT–LBS
10"		53–75	FT–LBS
12"		80–110	FT LBS

INSTALLATION NOTES:

1.) LEVEL HEADERS AND LATERALS BY LOOSENING FLANGE BOLTS AND ROTATING HEADER ASSEMBLY

2.) HAND TIGHTEN LATERALS UNTIL HOLES ARE POINTING STRAIGHT DOWN

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#	DATE	BY	DESCRIPTION

FILTER TECH SYSTEMS, Inc.
DESIGNERS & MANUFACTURERS OF
AquaFloc FILTERS
& WATER TREATMENT SYSTEMS
888–287–8292
GRAND JUNCTION, COLORADO

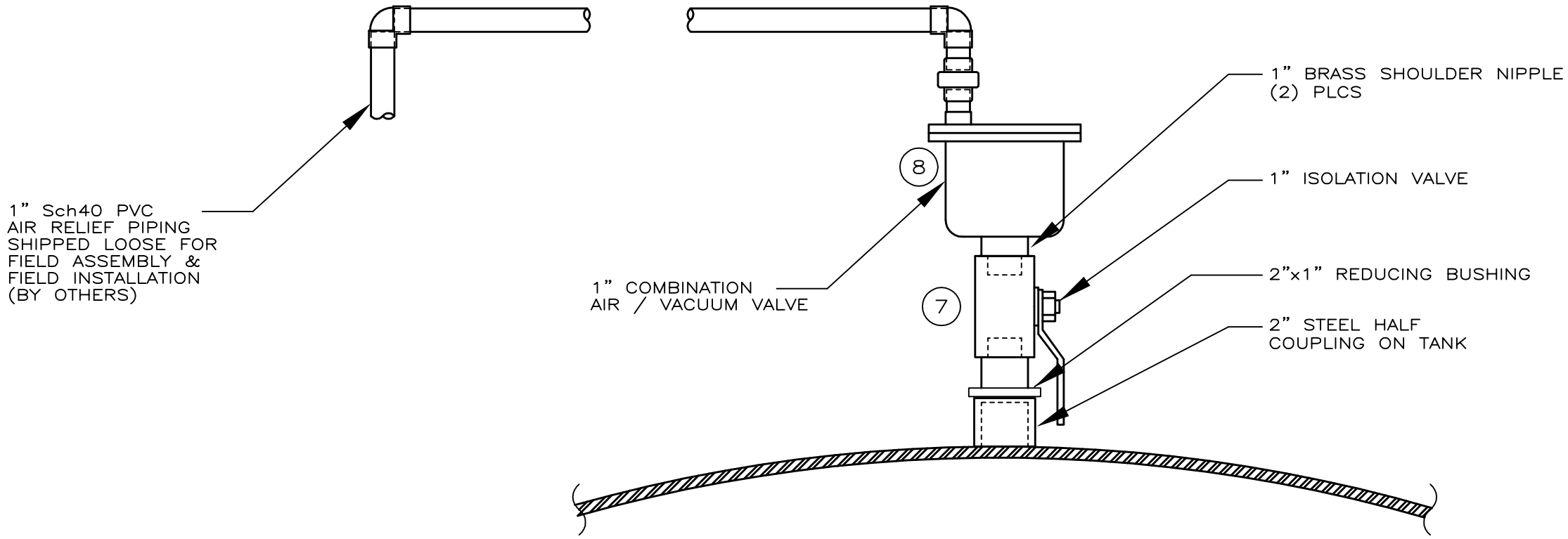
UNDERDRAIN INSTALLATION

AquaSand FILTER SYSTEM

GREEN ROAD WELL

DRAWN:	CHCKD:	DATE	SCALE	Sht.No.	REV
TJB		23 APR 21	– NONE –	4B–2	0

PROPOSAL No. 20–1235 PROJECT No. 4388–M



AIR RELIEF INSTALLATION

TYPICAL (3) PLACES

TO BE INSTALLED IN FIELD
BY OTHERS

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#	DATE	BY	DESCRIPTION

FILTER TECH SYSTEMS, Inc.
DESIGNERS & MANUFACTURERS OF
AquaFloc FILTERS
& WATER TREATMENT SYSTEMS

888-287-8292
GRAND JUNCTION, COLORADO

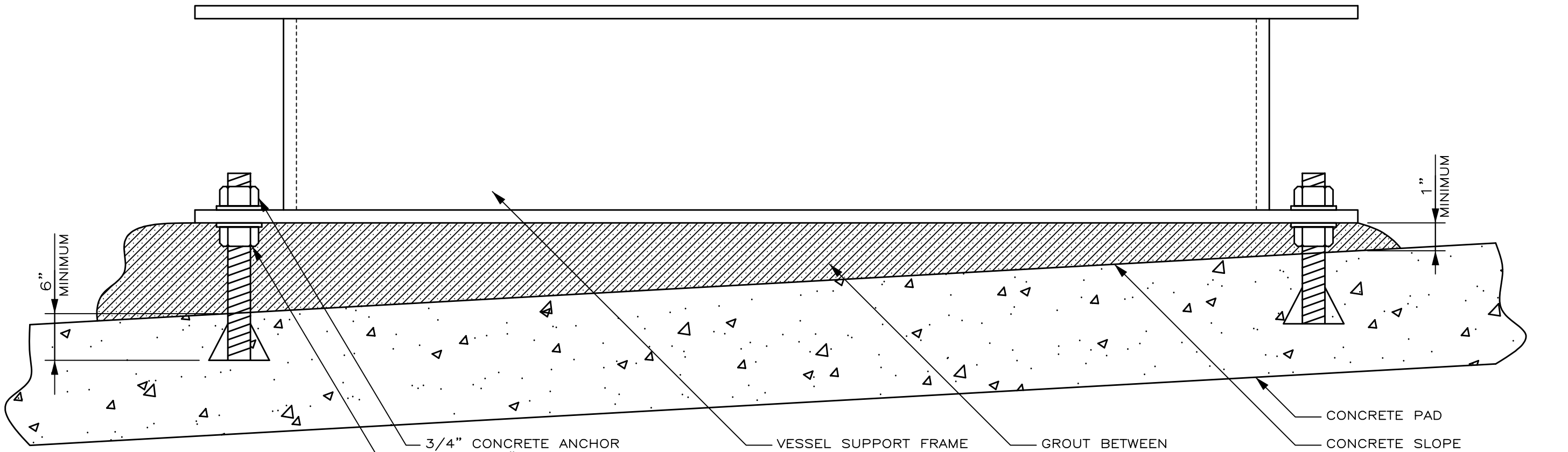
AIR/VAC VALVE

AquaSand FILTER SYSTEM

GREEN ROAD WELL

DRAWN:	CHCKD:	DATE	SCALE	Sht.No.	REV
TJB		23 APR 21	– NONE –	5A–1	0

PROPOSAL No.	PROJECT No.
20–1235	4388–M



SKID MOUNTING DETAILS

TO BE INSTALLED IN FIELD BY CONTRACTOR

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#	DATE	BY	DESCRIPTION

FILTER TECH SYSTEMS, Inc.
DESIGNERS & MANUFACTURERS OF
AquaFloc FILTERS
& WATER TREATMENT SYSTEMS
888–287–8292
GRAND JUNCTION, COLORADO

SKID MOUNTING DEATILS
AquaSand FILTER SYSTEM
GREEN ROAD WELL

DRAWN:	CHCKD:	DATE	SCALE	Sht.No.	REV
TJB		23 APR 21	– NONE –	6A–1	0

PROPOSAL No.	PROJECT No.
20–1235	4388–M

Filter Tech Systems
600 gpm AquaSand
Pressure Vessel System
Green Road Well Water Treatment

Section 3 Mechanical Equipment

Manufacturer	Description
Apollo	Isolation Valves
Ashcroft-WIKA	Pressure Gauges
Bray	Butterfly Valves
Dwyer	Pressure Transmitters
Matco-Norca	Hose Bibb (Sample Valves)
McCrometer	Flow Meter
Valmatic	Combination Air / Vacuum Breaker Valve

70LF-100 SERIES

LEAD FREE* BRONZE BALL VALVE

Item#: 7

1" Air Relief Valve Isolation Valve

Typical Three (3) Places

Item#: PGIV

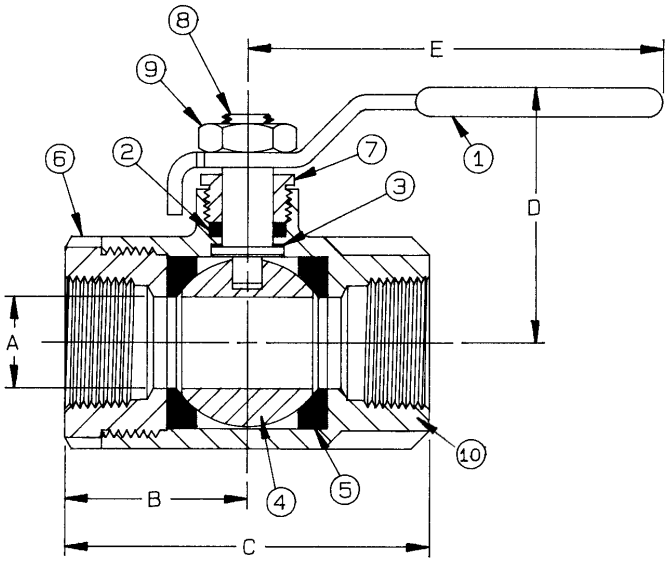
1/4" Gauge Supply Isolation Valves

Typical Two (2) Places

Female NPT Thread, 600 CWP (psig). 150 psig SWP. (See referenced P/T charts)
Vacuum Service to 29 inches Hg.
MSS SP-110 Compliant.
CRN: OC10908.5C

FEATURES

- Lead Free* brass and bronze materials
- NSF/ANSI/CAN 61 Section 8, Annex G
- Easily identifiable blue hang tag & white lever grip
- RPTFE seats and stuffing box ring
- Designed, manufactured, and 100% factory tested in the USA
- NSF/ANSI 372 - Drinking Water System Components - Lead Content



VARIATIONS AVAILABLE

- 70LF-140 Series (316 SS Ball & Stem)
- 70LF-HC Hose Cap & Chain

OPTIONS AVAILABLE

(MORE INFORMATION IN SECTION J)

- Minimum quantities apply
- To specify an option, replace the "01" standard suffix with the suffix of the option.
- To specify multiple options, replace the "01" suffix with the desired suffixes in the numerical order shown below. NOTE: Not all suffixes can be combined together.

(SUFFIX)	OPTION	SIZES
-01	Standard Configuration	All
-04-	2-1/4" Stem Extension (Carbon Steel, Zinc Plated)	1/4" to 3"
-07-	Steel Tee Handle	1/4" to 2"
-10-	SS Lever & Nut	All
-11-	Therma-Seal™ Insulating Tee Handle	1/4" to 2"
-27-	SS Latch-Lock Lever & Nut	1/2" to 4"
-32-	SS Tee Handle & Nut	1/2" to 2"
-47-	SS Oval Latch-Lock Handle & Nut	1/2" to 2"
-92-	Balancing Stop	1/4" to 3"
-94-	2-1/4" Stem Extension, Balancing Stop	1/4" to 3"
-HC-	Hose Cap & Chain with SS Lever & Nut	1/2" to 1"

Pressure/Temperature Ratings - Page M-10, Graph No. 3

STANDARD MATERIAL LIST

	PART	MATERIAL
1	Lever and grip	Steel, zinc plated w/vinyl
2	Stem packing	RPTFE
3	Stem bearing	RPTFE
4	Ball	C27451 Lead Free* Brass, Chrome Plated
5	Seat (2)	RPTFE
6	Retainer	C27451 Lead Free* Brass (1/4"-1") C89836 Lead Free* Bronze (1-1/4"-4")
7	Gland Nut	B16 Brass
8	Stem	C27451 Lead Free* Brass
9	Lever Nut	Steel, Zinc Plated
10	Body	C89836 Lead Free* Bronze

DIMENSIONS

PART NO.	SIZE	A	B	C	D	E	WT.
70LF-101-01	1/4"	0.37	1.03	2.06	1.75	3.87	0.60
70LF-102-01	3/8"	0.37	1.03	2.06	1.75	3.87	0.56
70LF-103-01	1/2"	0.50	1.12	2.25	1.75	3.87	0.63
70LF-104-01	3/4"	0.68	1.50	3.00	2.12	4.87	1.39
70LF-105-01	1"	0.87	1.68	3.37	2.25	4.87	1.72
70LF-106-01	1-1/4"	1.00	2.00	4.00	2.62	5.50	3.26
70LF-107-01	1-1/2"	1.25	2.18	4.37	3.06	8.00	4.61
70LF-108-01	2"	1.50	2.34	4.68	3.25	8.00	6.06
70LF-109-01	2-1/2"	2.00	3.12	6.25	3.72	8.00	13.96
70LF-100-01	3"	2.50	3.37	6.75	4.12	8.00	18.60
70LF-10A-01	4"	3.12	3.68	7.37	5.25	10.00	25.50

**LEAD FREE: The wetted surfaces of this product shall contain no more than 0.25% lead by weighted average. Complies with Federal Public Law 111-380. ANSI 3rd party approved and listed.*

Stainless Steel Pressure Gauges

Dry gauges are suitable for applications where vibration isn't a concern. Stainless steel cases and wetted materials resist corrosion. Suitable for use with potable water.

Item#: PG1 & 2: Influent & Effluent - 0-160 PSI

Back connection for panel mounting

ASHCROFT®

2½" & 3½" Ashcroft® Duralife® PLUS!™ Gauges with Back Connection

- **PLUS! performance provides vibration and pulse dampening without messy liquid**
- **Optional U-clamp panel kit allows for easy panel mounting**
- **Suitable for use with potable water**

NO LEAD

Back Connection shown with optional U-clamp

Accuracy:	±1.0% full scale
Range limits:	vacuum to 15,000 psi
Wetted materials:	316 stainless steel internal tube, no-lead bronze socket
Case material:	304 stainless steel, polycarbonate window
Process connection:	¼" NPT(M), back mount
Dial size:	2½" or 3½"
Pointer:	micrometer adjustable
Mounting:	stem, or U-clamp with back connection

		2½" DIAL GAUGES		3½" DIAL GAUGES	
RANGE	**GRADUATIONS**	**STOCK #**	**EACH**	**STOCK #**	**EACH**
30" to 0" Hg VAC	0.5	**34490**	**$ 76.95**	**34479**	**$ 99.95**
0 to 15 psi	0.2	**34491**	**76.95**	**34480**	**99.95**
0 to 30 psi	0.5	**34473**	**76.95**	**34481**	**99.95**
0 to 60 psi	1	**34474**	**76.95**	**34482**	**99.95**
0 to 100 psi	2	**34475**	**76.95**	**34483**	**99.95**
0 to 160 psi	2	**34476**	**76.95**	**34484**	**99.95**
0 to 200 psi	5	**34477**	**76.95**	**34485**	**99.95**
0 to 300 psi	5	**34478**	**76.95**	**34486**	**99.95**

Accessories

DESCRIPTION	**STOCK #**	**EACH**
U-Clamp for 2½" Back Connection Gauge	**34487**	**$ 8.89**
U-Clamp for 3½" Back Connection Gauge	**34488**	**12.49**

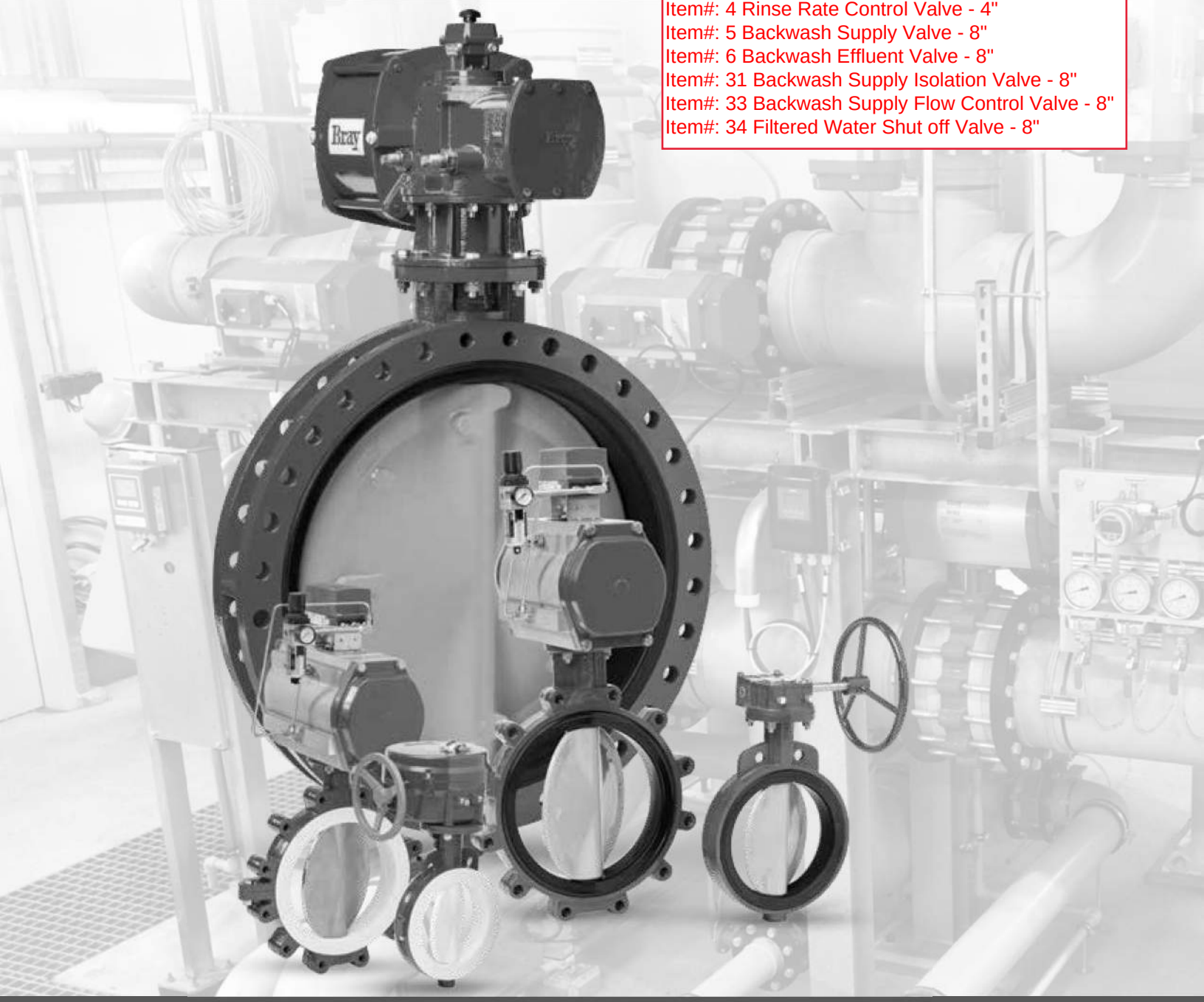
See pages 918-991 for our full selection of **Level & Pressure Equipment**.

USABlueBook-brand products are guaranteed to deliver the same or better performance as the more expensive brands.

RESILIENT SEATED

BUTTERFLY VALVES

Item#: 1 Raw Water Supply Valve - 6"
Item#: 2 Filtered Water Effluent Valve - 6"
Item#: 3 Rinse Valve - 4"
Item#: 4 Rinse Rate Control Valve - 4"
Item#: 5 Backwash Supply Valve - 8"
Item#: 6 Backwash Effluent Valve - 8"
Item#: 31 Backwash Supply Isolation Valve - 8"
Item#: 33 Backwash Supply Flow Control Valve - 8"
Item#: 34 Filtered Water Shut off Valve - 8"



Bray®

BRAY.COM

THE HIGH PERFORMANCE COMPANY

	Body Style	Size Range	Pressure Range	Page
Series 20	Wafer	1"-20" (25mm-500mm)	150 psi (10.3 bar)	**6**
Series 21	Lug	2"-20" (50mm-500mm)	150 psi (10.3 bar)	
Series 22	Wafer	2"-20" (50mm-500mm)	150 psi (10.3 bar)	**8**
Series 23	Lug	2"-20" (50mm-500mm)	150 psi (10.3 bar)	
	Double Flanged	24" (600mm)	150 psi (10.3 bar)	
Series 30	Wafer	2"-12" (50mm-300mm)	175 psi (12 bar)	**10**
		14"-20" (350mm-500mm)	150 psi (10.3 bar)	
Series 31	Lug	2"-12" (50mm-300mm)	175 psi (12 bar)	
		14"-20" (350mm-500mm)	150 psi (10.3 bar)	
Series 31H	Lug	2"-20" (50mm-500mm)	250 psi (17.2 bar)	**11**
Series 31U	Lug	2"-12" (50mm-300mm)	285 psi (20 bar)	**12**
Series 3A	Double Flanged	2"-12" (50mm-300mm)	175 psi (12 bar)	**14**
		14"-20" (350mm-500mm)	150 psi (10.3 bar)	
Series 3AH	Double Flanged	2"-20" (50mm-500mm)	250 psi (17.2 bar)	**15**
Series 32	Wafer	22"-36" (550mm-900mm)	75 psi (5.2 bar)	**18**
Series 33	Wafer	22"-36" (550mm-900mm)	150 psi (10.3 bar)	**18**
Series 35	Double Flanged	22"-120" (550mm-3000mm)	75 psi (5.2 bar)	**20**
Series 36	Double Flanged	22"-120" (550mm-3000mm)	150 psi (10.3 bar)	**20**
Series 35F	Double Flanged	32"-60" (800mm-1500mm)	75 psi (5.2 bar)	**21**
Series 36H	Double Flanged	22"-60" (550mm-1500mm)	232 psi (16 bar)	**21**
Actuators & Accessories				**22**

INTERNATIONAL COMPATIBILITY

Valve mounting top flanges meet ISO 5211 bolt circle standards for direct mounting of manual operators and power actuators. All Bray valves have extended necks which allow for at least 2" piping insulation.

ACTUATOR MOUNTING

All Bray actuators including handles, gear operators, pneumatic and electric actuators mount directly to Bray resilient seated valves. No brackets are required. This allows for simple installation in the field, minimizes possible misalignment and reduces overall height.

ISOLATION FROM LINE MEDIA

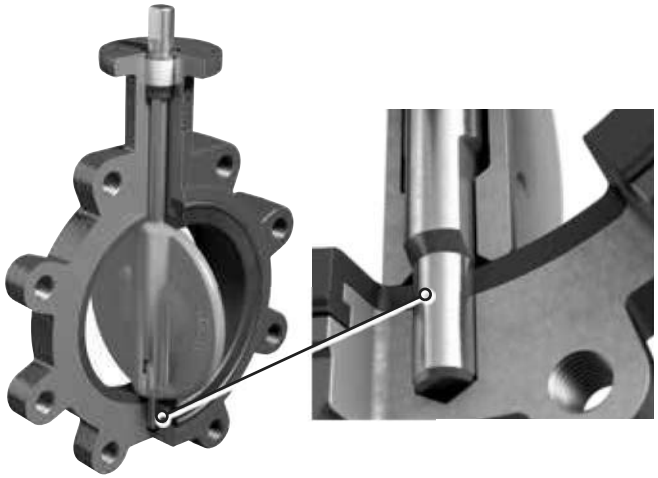
Bray's seat design and internal disc to stem connection isolates the line media from the body and stem.

INTERNAL DISC TO STEM CONNECTION

Series 30/31 Sizes 2"– 20" (50mm–500mm)

Bray offers Double "D" precision machined flats on the stem and in the disc. The Series 30/31 internal, non-wetted connections eliminate exposed external disc to stem connections.

The disc and the stem connection minimizes hysteresis and produces maximum strength engagements. All stem designs incorporate a blowout proof feature.



SEAT DESIGN

The seat is designed to seal with slip-on or weld-neck flanges and the molded o-ring eliminates the need for flange gaskets. The tongue and groove locks the seat in place and makes the valve dead end capable.

Tongue and Groove

POLYESTER COATING

The Bray standard polyester body coating is a hard, gloss red finish. The polyester coating provides excellent corrosion and wear resistance.

Chemical Resistant

Resistant to dilute acids and alkalies, petroleum solvents, alcohols, greases and oils.

Weatherability

Resistant to humidity, water and ultraviolet radiation.

Abrasion and Impact Resistant

NYLON 11 COATING

Nylon 11 has superior corrosion resistance and has been used successfully in many applications such as water, cement, food and seawater.

Weatherability

Bray's Nylon 11 coating has been salt spray tested in excess of 2000 hours and used in seawater immersion service for over 30 years without any deterioration of the coating resulting in no corrosion to the coated metal components.

Abrasion and Impact Resistant

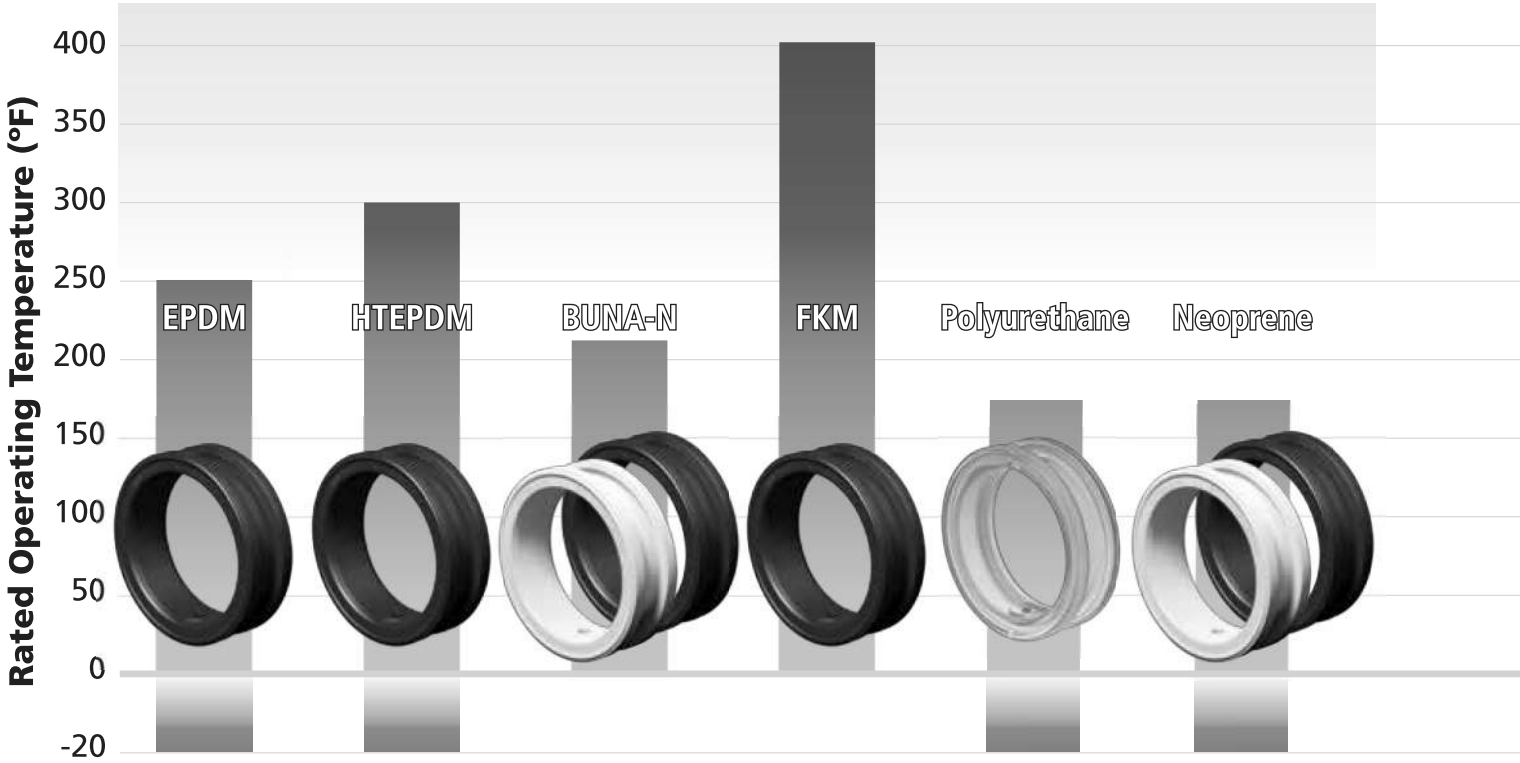
SEACORR® COATING

This proprietary coating for actuators provides superior product protection in corrosive conditions, tested to ASTM B-117.

Other customer specified coating materials are available. Please consult your local Bray representative for your specific application.

All Bray valves are pressure tested to 110% of rated pressure to assure bubble tight shutoff.

Series 20, 21, 3A, 30, 31, 32, 33, 35, 36



PEROXIDE CURED EPDM

-20°F to 250°F (-29°C to 121°C)

Bray's peroxide cured EPDM (Ethylene Propylene Diene Monomer) seats have a higher resistance to abrasion, lower compression set, and higher temperature capabilities than sulfur cured seats.

As a standard seat offering, Bray's peroxide cured EPDM is the most universal and economical seat material used in our resilient seated butterfly valves. All of Bray's peroxide cured EPDM seats are food grade and can be certified to NSF-61.

HTEPDM

-20°F to 300°F (-29°C to 150°C)

HTEPDM is a proprietary rubber blend offered by Bray to increase the thermal resistance properties of standard EPDM and is formulated to provide long term service at elevated temperatures for hot water. HTEPDM Food Grade seats are suitable for sanitary applications as well as standard industrial uses.

BUNA-N (Black or White)

0°F to 212°F (-18°C to 100°C)

BUNA-N is the commonly used name for Nitrile synthetic rubber. Nitrile is a copolymer of acrylonitrile and butadiene. BUNA-N is sometimes referred to as NBR, Nitrile, or Hycar. BUNA-N is a general purpose seat material particularly suitable for hydrocarbon service. BUNA-N is a standard Bray seat material and food grade is available for sanitary applications.

FKM

0°F to 400°F (-18°C to 204°C)

FKM is the ASTM D1418 designation for Fluorinated Hydrocarbon Elastomers (Fluoroelastomers) such as Viton® (DuPont). FKM has some outstanding characteristics such as improved acid, oil, and temperature resistance over other seat materials.

POLYURETHANE

-20°F to 175°F (-29°C to 80°C)

Polyurethane seats are primarily used because of their resistance to abrasive wear. Polyurethane can be used in a reasonably broad range of services and will withstand severe impact, recover its original shape after distortion and resist abrasion better than other elastomers.

NEOPRENE SEAT (Black or White)

0°F to 180°F (-18°C to 82°C)

Neoprene is an all-purpose polymer with desirable characteristics including high resiliency with low compression, resistance to vegetable and animal oil, and flame resistance. This sealing material is excellent for refrigerants, ammonia and Freon, and is principally used in pulp and (non-bleached) paper lines. Neoprene is not recommended for strong oxidizing acids, chlorinated solvents, esters, ketones, aromatic hydrocarbons or hydraulic fluids. White neoprene is generally used in sanitary applications while the black grade provides better abrasion and oil resistance.

The Bray Series 30/31 features a high strength one piece stem design utilizing an efficient internal disc to stem connection. This resilient seated butterfly valve provides a primary and secondary seal between the disc and seat as well as the stem and seat which ensures the total encapsulation of the line media and zero external leakage.

PRESSURE RATINGS

BIDIRECTIONAL BUBBLE TIGHT SHUT OFF – Standard Disc* Downstream flanges and disc in closed position		
Series 30/31 Standard Disc*	2"-12" (50-300mm)	175 psi (12 bar)
	14"-20" (350-500mm)	150 psi (10.3 bar)
DEAD END SERVICE – Lug Bodies and Standard Disc* No downstream flanges and disc in closed position		
Series 31	2"-12" (50-300mm)	75 psi (5.2 bar)
	14"-20" (350-500mm)	50 psi (3.4 bar)
BODY: 250 psi (17.2 bar) CWP		

*For low pressure (50 psi) applications, Bray offers a standard reduced disc diameter to decrease seating torques and extend seat life, thus increasing the valve's performance and reducing actuator costs.

VELOCITY LIMITS FOR ON/OFF SERVICES

FLUIDS: 30 ft/sec (9 m/s)	**GASES:** 175 ft/sec (54 m/s)

1 – **STEM RETAINING ASSEMBLY:** The stem is retained in the body by means of a unique stainless steel Spirolox® retaining ring, a thrust washer and two C-rings, manufactured from brass as standard, stainless steel upon request.

2 – **STEM BUSHING:** Non-corrosive, heavy duty acetal bushing absorbs actuator side thrust.

3 – **STEM SEAL:** Double "U" cup seal design is self-adjusting and gives positive sealing in both directions.

4 – **PRIMARY AND SECONDARY SEALS:** These seals prevent line media from coming in contact with the stem or body. The primary seal is an interference fit of the molded seat flat with the disc hub. The secondary seal is created because the stem diameter is greater than the diameter of the seat stem hole.

5 – **BODY:** One piece wafer or lug style. Polyester coating for excellent corrosion resistance. Nylon 11 coating is available as an option.

6 – **SEAT:** Bray's tongue and groove seat design provides complete isolation of flowing media from the body. The seat also features a molded o-ring which eliminates the use of flange gaskets.

7 – **DISC:** Casting is spherically machined and hand polished to provide a bubble tight shutoff, minimum torque, and longer seat life. Bray's resilient Nylon 11 coating comes as standard.

8 – **STEM:** Precision double "D" disc to stem connection drives the disc without the need for screws or pins. The close tolerance, double "D" connection that drives the valve disc is an exclusive feature of the Bray valve. Disassembly of the Bray stem is just a matter of pulling the stem out of the disc.

MATERIAL SELECTION OPTIONS

BODY	DISC	STEM	SEAT
Cast Iron✦	Nylon 11 Coated Ductile Iron✦	416 Stainless Steel✦	BUNA-N Food Grade✦
Ductile Iron✦	316 Stainless Steel✦	304 Stainless Steel	EPDM Food Grade✦
Carbon Steel	Nickel Aluminum Bronze	316 Stainless Steel	FKM*
Aluminum	Coated Ductile Iron	Monel® K500	White BUNA-N Food Grade
	Halar® Coated Ductile Iron		Bonded EPDM
	304 Stainless Steel		Bonded BUNA-N
	Duplex Stainless Steel		
	Super Duplex Stainless Steel		
	Hastelloy®		

✦Standard Option

*FKM is the ASTM D1418 designation for fluorinated hydrocarbon elastomers (also called fluoroelastomers).

Monel® is a registered trademark of The International Nickel Company, Inc.

Halar® is a registered trademark of Solvay Solexis, Inc.

Hastelloy® is a registered trademark of Haynes International, Inc.

SERIES 31H

2"-20" (50mm-500mm)

Series 31H Lug valves are drilled and tapped to meet ASME Class 125/150 and PN16 flanges. Series 31H valves are designed for manual operation only.

PRESSURE RATINGS

BIDIRECTIONAL BUBBLE TIGHT SHUT OFF AND DEAD END SERVICE	
2"-20" (50-500mm)	250 psi (17.2 bar)
BODY: 250 psi (17.2 bar) CWP	

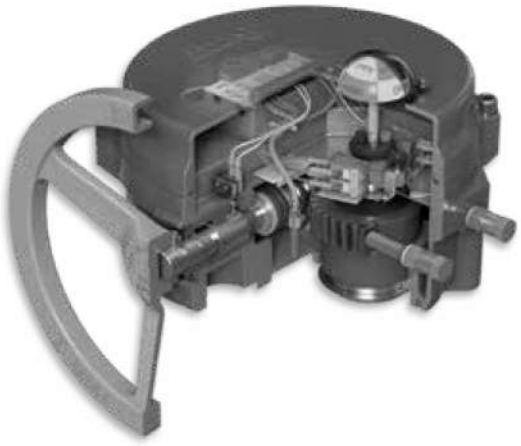
VELOCITY LIMITS FOR ON/OFF SERVICES

FLUIDS: 30 ft/sec (9 m/s)	**GASES:** 175 ft/sec (54 m/s)

STANDARD MATERIAL SELECTIONS

Body	Cast Iron Ductile Iron
Disc	Nickel Aluminum Bronze Nylon 11 Coated Ductile Iron 316 Stainless Steel
Stem	416 Stainless Steel
Seat	Bonded EPDM Bonded BUNA-N

Material availability depends on valve size and series. Other materials are available. Please consult your local Bray representative for your specific application.



SERIES 70 ELECTRIC ACTUATOR

The Series 70 is a low profile, compact, and powerful actuator with customer-friendly features

- Manual declutchable handwheel
- Local high visibility dome position indicator
- Digital interface available
- Optional microprocessor based modulating control

Torque	300 to 18,000 lb-ins (34 - 2030 Nm)
Voltage	VAC: 24, 120, 220, VDC: 12, 24
Standard Enclosure	NEMA Type 4, 4X
Explosion Proof	NEMA Type 4, 4X and specifications for USA and Canadian hazardous locations Class I Div 1 & 2 Groups C & D Class II Div 1 & 2 Groups E, F, & G.

Extreme High Temperature Actuator

Stainless Steel Actuator

SERIES 92/93 PNEUMATIC ACTUATOR

Bray rack and pinion actuators available in double acting and spring return

- Standard units have anodized aluminum bodies with polyester coated end caps
- Seacorr coating for harsh environments
- Integral porting
- Internal bidirectional travel stops
- SIL 3 capable
- NAMUR accessory compatible

Torque	Double Acting up to: 44,130 lb-in (4,986 Nm) Spring End Torque up to: 14,173 lb-in (1,601 Nm)	
Pressure Range	40 - 140 psi (2.8 - 10 bar)	
Media	Dry Compressed Air/Inert Gas*	
Temperature Range	Standard	-4°F to 200°F (-20°C to 93°C)
	Low	-40°F to 176°F (-40°C to 80°C)
	High	0°F to 300°F (-18°C to 149°C)
	Extreme High Temperature	0°F to 482°F (-18°C to 250°C)

Torque	Double Acting up to:	885,000 lb-in (100,000 Nm)
	Spring Return (Spring End) up to:	445,261 lb-in (50,306 Nm)
Pressure Range	40 - 150 psi (2.8 - 10.3 bar)	
Media	Dry Compressed Air/Inert Gas*	
Temperature Range	Standard	-4°F to 200°F (-20°C to 93°C)
	High Temperature	Up to 300°F (149°C)
	Low Temperature	Down to -50°F (-46°C)

SERIES 98 SCOTCH YOKE PNEUMATIC ACTUATOR

Bray scotch yoke actuator for quarter turn rotary operation

- Compact design with a high torque to weight ratio
- Modular design offers easy configuration in the field
- Optional modular components: manual overrides, hydraulic dampener for fast acting operation, lockout/PST device
- Premium epoxy/polyurethane coating as standard
- Pressure Equipment Directive (PED) 97/23/EC compliant
- Standardized interfaces: ISO 5211, VDI/VDE 3845 for accessories
- Optional Seacorr coating for harsh environments
- SIL 3 capable

Bray®

THE HIGH PERFORMANCE COMPANY

BRAY INTERNATIONAL
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B-1050_EL_Resilient Seated Valves_4_2019

Item#: 1 Raw Water Supply Valve - 6"
Item#: 2 Filtered Water Effluent Valve - 6"
Item#: 3 Rinse Valve - 4"
Item#: 4 Rinse Rate Control Valve - 4"
Item#: 5 Backwash Supply Valve - 8"
Item#: 6 Backwash Effluent Valve - 8"
Item#: 31 Backwash Supply Isolation Valve - 8"
Item#: 33 Backwash Supply Flow Control Valve - 8"
Item#: 34 Filtered Water Shut off Valve - 8"

Bray®

SERIES 30/31 Wafer/Lug
2" - 20" (50mm-500mm)

BUTTERFLY VALVES
RESILIENT SEATED

CELEBRATING 20 YEARS

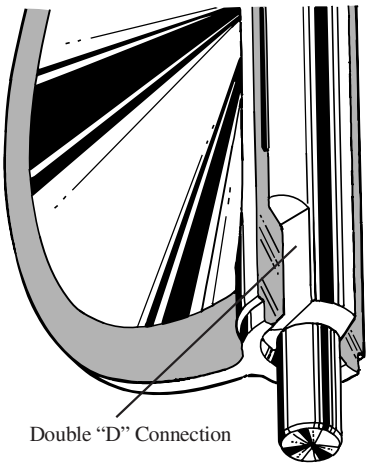
The High Performance Company

SERIES 30

2"–20" (50mm–500mm)
Bray® Controls is proud to offer a high quality line of butterfly valves to meet the requirements of today's market. Combining years of field application experience, research and development, Bray has designed many unique features in the Series 30/31 not previously available. The results are longer service life, greater reliability, ease of parts replacement and interchangeability of components.

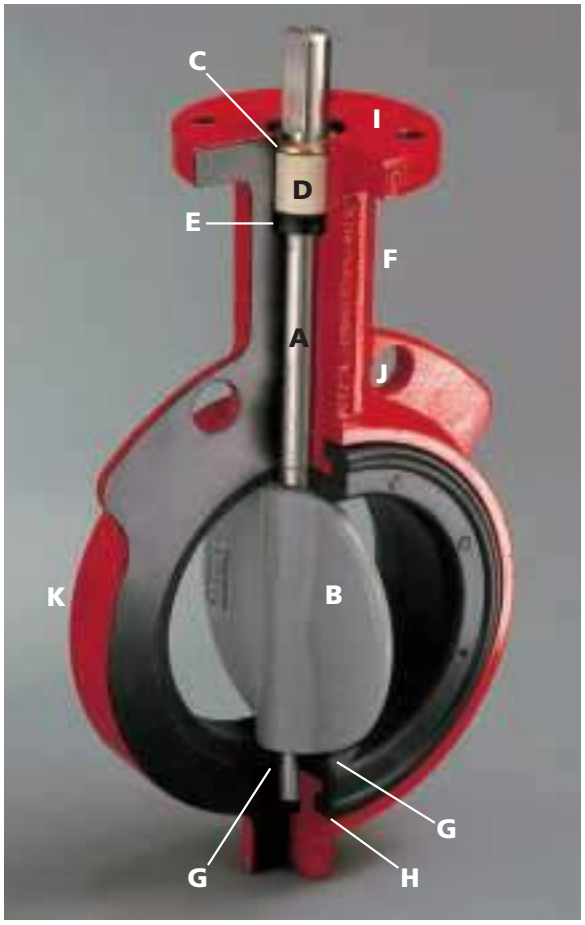
DISC AND STEM CONNECTION

(**A**) Features a high-strength through stem design. The close tolerance, double "D" connection that drives the valve disc is an exclusive feature of the Bray valve. It eliminates stem retention components being exposed to the line media, such as disc screws and taper pins, which commonly result in leak paths, corrosion, and vibration failures. Disc screws or taper pins, due to wear and corrosion, often


Double "D" Connection

require difficult machining for disassembly. Disassembly of the Bray stem is just a matter of pulling the stem out of the disc. Without fasteners obstructing the line flow, the Series 30/31 C_V values are higher than many other valves, turbulence is reduced, and pressure recovery is increased. The stem ends and top mounting flange are standardized for interchangeability with Bray actuators.

DISC (**B**) Casting is spherically machined and hand polished to provide a bubble-tight shut off, minimum torque, and longer seat life. The disc O.D. clearance is designed to work with all standard piping.



STEM BUSHING (D)

Non-corrosive, heavy duty acetal bushing absorbs actuator side thrusts.

STEM SEAL (E)

Double "U" cup seal design is self-adjusting and gives positive sealing in both directions. Prevents external substances from entering the stem bore.

NECK (F)

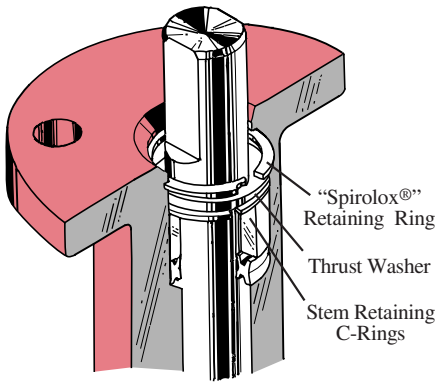
Extended neck length allows for 2" of piping insulation and is easily accessible for mounting actuators.

PRIMARY AND SECONDARY SEALS (G)

The Primary Seal is achieved by an interference fit of the molded seat flat with the disc hub. The Secondary Seal is created because the stem diameter is greater than the diameter of the seat stem hole. These seals prevent line media from coming in contact with the stem or body.

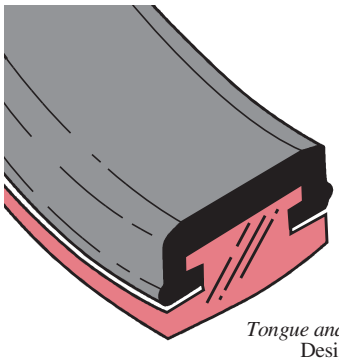
STEM RETAINING ASSEMBLY (C)

The stem is retained in the body by means of a unique Stainless Steel "Spirolox®" retaining ring, a thrust washer and two C-rings, manufactured from brass as standard, stainless steel upon request. The retaining ring may be easily removed with a standard hand tool. The stem retaining assembly prevents unintentional removal of the stem during field service.



BRAY UNIQUE SEAT DESIGN (H)

One of the valve's key elements is Bray's unique *tongue and groove* seat design. This resilient seat features lower torque than many valves on the market today and provides complete isolation of flowing media from the body. The tongue-and-groove seat to body retention method is superior to traditional designs, making field replacement simple and fast. The seat is specifically designed to seal with slip-on or weld-neck flanges. The seat features a molded O-ring which eliminates the use of flange gaskets. An important maintenance feature is


Tongue and Groove Design

*"Spirolox®" designation is a registered trademark of Kaydon Ring and Seal, Inc.

that all resilient seats for Bray butterfly valves Series 20, 21, 30, 31 and 34 are completely interchangeable.

ACTUATOR MOUNTING FLANGE AND STEM CONNECTION (I)
Universally designed to ISO 5211 for direct mounting of Bray® power actuators and manual operators.

FLANGE LOCATING HOLES (J)
Provide quick and proper alignment during installation.

BODY (K) One-piece wafer or lug style. Polyester coating for excellent corrosion resistance. Bray valve bodies meet ANSI 150 pressure ratings for hydrostatic shell test requirements.

DESIGN FEATURES

Bray's Series 30 valve is a wafer version with flange locating holes, and the Series 31 is the companion lug version for dead-end service and other flange requirements. All Bray valves are tested to 110% of full pressure rating before shipment.

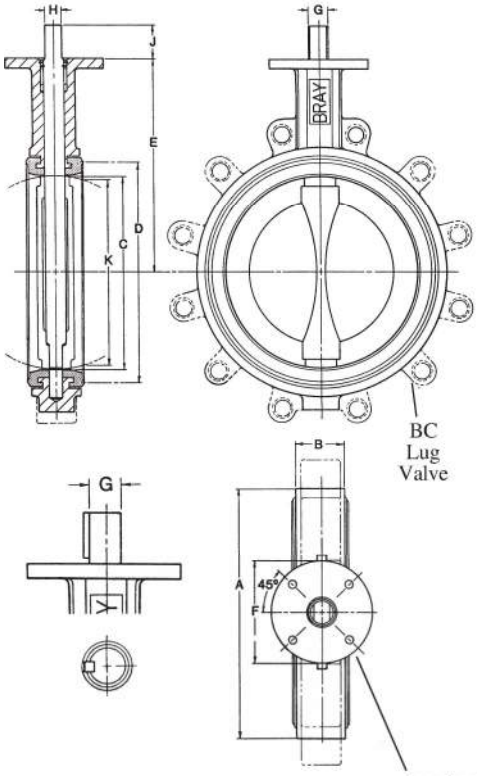
A major design advantage of Bray valve product lines is international compatibility. The same valve is compatible with most world flange standards – ANSI Class 125/150, BS 10 Tables D and E, BS 4504 NP 10/16, DIN ND 10/16, AS 2129 and JIS10. In addition the valves are designed to comply with ISO 5752 face-to-face and ISO 5211 actuator mounting flanges. Therefore, one valve design can be used in many different world markets.

Due to a modular concept of design, all Bray® handles, manual gear operators and pneumatic and electric actuators mount directly to Bray valves. No brackets or adapters are required.

Bray interchangeability and compatibility offers you the best in uniformity of product line and low-cost performance in the industry today.

POLYESTER COATING CORROSION PROTECTION Bray's standard product offers valve bodies with a polyester coating, providing excellent corrosion and wear resistance to the valve's surface. The Bray polyester coating is a hard, gloss red finish.
Chemical Resistance – resists a broad range of chemicals including: dilute aqueous acids and alkalies, petroleum solvents, alcohols, greases and oils. Offers outstanding resistance to humidity and water.
Weatherability – outdoor tested resistant to ultra-violet radiation.
Abrasion Resistance – excellent resistance to abrasion.
Impact Resistance – withstands impact without chipping or cracking.

NYLON 11 COATING
Optionally available for valve bodies where outstanding protection and performance is needed. A thermoplastic produced from a vegetable base, this coating is inert to fungus growth and molds. Nylon 11 is *USDA Approved*, as well as certified to ANSI/NSF 61 for water service.
Corrosion Resistance – superior resistance to a broad range of chemical environments. Salt spray tested in excess of 2,000 hours and seawater immersion tested for over 10 years without corrosion to metal substrates.
Nylon 11 features a very low coefficient of friction and excellent resistance to impact and ultra-violet radiation.



See chart for Actuator Mounting Flange Drilling.

DIMENSIONS SERIES 30 Wafer

Valve Size ins	Valve Size mm	A	B	C	D	E	F	Mounting Flange Drlg. BC	Mounting Flange Drlg. No. Holes	Mounting Flange Drlg. Hole Dia.	G	H	J	K
2	50	3.69	1.62	2.00	2.84	5.50	3.54	2.76	4	.39	.55	.39	1.25	1.32
2 1/2	65	4.19	1.75	2.50	3.34	6.00	3.54	2.76	4	.39	.55	.39	1.25	1.91
3	80	4.88	1.75	3.00	4.03	6.25	3.54	2.76	4	.39	.55	.39	1.25	2.55
4	100	6.06	2.00	4.00	5.16	7.00	3.54	2.76	4	.39	.63	.43	1.25	3.57
5	125	7.06	2.12	5.00	6.16	7.50	3.54	2.76	4	.39	.75	.51	1.25	4.63
6	150	8.12	2.12	5.75	7.02	8.00	3.54	2.76	4	.39	.75	.51	1.25	5.45
8	200	10.50	2.50	7.75	9.47	9.50	5.91	4.92	4	.57	.87	.63	1.25	7.45
10	250	12.75	2.50	9.75	11.47	10.75	5.91	4.92	4	.57	1.18	.87	2.00	9.53
12	300	14.88	3.00	11.75	13.47	12.25	5.91	4.92	4	.57	1.18	.87	2.00	11.47

SERIES 31 Lug

Lug Bolting Data BC	No. Holes	Threads UNC-2B
4.75	4	5/8-11
5.50	4	5/8-11
6.00	4	5/8-11
7.50	8	5/8-11
8.50	8	3/4-10
9.50	8	3/4-10
11.75	8	3/4-10
14.25	12	7/8-9
17.00	12	7/8-9

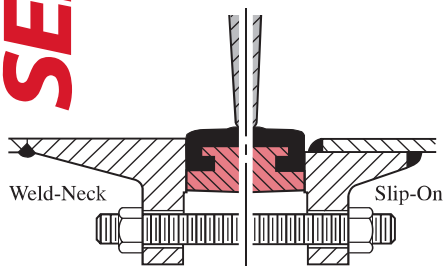
Valve Size ins	Valve Size mm	A	B	C	D	E	F	Mounting Flange Drlg. BC	Mounting Flange Drlg. No. Holes	Mounting Flange Drlg. Hole Dia.	G	J	KEY SIZE	K
14	350	17.05	3.00	13.25	15.28	13.62	5.91	4.92	4	.57	1.38	2.00	.39x.39	13.04
16	400	19.21	4.00	15.25	17.41	14.75	5.91	4.92	4	.57	1.38	2.00	.39x.39	14.85
18	450	21.12	4.25	17.25	19.47	16.00	8.27	6.50	4	.81	1.97	2.50	.39x.47	16.85
20	500	23.25	5.00	19.25	21.59	17.25	8.27	6.50	4	.81	1.97	2.50	.39x.47	18.73

Lug Bolting Data BC	No. Holes	Threads UNC-2B
18.75	12	1-8
21.25	16	1-8
22.75	16	1 1/8-7
25.00	20	1 1/8-7

SELECTION DATA

FLANGE REQUIREMENTS

Bray valves are designed for installation between ANSI Class 125/150 lb. weld-neck or slip-on flanges, BS 10 Tables D & E, BS 4504 NP 10/16, DIN ND 10/16, AS 2129 and JIS 10, either flat faced or raised faced. While weld-neck flanges are recommended, Bray has specifically designed its valve seat to work with slip-on flanges, thus eliminating common failures of other butterfly valve designs. When using raised face flanges be sure to properly align valve and flange. Type C stub-end flanges are not recommended.



PRESSURE RATINGS*

For bi-directional bubble-tight shut off, disc in closed position:

Inches	mm	psig	bar
2-12	50-300	175	12
14-20	350-500	150	10

For Dead-end Service Applications:

With *downstream flanges installed* or with *vulcanized seats,* the dead-end pressure ratings are equal to valve bi-directional ratings as stated above. With no downstream flanges or with seats that are not vulcanized, the dead-end pressure rating for 2"-12" valves is 75 psi (5 bar) for 14"-20" valves, 50 psi (3.5 bar).

*Pressure Ratings are based on standard disc diameters. For low pressure application, Bray offers a standard reduced disc diameter to decrease seating torques and to extend seat life, thus increasing the valve's performance and reducing actuator costs for the customer.

VELOCITY LIMITS

For On/Off Services:
Fluids – 30 ft / sec (9m / s)
Gases – 175 ft / sec (54m / s)

C_V VALUES–VALVE SIZING COEFFICIENT

Valve Size		Disc Position (degrees)								
ins	mm	90°	80°	70°	60°	50°	40°	30°	20°	10°
2	50	144	114	84	61	43	27	16	7	1
2 1/2	65	282	223	163	107	67	43	24	11	1.5
3	80	461	364	267	154	96	61	35	15	2
4	100	841	701	496	274	171	109	62	27	3
5	125	1376	1146	775	428	268	170	98	43	5
6	150	1850	1542	1025	567	354	225	129	56	6
8	200	3316	2842	1862	1081	680	421	241	102	12
10	250	5430	4525	2948	1710	1076	667	382	162	19
12	300	8077	6731	4393	2563	1594	1005	555	235	27
14	350	10538	8874	5939	3384	2149	1320	756	299	34
16	400	13966	11761	7867	4483	2847	1749	1001	397	45
18	450	17214	14496	10065	5736	3643	2237	1281	507	58
20	500	22339	18812	12535	7144	4536	2786	1595	632	72

C_V is defined as the volume of water in U.S.G.P.M. that will flow through a given restriction or valve opening with a pressure drop of one (1) p.s.i. at room temperature. Recommended control angles are between 25°–70° open. Preferred angle for control valve sizing is 60°–65° open.

EXPECTED SEATING/UNSEATING TORQUES (Lb.-Ins.)

Valve Size		Full-Rated Pressure Valves				Reduced Disc Diameter
		ΔP (PSI)				ΔP (PSI)
ins	mm	50	100	150	175	50
2	50	125	130	135	140	125
2 1/2	65	195	205	215	220	195
3	80	260	275	290	297	260
4	100	400	425	450	462	267
5	125	615	670	725	755	410
6	150	783	871	953	1003	537
8	200	1475	1650	1825	1915	983
10	250	2240	2520	2800	2940	1493
12	300	3420	3870	4320	4545	2280
14	350	4950	5700	6450	—	3300
16	400	6400	7700	9000	—	4267
18	450	7850	9850	11850	—	5267
20	500	10300	12900	15500	—	6867

Valve Torque Rating – Bray has classified valve torque ratings according to 3 types: non-corrosive lubricating service, general service, and severe service. Torques listed above are for general services. Consult Bray for torque information corresponding to specific applications.

TO USE TORQUE CHART, NOTE THE FOLLOWING:
1) For Bray valves, Series 20, 21, 30, 31 and 34.
2) Review Technical Bulletin No. 1001, Expected Seating/Unseating Torques, for explanation of the 3 service classes and their related seating/unseating torque values for given pressure differentials of Full-Rated and Reduced Disc Diameter valves.
3) Dynamic Torque values are not considered. See Technical Bulletin No. 1002 for evaluation of Dynamic Torque values vs. Seating/Unseating Torque values.
4) Do not apply a safety factor to above torque values when determining actuator output torque requirement.
5) For 3 way assemblies where one valve is opening and other is closing, multiply torque by 1.5 factor.

SPECIFICATIONS

RECOMMENDED SPECIFICATIONS FOR BRAY SERIES 30/31 SHALL BE:

- Polyester coated, cast iron, wafer or lug bodies.
- With flange locating holes that meet ANSI Class 125/150 (or BS 10 Tables D & E, BS 4504 NP 10/16, DIN ND 10/16, AS 2129 and JIS 10) drillings.
- Through-stem direct drive double "D" design requiring no disc screws or pins to connect stem to disc with no possible leak paths in disc/stem connection.
- Stem mechanically retained in body neck and no part of stem or body exposed to line media.
- Tongue-and-groove seat design with primary hub seal and a molded O-ring suitable for weld-neck and slip-on flanges. Seat totally encapsulates the body with no flange gaskets required.
- Spherically machined, hand polished disc edge and hub for minimum torque and maximum sealing capability.
- Equipped with non-corrosive bushing and self-adjusting stem seal.
- Bi-directional and tested to 110% of full rating.
- Bi-directional pressure ratings:
2"-12" valves: 175 psi, 14"-20" valves: 150 psi
Lug bodies for dead end service
With downstream flanges or vulcanized seats, pressure ratings are equal to bi-directional ratings as stated above.
With no downstream flanges or non-vulcanized seats: 2"-12" valves: 75 psi, 14"-20" valves: 50 psi
- No field adjustment necessary to maintain optimum field performance.
- The valve shall be Bray Series 30 wafer / 31 lug or equal.

WEIGHTS

Valve Size		Series 30	Series 31
ins	mm		
2	50	5.5	7.0
2 1/2	65	7.0	8.0
3	80	7.5	9.0
4	100	11.5	15.0
5	125	14.0	20.0
6	150	17.0	23.0
8	200	34.0	42.0
10	250	49.0	66.0
12	300	67.0	88.0
14	350	95.0	114.0
16	400	135.0	166.0
18	450	200.0	226.0
20	500	260.0	305.0

Weights are in lbs.

MATERIALS SELECTION

2"–20" (50mm-500mm)

BODY:

- Cast Iron ASTM A126 Class B
- Ductile Iron ASTM A536
- Cast Steel ASTM A216 WCB
- Aluminum ASTM B26

SEAT:

- Buna-N – Food Grade
- EPDM – Food Grade
- FKM*
- White Buna-N – Food Grade

STEM:

- Coated Carbon Steel
- 416 Stainless Steel ASTM A582 Type 416
- 304 Stainless Steel ASTM A276 Type 304
- 316 Stainless Steel ASTM A276 Type 316
- Monel

DISC:

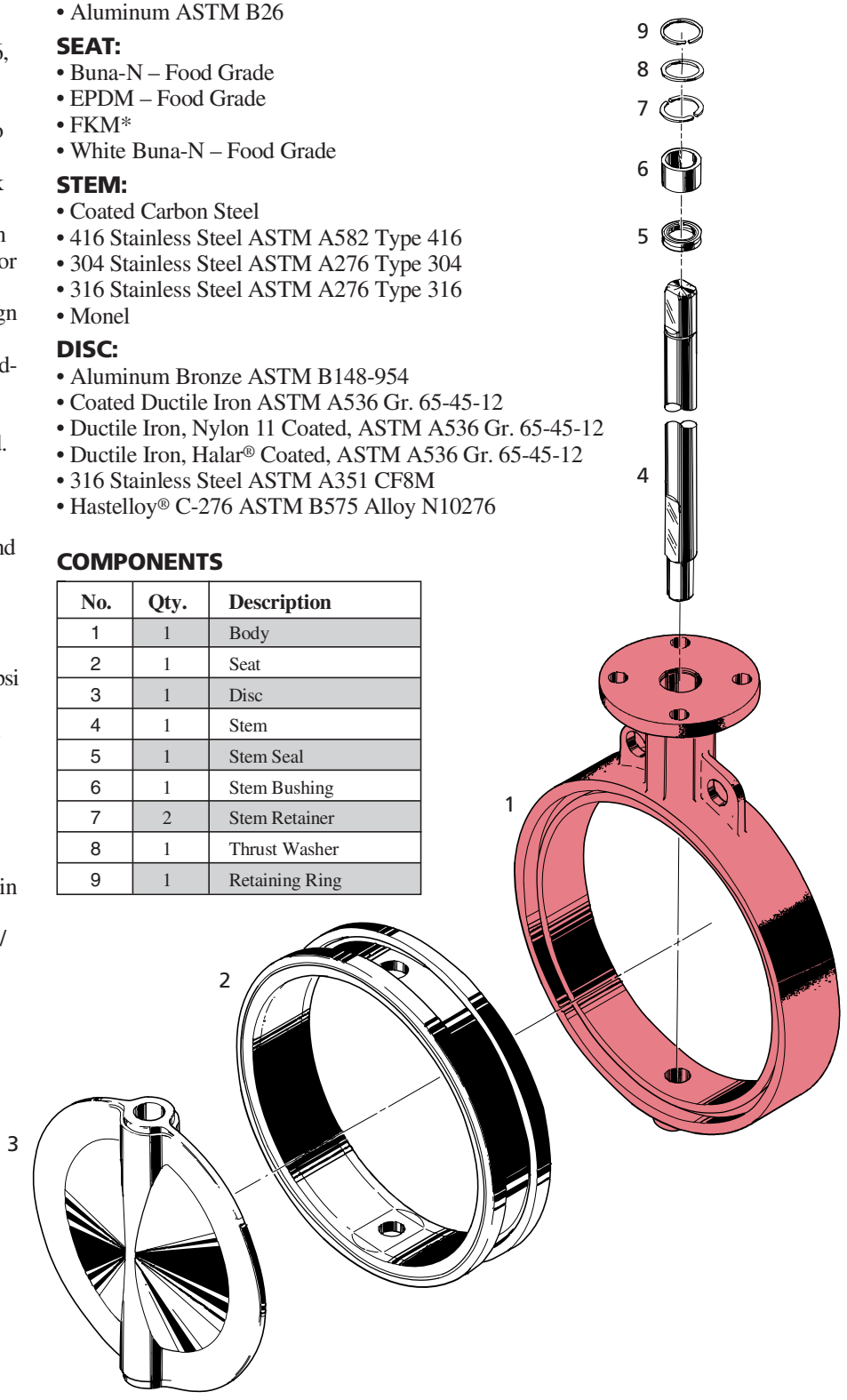
- Aluminum Bronze ASTM B148-954
- Coated Ductile Iron ASTM A536 Gr. 65-45-12
- Ductile Iron, Nylon 11 Coated, ASTM A536 Gr. 65-45-12
- Ductile Iron, Halar® Coated, ASTM A536 Gr. 65-45-12
- 316 Stainless Steel ASTM A351 CF8M
- Hastelloy® C-276 ASTM B575 Alloy N10276

TEMPERATURE RANGE OF SEATS

Type	Maximum	Minimum
EPDM	+250°F(121°C)	-40°F(-40°C)
Buna-N	+212°F(100°C)	0°F(-18°C)
FKM*	+400°F(204°C)	0°F(-18°C)

COMPONENTS

No.	Qty.	Description
1	1	Body
2	1	Seat
3	1	Disc
4	1	Stem
5	1	Stem Seal
6	1	Stem Bushing
7	2	Stem Retainer
8	1	Thrust Washer
9	1	Retaining Ring



*FKM is the ASTM D1418 designation for Fluorinated Hydrocarbon Elastomers (also called Fluoroelastomers).

Hastelloy® is a registered trademark of Haynes International, Inc.
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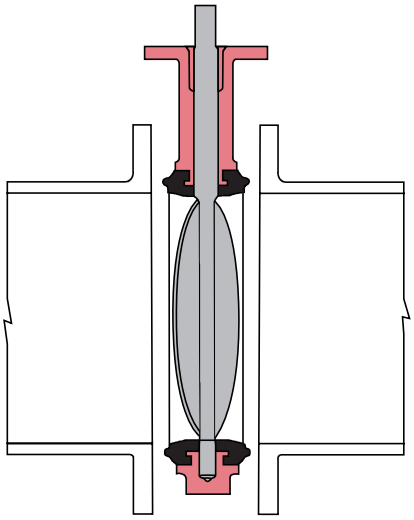
ASSEMBLY

INSTALLATION

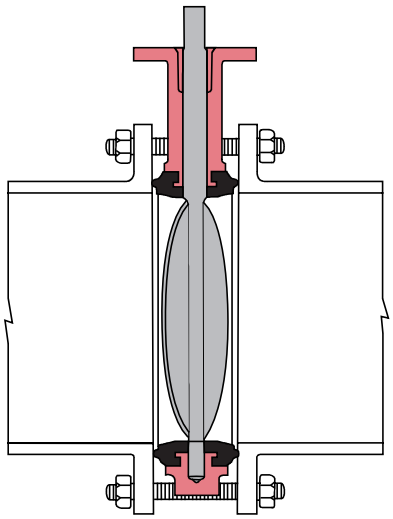
Position the disc in the partially open position, maintaining the disc within the body face-to-face. Place the body between the flanges and install flange bolts. *Do not use flange gaskets.* Before tightening flange bolts, carefully open the disc to the full open position to ensure proper alignment and clearance of the disc O.D. with the adjacent pipe I.D. Leave disc in the full open position and tighten flange bolts per required specification. Once bolts are tightened, carefully rotate disc to closed position to ensure disc O.D. clearance.

MAINTENANCE AND REPAIR

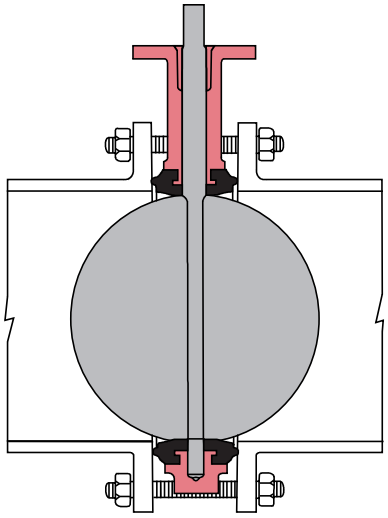
The many Bray features minimize wear and maintenance requirements. No routine lubrication is required. All components – stem, disc, seat, bushing, stem seal, etc., are field replaceable, no adjustment is needed. If components require replacement, remove the valve from the line by placing the disc near the closed position, spread the flanges, support the valve, then remove the flange bolts. No valve maintenance, including removal of manual or power actuators, should be performed until the piping system is completely depressurized.



Disc in the Near Closed Position



Disc in the Partially Open Position



Disc in the Full Open Position

DISASSEMBLY

Remove the handle, gear operator, or actuator from actuator mounting flange. Remove "Spirolox®" retaining ring. Remove stem with its thrust washer and two C-ring stem retainers. Remove bushing and seal. Remove the disc from the seat, protecting disc edge at all times. Push the seat into an oval shape, then remove the seat from the body.

ASSEMBLY

Push the valve seat into an oval and push it into the body with seat stem holes aligned to body stem holes. Push stem into the stem hole of body. For aid in inserting disc, slightly protrude stem beyond the I.D. of the top of the seat. Install a light coating of foodgrade silicone oil (for silicone free applications use soap and water) on the I.D. of seat. Insert the disc into the seat by lining up the disc hole with the stem hole of the seat. Note: the broached double "D" flats in the disc must be toward the bottom of valve body. (Take special care when lining disc up with stem.) With a downward pressure and rotating the stem back and forth, push the stem until the stem touches the bottom of the body stem hole. Make certain that when pushing the stem through disc bottom, the broached flats of stem and disc are aligned. After the stem has engaged the disc, but before the stem is firmly seated in the body, replace the stem seal and bushing. Install the two C-ring stem retainers in the groove in the stem and thrust washer on top of the C-rings. Seat the stem firmly in the body and install the "Spirolox®" retaining ring back into position.

DISTRIBUTOR

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United States patent number 5,152,501.
Other patents issued and applied for worldwide.

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Bray CONTROLS

MANUAL OPERATORS

Bray Controls offers three operators for manual control of valve position. All manual operators mount directly to Bray valves, and all are epoxy coated for excellent corrosion, abrasion and impact resistance.

MANUAL OPERATORS	
SERIES 01 - Handle	1"-12" (25mm -300mm)
SERIES 04 - Gear Operator	2"-48" (50mm -1200mm)
SERIES 05 - Declutchable Gear Operator	2"-36" (50mm -900mm)

SERIES 01 - HANDLE & NOTCH PLATE

Bray offers two handles for on-off and throttling service – one for resilient seated valves from 1"-12" (25mm-300mm), and a high torque handle for high pressure valves from 2½"- 8" (65mm-200mm). These quarter turn handles have a locking spring and a directional pointer for valve disc position indication. Bolted notch plates are offered. For resilient seated valves a 10 position plate is standard. For high pressure valves a 9 position plate is standard. Both contain on-off stops to prevent over rotation of the valve. Optionally available are an infinite position plate, a 180° notch plate, a memory stop, a padlock kit, and a 2" square nut version.

SERIES 04 - GEAR OPERATOR

For heavy duty on-off and throttling service of 2"-48" (50mm-1200mm) valves, the Series 04 is self lubricated for smooth, trouble-free operation. The rugged, cast iron body with O-ring body seals is weatherproof to IP65. A self-locking worm and worm gear drive holds the valve in the desired position. Features include a readily accessible handwheel, a valve position indicator and mechanical travel stops which permit field adjustment of valve movement to specific degrees of rotation. Optionally available are chainwheel accessories, padlock kits and 2" square nut versions. A Gear Operator with a stainless steel housing is also available for valve sizes 1"-16".

SERIES 05 - DECLUTCHABLE GEAR OPERATOR

Available for 2"-36" (50mm-900mm) valves. This operator is excellent for the safe handling of spring return actuators. During pneumatic operation, the worm of the gear unit is disengaged. Should the valve require opening or closing in the event of power loss, manual rotation of the declutch lever will provide a camming action and engage the worm to the segmented worm gear, allowing rotation of the valve using the handwheel. The Series 05 can be installed in the field with existing Bray pneumatic actuators.

SERIES 04 OPTIONS

316 Stainless Steel
for sanitary & corrosive applications

Bray Controls proudly offers the Series 04 Stainless Steel Gear Operator for manual operation of quarter turn valves. With stainless steel housings, input shafts and handwheels, the Series 04 is designed for service in highly corrosive environments, sanitary, breweries and pharmaceutical applications. The units are suitable for on-off and throttling service.

Series 04 Stainless Steel Gear Operator units have different gear ratios – providing a torque output range of 2,000 to 24,000 lb-in. The temperature range is -4°F (-20°C) to 250°F (120°C).

These weatherproof gear operators meet NEMA 4, 4x and IP 65 specifications.

CHAINWHEEL for remote access to valve positioning when the handwheel is not accessible, such as valves positioned high out of reach.

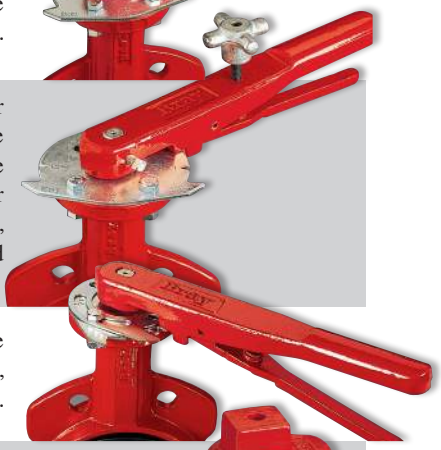
A PADLOCK KIT & 2" SQUARE NUT version for buried service are also available with the Series 04 (not shown).

SERIES 01

STANDARD 10 POSITION NOTCH PLATE has been designed to lock the handle securely in place, preventing position change of disc due to line pressure, vibration or shock. Standard 9 Position Plate for high pressure valves is not shown.

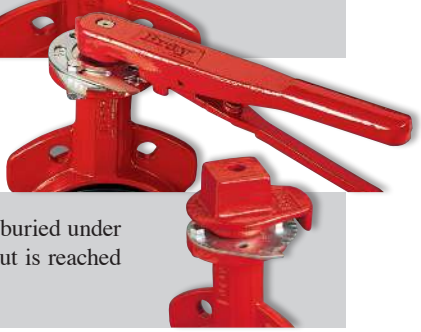
PADLOCK KIT allows the customer to lock the valve in the full open or closed position, tamper proofing the valve. By drilling a new hole in the top plate, the handle can be locked in mid travel.

HANDLE AND 180° NOTCH PLATE allows the operator to switch the handle to either side without removing the notch plate from the valve.



INFINITE POSITION NOTCH PLATE for throttling applications, allows for very precise adjustments of valve disc positioning anywhere from 0° to 90°. Positioning is simply a matter of loosening the set knob, moving the handle, then retightening the knob. For resilient seated valves only.

MEMORY STOP allows the operator to set the maximum amount the valve can open. When set, this limit will remain fixed until the stop is reset.



2" SQUARE NUT is used where the valve is buried under the surface. To rotate valve disc position, the nut is reached with a T-handle wrench.

SERIES 05

DECLUTCHABLE GEAR OPERATOR

The Series 05 offers the same superior features as the Series 04 gear operator with the added ability to manually override pneumatic actuators or rotate the valve when air pressure is not available.

Bray® CONTROLS
A Division of BRAY INTERNATIONAL, Inc.
13333 Westland East Blvd. Houston, Texas 77041
281.894.5454 FAX 281.894.9499 www.bray.com

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Item#: PT1, 0 - 150 psi Influent Pressure Transmitter
Item#: PT2, 0 - 150 psi Effluent Pressure Transmitter

SERIES 626 & 628 | INDUSTRIAL PRESSURE TRANSMITTER/TRANSDUCER

FEATURES/BENEFITS

Standard:

- **NEMA 4X rated enclosure**
- **Robust 316L SS oil filled sensor**
- **CE Approved Design**
- **626: 0.25% FS**
- **628: 1.0% FS**

Optional:

- **Advanced environmental protection**
- **C-276 wetted materials**
- **Digital or Analog Outputs (I2C)**
- **Custom range configuration**
- **Overpressure and/or vacuum protection**

626/628 Pressure Transmitters with General Purpose Housing (-GH)

APPLICATIONS

- Booster stations
- Pumping systems
- Irrigation equipment
- PTO systems
- Submersible pump control

626/628 Pressure Transmitters with Conduit Box Housing (-CB) and LCD display

DESCRIPTION

The **SERIES 626 & 628** Pressure Transmitters feature a piezo-resistive sensor contained in a compact, rugged, NEMA 4X (IP66) stainless steel general purpose housing or cast aluminum conduit housing.

Dwyer offers optional configurations to address multiple common points of failure that have traditionally challenged the use of similar products in extreme conditions. The 626 & 628 are uniquely suited for precision irrigation and additional outdoor power equipment applications. The corrosion resistant 316L stainless steel wetted parts allow the Series 626 & 628 transmitters to measure pressure in a multitude of processes from simple irrigation systems to chemical dosing and injection systems. Optional wetted materials such as C-276 offer chemical compatibility with aggressive media. The 626 & 628 can be configured to provide advanced environmental protection. This includes, but is not limited to, freeze/thaw protection for outdoor cold weather applications, vibration resistance, and/or overpressure protection to protect the sensors against pressure surges or pump cavitation. The Series 626 & 628 are available in absolute and gauge pressure ranges with a variety of optional outputs, process connections, electrical terminations, and select agency approvals to allow you to select the correct transmitter for your application.

Contact Dwyer Instruments today to discuss your specific application needs.

SPECIFICATIONS

Service	Compatible gases and liquids.
Wetted Materials	Type 316L SS. (Consult factory for additional options)
Accuracy	626: 0.25% FS, 0.20% RSS; 628: 1.0% FS, 0.5% RSS; 626 Absolute Ranges: 0.5% FS, 0.30% RSS. (Includes linearity, hysteresis, and repeatability).
Temperature Limit	0 to 200°F (-18 to 93°C).
Compensated Temperature Range	0 to 175°F (-18 to 79°C).
Thermal Effect	±0.2% FS/°F (includes zero and span).
Pressure Limits	See table on catalog page.
Display	Optional 4-1/2 digit LCD field attachable display.
Power Requirement	10 to 30 VDC (for 4 to 20 mA, 0 to 5, 1 to 5, VDC outputs); 13 to 30 VDC (for 0 to 10 VDC output); 5 VDC ±0.5 VDC (for 0.5 to 4.5 VDC ratiometric output), 10 to 35 VDC (for 4 to 20 mA with -CB option); 13 to 35 VDC or isolated 16 to 33 VAC (for selectoable output with -CB option).
Output Signal	4 to 20 mA, 0 to 5 VDC, 1 to 5 VDC, 0 to 10 VDC, or 0.5 to 4.5 VDC, or selectable 0 to 5, 1 to 5, 0 to 10, 2 to 10 VDC for -CB option.
Response Time	300 ms.
Loop Resistance	0 to 1000 Ohms max. R max = 50 (Vps-10) Ohms (4 to 20 mA output), 0 to 1250 Ohms max. Rmax = 50(Vps-10) Ohms (4 to 20 mA output with -CB option), 5K Ohms (0 to 5, 1 to 5, 0 to 10, 0.5 to 4.5 VDC output).
Stability	1.0% FS/year (typ).
Current Consumption	38 mA maximum (for 4 to 20 mA output); 10 mA maximum (for 0 to 5, 1 to 5, 0 to 10, 0.5 to 4.5 VDC output); 140 mA maximum (for all 626/628/629-CH with optional LED).
Electrical Connections	Conduit housing (-CH): Terminal block, 1/2″ female NPT conduit; General purpose housing (-GH): Cable DIN EN 175801-803-C.
Process Connections	1/4″ male or female NPT and BSPT.
Enclosure Rating	NEMA 4X (IP66).
Weight	10 oz (283 g).
Agency Approvals	Standard: CE; Optional: NSF/ANSI 61/372, ANSI/UL 218, ANSI/UL 508, NEPA 20

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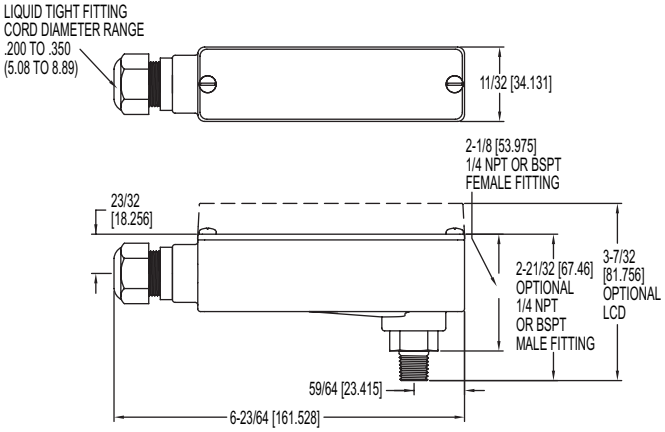
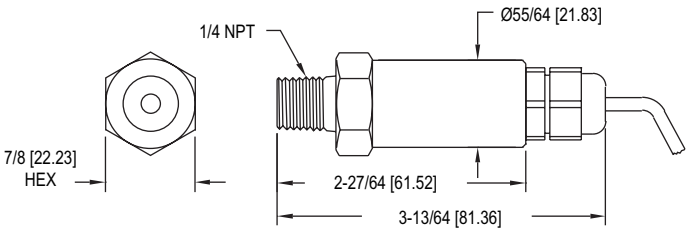
800-872-9141

DIMENSIONS



Conduit Housing



General Purpose Housing

HOW TO ORDER

p/n 626 - 10 - GH - P1 - E1 - S1 - NW Tag: PT1, PT2, PT3

Use the **bold** characters from the chart below to construct a product code.

626 **-05** **-CH** **-P3** **-E1** **-S1** **-NIST**

SERIES

626 - 0.25% full scale accuracy
628 - 1.0% full scale accuracy

RANGE

-00 - 0 to 15 psia*
-01 - 0 to 30 psia*
-02 - 0 to 50 psia*
-03 - 0 to 100 psia*
-04 - 0 to 200 psia*
-05 - 0 to 300 psia*
-06 - 0 to 5 psi
-07 - 0 to 15 psi
-08 - 0 to 30 psi
-09 - 0 to 50 psi
-10 - 0 to 100 psi
-11 - 0 to 150 psi
-12 - 0 to 200 psi
-13 - 0 to 300 psi
-14 - 0 to 500 psi
-22 - 0 to 600 psi
-15 - 0 to 1000 psi
-16 - 0 to 1500 psi
-18 - 0 to 3000 psi
-19 - 0 to 5000 psi
-26 - 0 to 8000 psi
-67 - 0 to 0.5 bar*
-71 - 0 to 2.5 bar*
-75 - 0 to 10 bar*
-81 - 0 to 40 bar*

*Only available on -GH housing models

OPTIONS

-AT - Aluminum tag
-LED - Bright red LED display
-NIST - NIST traceable calibration certificate
-NW - NSF/ANSI 61/372 certified

SIGNAL OUTPUT

-S1 - 4 to 20 mA
-S2 - 1 to 5 VDC
-S4 - 0 to 5 VDC
-S5 - 0 to 10 VDC
-S7 - 0.5 to 4.5 VDC
-S8 - 0 to 5, 1 to 5, 0 to 10, 2 to 10 VDC

ELECTRICAL CONNECTIONS

-E1 - Cable gland with 3´ of prewired cable
-E3 - Cable gland with 9´ of prewired cable
-E4 - DIN EN 175801-803-C
-E5 - 1/2˝ female NPT conduit
-E6 - M-12 4-pin connector UL listed
-E8 - Packard connector
-E9 - M-12 4-pin connector non-UL listed

PROCESS CONNECTIONS

-P1 - 1/4˝ male NPT
-P2 - 1/4˝ female NPT
-P3 - 1/4˝ male BSPT
-P5 - 1/4˝ female SAE w/ refrigerant valve depressor
-P9 - 1/2˝ male NPT

HOUSING

-CB - Conduit box housing
-GH - General purpose housing

ACCESSORIES

Model	Description	Model	Description
A-164	16.4´ (5 m) cable with M-12 4-pin female connector	**A-961**	9´ (3 m) Packard cable
A-62X-LCD	Field-upgradeable LCD	**A-962**	20´ (7 m) Packard cable
A-960	3´ (1 m) Packard cable		

Important Notice: Dwyer Instruments, Inc. reserves the right to make changes to or discontinue any product or service identified in this publication without notice. Dwyer advises its customers to obtain the latest version of the relevant information to verify, before placing any orders, that the information being relied upon is current.

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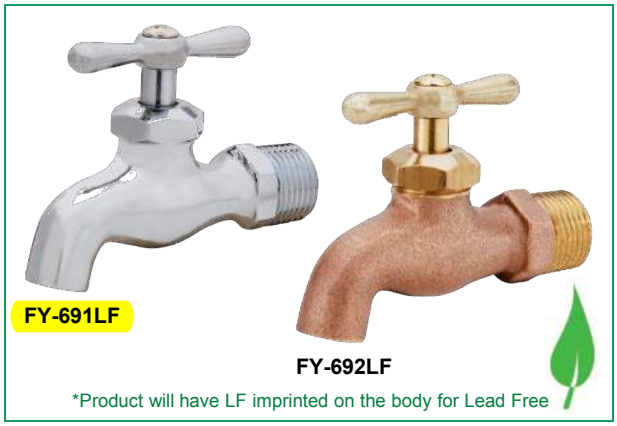
FY-691LF & FY-692LF Hose Bibb • Spec Sheet



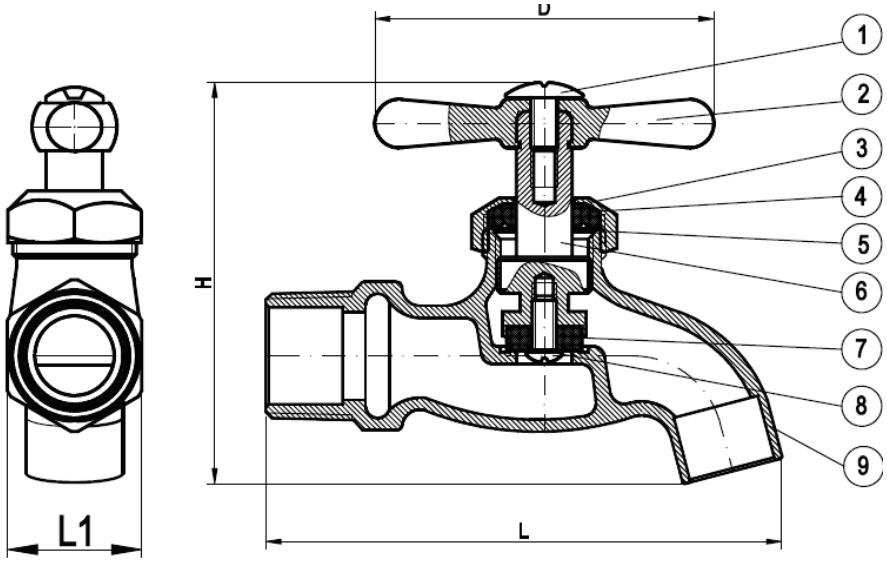
Item#: SV1 & 2 Typical Two (2) Places
Raw Water, Filtered Water

FEATURES & BENEFITS

- Lead Free Brass*
- Chrome Plated - FY-691LF
- Rough Brass - FY-692LF
- Plain End Outlet
- 1/2" MIP Inlet

DIMENSIONS

Size	H	L	L1	D
1/2”	2.64	3.36	0.87	2.19



MATERIAL SPECIFICATIONS

No.	Part	Material
1	Bolt	JIS G3507-1
2	Handle	Zinc Z30A
3	Bonnet	Brass B124 C37700
4	Packing	Buna SN-719F
5	Washer	Stainless Steel 304
6	Stem	Brass C 46400
7	Seat Packing	Buna SN-719F
8	Seat Screw	JIS H3260 - C2600W
9	Body	Brass C 46400

* These product complies with 0.25% weighted average lead content on wetted surfaces in accordance with Safe Water Drinking Act (SDWA) / Federal Public Law No. 111-380.

MATCO NORCA LEAD FREE

Global sourcing. National compliance. Local service.

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NEW YORK PO Box 27, Rt. 22, Brewster NY 10509 • Toll Free: 800-431-2082 • Fax: 845-278-9056
WEB: **www.matco-norca.com** EMAIL: **mail@matco-norca.com**

Item#: 32 8" Backwash Supply Flow Meter

MODEL UM06 AND UM08

ULTRA MAG® ELECTROMAGNETIC FLOW METER

150 PSI FLANGED TUBE METER, SIZES 2" thru 48"
300 PSI FLANGED TUBE METER, SIZES 2" thru 48"

M-SERIES SIGNAL CONVERTER

UltraLiner™ TECHNOLOGY

DESCRIPTION

MODELS UM06 AND UM08 FLANGED TUBE ULTRA MAG® meters are manufactured to the highest standard available for magmeters. They incorporate microprocessor technology to offer very low flows and broad rangeability. The flanged end tube design permits use in a wide range of applications with up to 300 PSI working pressure. Flanged ends are Class "D" flat face flanges (150 PSI) or Class "F" raised face flanges (300 PSI). The fabricated tube is stainless steel with steel or stainless steel flanges and is lined with UltraLiner™, an NSF approved, fusion bonded epoxy material.

INSTALLATION is made similar to placing a short length of flanged end pipe in the line. The meter can be installed vertically, horizontally, or inclined on suction or discharge lines. The meter must have a full pipe of liquid for proper operation. Fluid must be grounded to the downstream flange of the sensor either via internal grounding electrodes (4 - 12") or using McCrometer 316 SS Grounding Rings. Any 90 or 45 degree elbows, valves, partially opened valves, etc. should not be placed closer than five pipe diameters upstream and two pipe diameters downstream. All blending and chemical injection should be done early enough so the flow media is thoroughly mixed prior to entering the measurement area.

SIGNAL CONVERTER: The M-Series signal converter is the reporting, input and output control device for the sensor. The converter allows the measurements, functional programming, control of the sensor and data recording to be communicated through the display and inputs/outputs. The M-Series microprocessor-based signal converter has a curve-fitting algorithm to improve accuracy, dual 4-20mA analog outputs, a RS485 communication port, an 8 line graphical backlit LCD display with 3-key touch programming, and a rugged enclosure that meets IP67. In addition to a menu-driven self-diagnostic test mode, the converter continually monitors the microprocessor's functionality. The converter will output rate of flow and total volume. The converter also comes standard with password protection and many more features.

OPTIONAL:

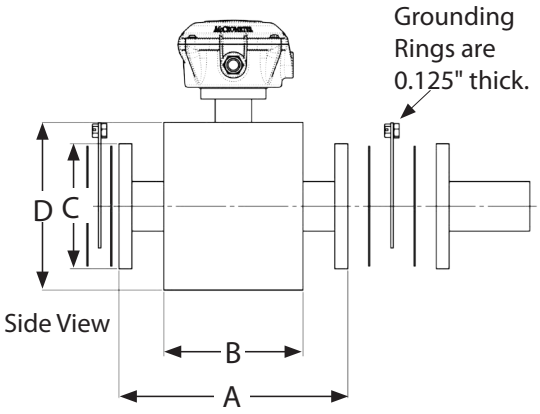
DC powered converter (10-35 VDC, 21 W)
Meter mounted converter
Extended warranty
Hastelloy® electrodes
ANSI or DIN flanges
Special lay lengths, including ISO standard lay lengths
Converter sun shield
Modbus Protocol RS485

SPECIFICATIONS

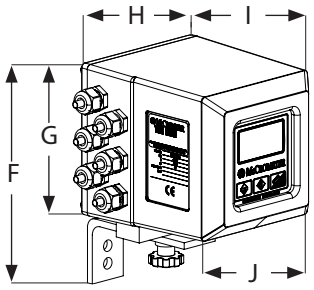
WARRANTY	2 Years
ACCURACY TESTS	3-point wet flow calibration of every complete flow tube with its signal converter. If desired, the tests can be witnessed by the customer. The McCrometer test facilities are traceable to the National Institute of Standards & Technology. Uncertainty relative to flow is ±0.15%
ACCURACY	Plus or minus 0.5% of actual flow
REPEATABILITY	±0.05% or ±.0008ft/s (±0.25mm/s), whichever is greater
HEAD LOSS	None. No obstruction in line and no moving parts
PRESSURE RANGE	150 PSI maximum working pressure (UM06) 300 PSI maximum working pressure (UM08)
TEMPERATURE RANGE	Operating: -10 to 77°C (14 to 170°F) Storage: -15 to 77°C (5 to 170° F)
VELOCITY RANGE	.2 to 32 FPS
BI-DIRECTIONAL FLOW	Forward and reverse flow indication and forward, reverse, net totalization are standard with all meters
CONDUCTIVITY	5 µs/cm
LINER	UltraLiner NSF approved, fusion bonded epoxy
ELECTRODES	Type 316 stainless steel, others optional
POWER SUPPLY	AC: 90-265VAC/45-66 Hz (20W/25VA) or DC: 10-35VDC (21W). AC or DC must be specified at time of ordering.
OUTPUTS	Dual 4-20mA Outputs: Galvanically isolated and fully programmable for zero and full scale (0-21mA) Four separate digital programmable outputs: open collector transistor usable for pulse, frequency, or alarm settings. • Volumetric Pulse • Hardware Alarm • Flow Rate (Frequency) • Empty Pipe • Directional Indication • Range Indication • High/Low Flow Alarms
EMPTY PIPE SENSING	Zero return when electrodes are uncovered
ALARMS	Programmable alarm outputs
DIGITAL TOTALIZER	M-Series restrictive based on pipe size. Cubic Meter, Cubic Centimeter, Mililiter, Liter, Cubic Ddecimeter, Decaliter, Hecaliter, Cubic Inches, American Gallons, Imperial Gallons, Cubic Feet, Standard Barrel, Oil Barrel, Cubic Yard, American Kilogallon, Imperial Kilogallon, Acre Feet, Megagallon, Imperial Megagallon
RATINGS	• Metering Tube: NEMA 6P/IP68 with remote converter (six foot depth continuous submersion) • Electronics enclosure: IP67
CERTIFICATIONS	• Listed by CSA to 61010-1: Certified by CSA to UL 61010-1 and CSA C22.2 No.61010-1-04 • CE Certified (Converter only)

MODEL UM06 AND UM08

ELECTROMAGNETIC FLOW METER



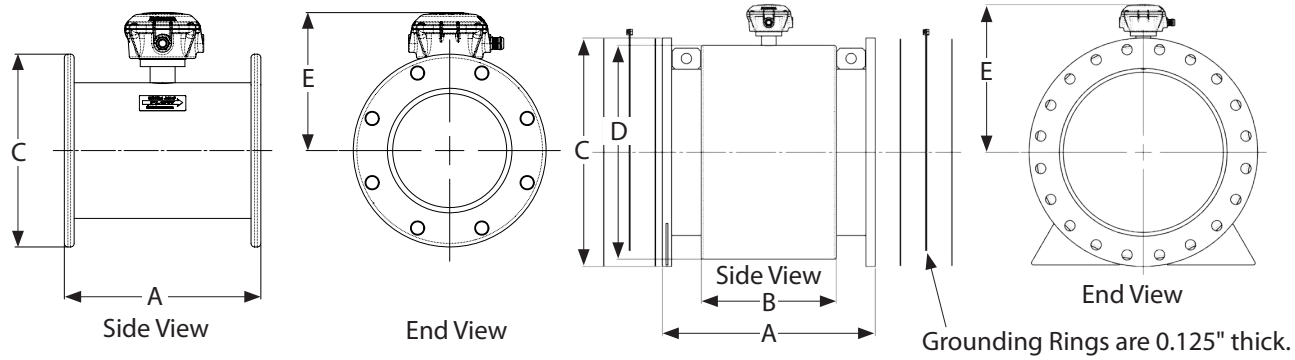
2" and 3" Models Body Style



Bracket mounting holes are 0.27"

F	9.06"
G	5.75"
H	5.75"
I	6.69"
J	5.44"

Converter Dimensions



4" to 12" Models Body Style

14+" Models Body Style

Pipe Size (Nominal)	Meter Pipe ID	Flow Ranges GPM Standard .2 to 32 FPS Min - Max	DIMENSIONS (Lay Lengths)							Estimated Shipping Weight (lbs.)	
			A*		B	C		D	E	UM06	UM08
			UM06	UM08		UM06	UM08				
2"	2.156	2 - 340	11.00	11.00	6.70	6.00	6.50	7.90	9.26	93	107
3"	3.250	5 - 730	13.40	13.40	6.70	7.50	8.25	9.40	10.01	97	111
4"	3.750	8 - 1,140	13.40	13.40	n/a	9.00	10.00	n/a	8.06	78	108
6"	5.750	19 - 2,660	14.60	14.60	n/a	11.00	12.50	n/a	9.06	82	138
Item# 32 → 8"	7.375	33 - 4,870	16.10	17.25	n/a	13.50	15.00	n/a	10.06	115	195
10"	9.750	52 - 7,670	18.50	18.50	n/a	16.00	17.50	n/a	10.46	144	247
12"	11.750	74 - 11,180	19.70	19.70	n/a	19.00	20.50	n/a	12.31	193	342
14"	13.625	90 - 16,070	21.70	22.75	12.00	21.00	23.00	20.30	15..46	321	476
16"	15.625	118 - 20,900	23.60	25.25	14.20	23.50	25.50	21.10	16.21	390	645
18"	17.625	150 - 26,480	23.60	25.25	14.20	25.00	28.00	21.10	17.21	446	750
20"	19.563	185 - 32,720	25.60	28.25	16.20	27.50	30.50	24.80	18.26	588	874
24"	23.500	270 - 47,180	30.70	35.75	21.70	32.00	36.00	29.60	20.11	769	1,568
30"	29.250	420 - 73,620	35.80	41.75	26.50	38.75	43.00	35.90	23.26	1,261	2,317
36"	35.250	610 - 105,930	46.10	46.10	28.20	46.00	50.00	42.70	26.66	1,696	2,915
42"	41.250	830 - 144,370	48.05	**	32.10	52.75	**	48.35	29.99	**	**
48"	47.250	1,080 - 188,430	50.00	**	36.00	59.50	**	54.00	33.31	**	**

(1) 8" 300 gpm

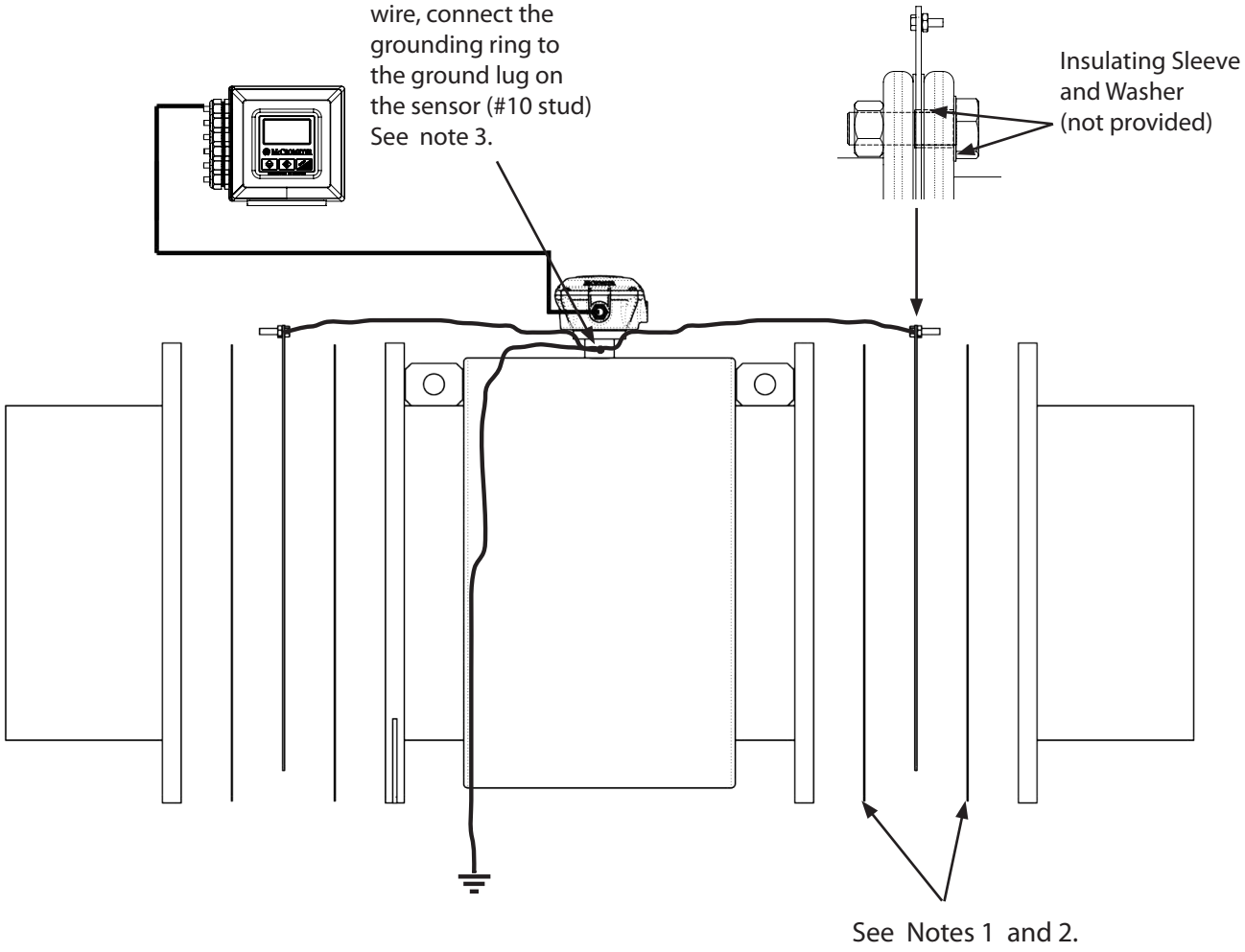
* Laying lengths for meters with ANSI Class 150 Flanges are equal to UM08 laying lengths

** Consult factory

Basic Sensor Wiring And Grounding

Information.

On meters installed on a line with cathodic protection, insulated sleeves and washers must be used on all flange bolts to insulate the meter from the line. Consult your cathodic protection vendor.



Meter & Converter Wiring and Grounding

Information.

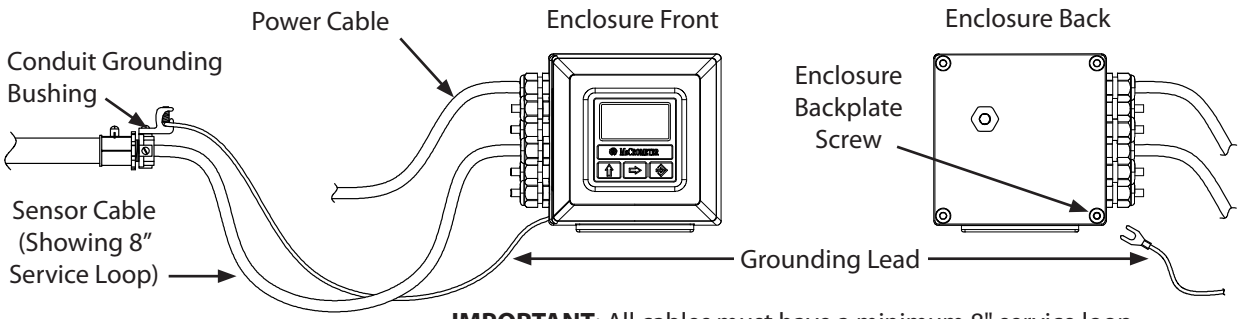
Note #1: Gaskets must be used on either side of the grounding ring to provide a proper seal on the flanges. One gasket is used on the flange end opposite of the grounding ring.

Note #2: Rings & gaskets must align concentrically with the pipe so they do not obstruct or affect flow through the tube.

Note #3: Using 10 awg copper wire, connect the sensor ground lug to plain earth ground (ground bonding). Factory recommends dedicated grounding rod.

Note #4: Grounding ring is optional for sizes 4" to 12". However, the connection of the ground lug to a plain earth ground is still required.

WARNING: Do not connect any form of conduit directly to the converter enclosure. Doing so will allow moisture and potentially dangerous gasses to enter directly into the converter. Attaching any conduit to the enclosure, or altering the enclosure in any way will void the warranty.



IMPORTANT: All cables must have a minimum 8" service loop.

Cable Installation, Service Loop And Bonding To Metallic Conduit

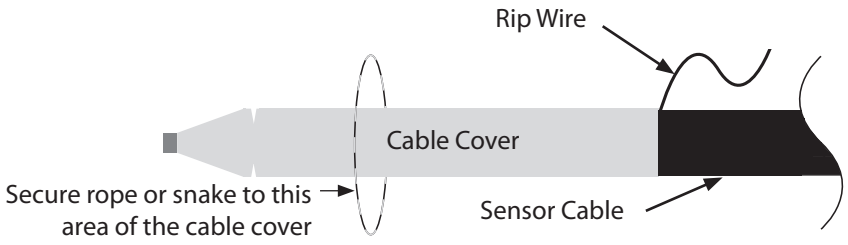
Pulling Sensor Cable Through Electrical Conduit

It is very important to protect the end of the sensor cable when pulling it through a conduit. Water can accumulate in low portions of conduit. Always use the factory supplied cable cover, or similar method, to seal the end of the cable against water when pulling the cable through conduit. *See Figure below*. This will insure proper operation of the meter.

Pulling The Sensor Cable:

1. Tie a rope or cable-snake securely around the middle of the cable cover.
2. Carefully pull the rope or snake until the sensor cable end clears the conduit.
3. Bring the cable end to the converter location. If necessary, secure the cable so that it does not fall back through the conduit.
4. Remove the cable cover by pulling the rip wire. The cable cover will tear off (discard the cover).

Caution: Do not cut the cable cover off. Doing so may damage the sensor cable and adversely effect the calibration of the meter.



Cable Cover

FPI Mag™ Electrical Cable Connections

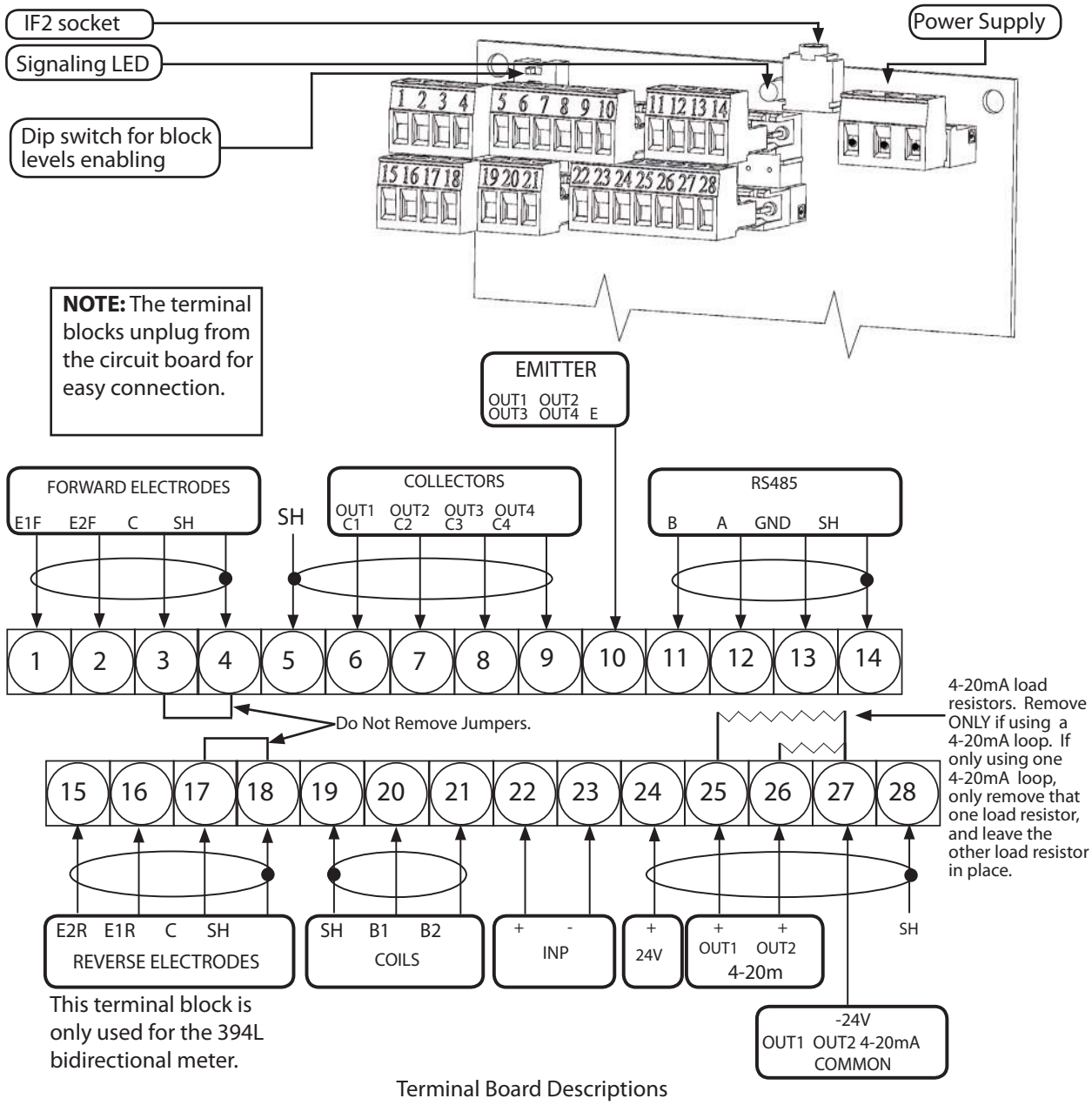
Sensor Electrical Cable Connections

CAUTION - Always disconnect the power cord before attempting any electrical connections.

All electrical cables enter the converter through compression fittings located on the side of the converter. Ensure that all compression glands are properly tightened and all unused fittings are plugged so the case remains sealed.

Terminal Board

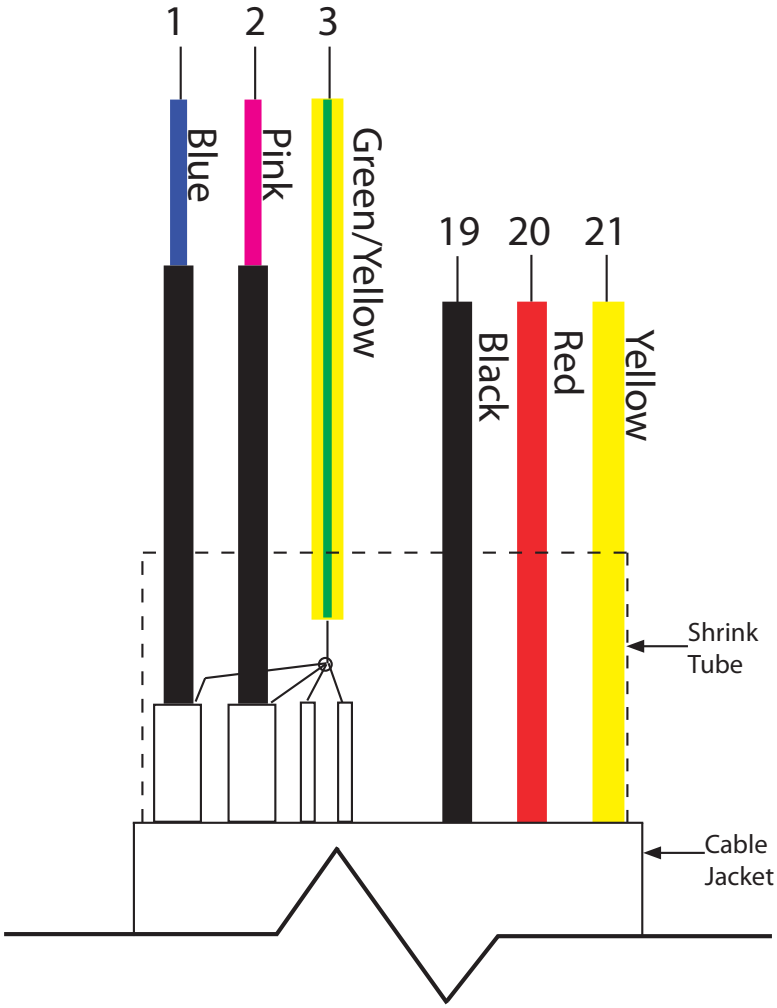
All connections are made on the terminal board. To access the terminal board, loosen the four screws on the back of the converter to remove the rear cover.



Terminal Board Descriptions

Terminal	Wire Color	Connected To
#1 (E1F)	Blue	Right sensing electrodes
#2 (E2F)	Pink	Left sensing electrodes
#3 (C)	Green/Yellow	Ground electrodes Combination of: Purple, green/yellow and drain wires from sensing electrode cables
#19 (SH)	Black	Magnet shield / overall cable shield
#20 (B1)	Red	Coil
#21 (B2)	Yellow	Coil

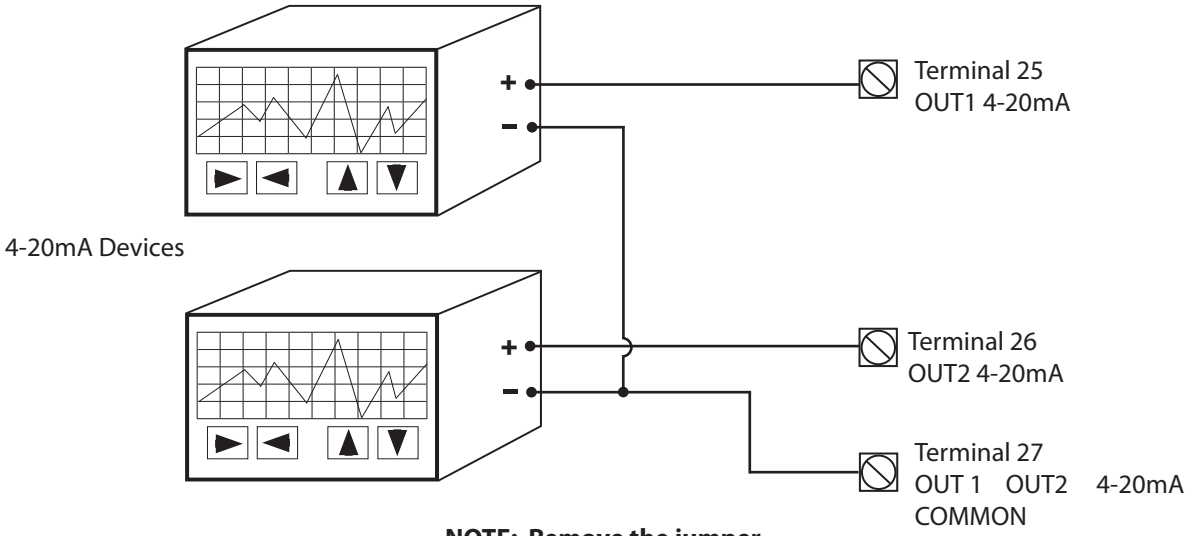
Figure 12: Terminal Block M1 Assignments



Ultra Mag And Mx Ultra Mag Sensor Cable Connections

4-20mA Hook-Up

Isolated 4-20mA current loops are used to output flow data to external devices. Maximum load impedance is 1,000Ω, and the maximum voltage without load is 27VDC. The converter has the capability to detect a loss of load on this output. To disable this function set the value "mA Val. Fault" under the ALARMS menu to zero (*See Section 8.4.6*). A graphical example of the usage of the current loop with external device is shown below:



NOTE: Remove the jumper from terminals 25 & 27 and/ or 26 & 27 before attaching 4-20mA cables. *See Figure 5*.

4-20mA Hook-Up

If the external device requires a voltage input, a precision resistor placed across the input terminals of the external device will change the current to voltage. Calculate the required resistor using Ohm's law (V = I x R). For example, a 250Ω resistor will provide an input voltage of one to five volts with the transmitter range being set from 4mA to 20mA. An additional 4 to 20mA loop output is available.

IMPORTANT

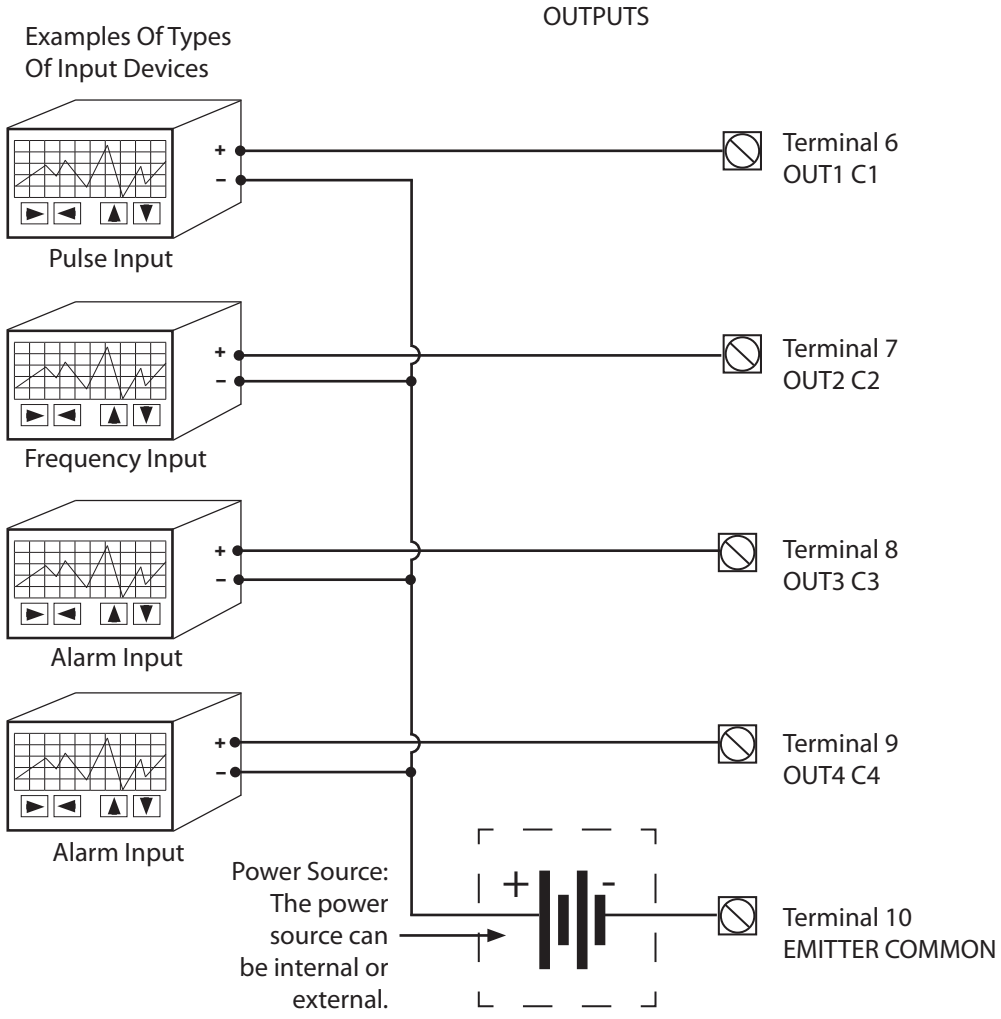
The converter powers the 4-20mA loops. Do not use external power for the 4-20mA loop as it may cause permanent damage to the converter.

Opto-Isolated Pulse Output Hook-Up

The four outputs are open collector transistor outputs used to communicate with or activate external devices when the flow reaches a predetermined set point.

- Opto-isolated output with collector and emitter terminals floating and freely connectable
- Maximum switching voltage: 40 VDC
- Maximum switching current: 100mA
- Maximum saturation voltage between collector and emitter 1.2V@100mA
- Maximum switching frequency (load on the collector or emitter, RL=470Ω, VOUT=24VDC): 1250Hz
- Maximum reverse current bearable on the input during an accidental polarity reversion (VEC): 100mA
- Insulation from other secondary circuits: 500 V

A common application of outputs should be connected as follows:



IMPORTANT

Outputs are not isolated from each other. All outputs MUST use the same power source.

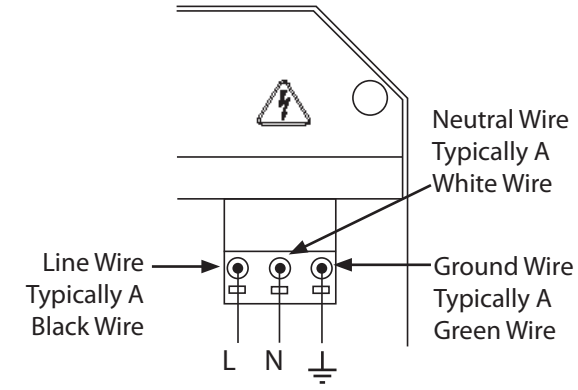
Opto-Isolated Pulse Output Diagram

Converter Power Hook-Up

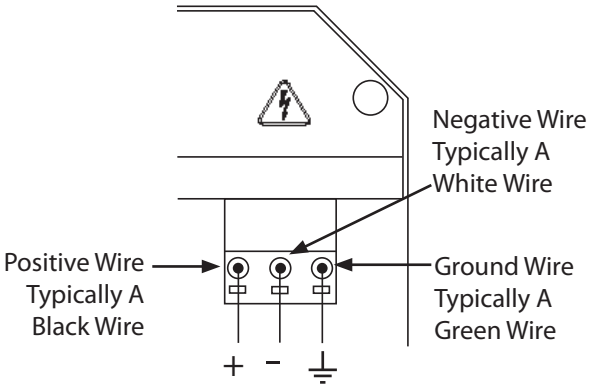
WARNING!! Hazardous supply voltage can shock, burn, or cause death.

The power supply line must be equipped with external surge protection for current overload (fuse or circuit breaker with limiting capacity not greater than 10A). It must be easily accessible for the operator and clearly identified.

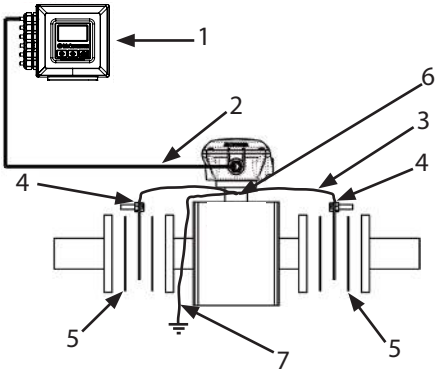
Power connection is made using the power terminal block on the upper right side of the terminal board. **NOTE**: The terminal block uplugs from the circuit board for easy connection. Connect earth ground to the protective grounding terminal before making other connections. The power supply of a standard converter is 90-265VAC, 44-66Hz at maximum 20W. DC converter is available as an option.



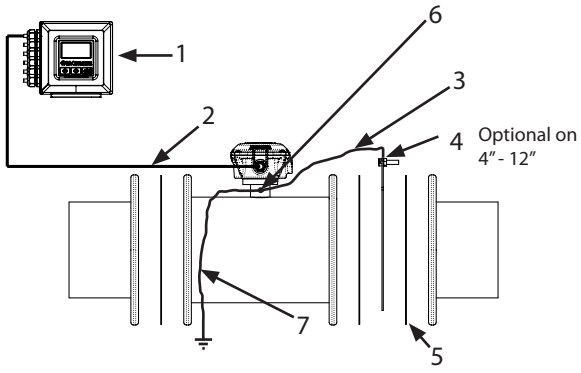
AC Power Supply Terminal Block



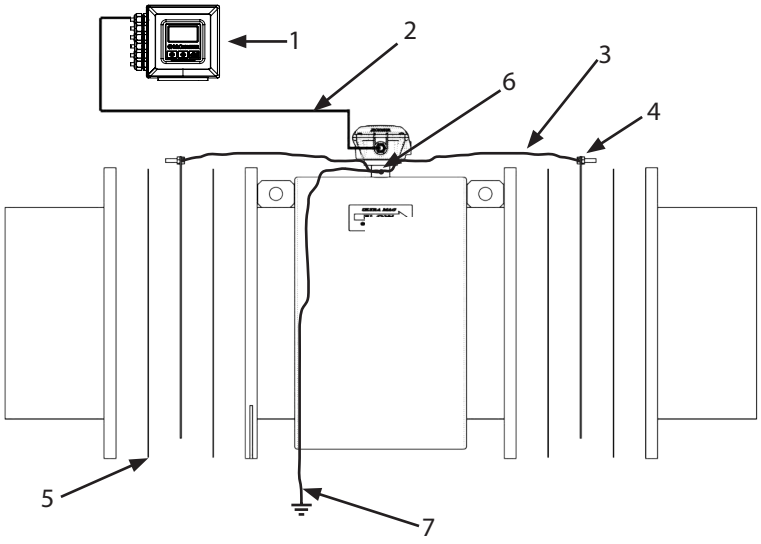
Optional DC Power Supply Terminal Block



2″- 3″ Model



4″ - 12″ Model



4″ And Larger Model

NO.	PART NUMBER	DESCRIPTION
1	880003032	AC Converter (Dual 4-20mA Output)
1	880003042	DC Converter (Dual 4-20mA Output)
1	880003043	AC Converter w/ Modbus RS485 Communications Protocol
2	1-1701-11	Cable Submersible
3	3-2757-‡‡	Grounding Wire Assembly
4	3-2781-*	Grounding Ring, Stainless Steel (Optional on 4″-12″)
5	1-1557-*	Gaskets (Optional)
6	1-1201-10	Nut, Hex, Brass

*** INSERT METER SIZE TO COMPLETE PART NUMBER - INSERT -02 FOR 2″, -04 FOR 4″, -06 FOR 6″, ETC.**

‡‡ 2″ - 6″ INSERT -02; 8″ - 12″, INSERT -08; 14″ -20″, INSERT -14; 24″ -30″, INSERT -24; 36″, INSERT -36

When ordering replacement parts, please specify: Meter Size • Meter Model • Meter Serial Number

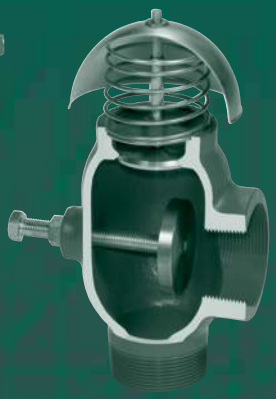
VAL-MATIC®

Protection airValve Efficiency

Bulletin 1500

Item#: 8
1" Combination Air / Vac Valve
Model 201C.2
Typical (3) Places

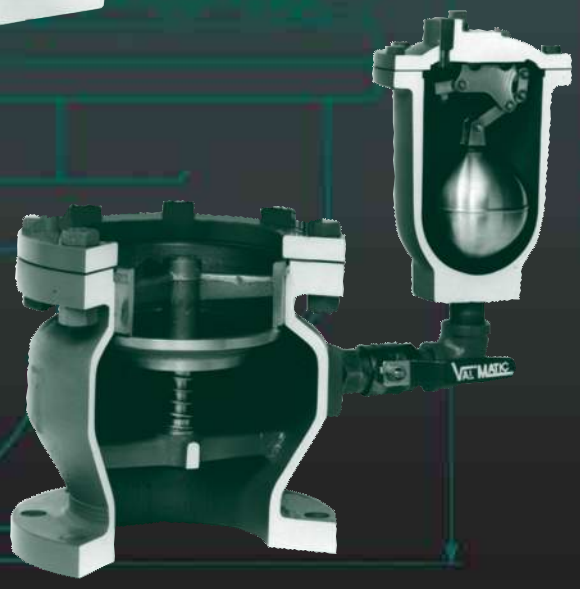
AIR VALVES



PROVIDING SYSTEM EFFICIENCY AND PROTECTION

CLASSIFIED UL WATER QUALITY

NSF/ANSI 61 Certified



AIR & Its Impact on a Water and Wastewater System

One of the most misunderstood aspects of the Water & Wastewater industry is the presence of air in a pipeline and its impact on operations. Many operational problems, especially at the time of initial start-up, including broken pumps, valves and pipe, as well as faulty instrumentation readings, are blamed on inadequate thrust blocking, improper pipeline bedding, etc. In reality, many of these problems are not caused by improper installation of the line, but by failure to de-aerate the line. Properly de-aerating your pipeline will safeguard it from air-related problems, however if no steps are taken to accomplish this, you should be ready for trouble.

SOURCES OF AIR

Air in a pressurized, operating pipeline comes from three primary sources. First, prior to start-up, the line is not empty - it is full of air. To entirely fill a pipeline with fluid, it is necessary to eliminate this air. As the line fills, much of this air will be pushed downstream to be released through hydrants, faucets, etc. but a large amount will become trapped at system high points (Figure 1). This phenomenon will occur because air is lighter than water

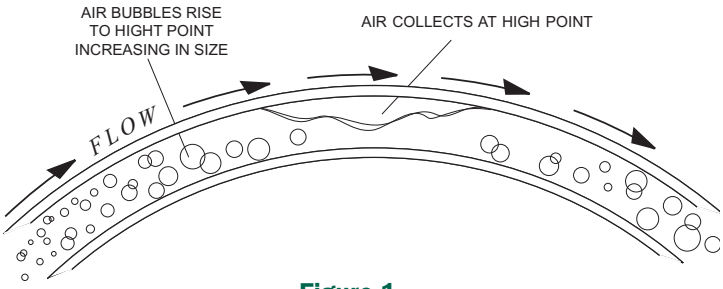


Figure 1
Air in pipeline collects at high points

and therefore, will collect at the high points. This air will continuously be added to by the second and third sources as the system continues operation.

Source number two is the water itself. Water contains approximately 2% air by volume. During system operation, the entrained air will continuously separate out of the water and once again accumulate at system high points. To illustrate the potential massive amount of air this 2% represents, consider the following: A 1000 ft. length of pipe could contain a pocket of air 20 ft. long if all the air accumulated in one location. Or a one mile length of pipe could contain a 100 ft. pocket of air. This would be true regardless of the diameter of the pipe.

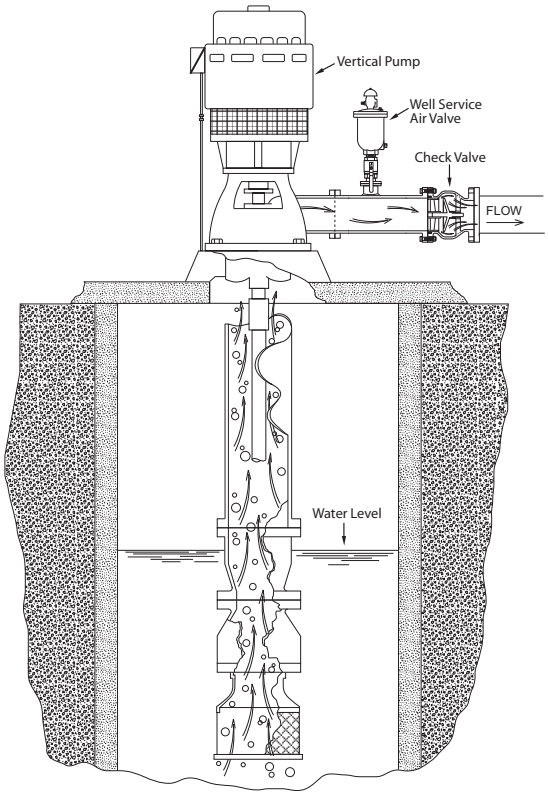


Figure 2
Air entering through mechanical equipment

The third source of air is that which enters through mechanical equipment (Figure 2). This includes air being forced into the system by pumps as well as air being drawn in through packing, valves, etc. under vacuum conditions. As one can see, a pressurized pipeline is never without air and typically the volume is substantial.

IMPACT OF AIR ON SYSTEM

Now that we have identified the air sources, let us consider their impact on the system. Two problems are apparent. The pocket(s) of air accumulating at a high point(s) can result in a line restriction (Figure 3). Like any restriction, the

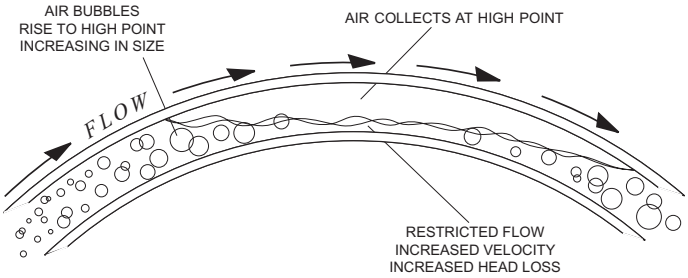


Figure 3
Air pockets can lead to line restriction

pocket(s) of air increases headloss, extends pumping cycles and increases energy consumption. The presence of air can also promote corrosion of pipe and fittings. As air continues to accumulate at system high points, the fluid velocity increases as the fluid is forced through a smaller and smaller opening.

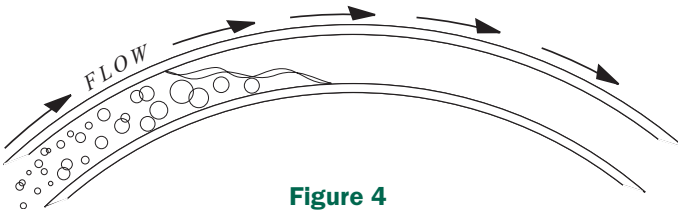


Figure 4
Air pockets can lead to total flow stoppage

As the pocket(s) grows, one of two phenomena will occur. The first possibility is a total flow stoppage (Figure 4). If system dynamics are such that the air cannot be continuously removed by the increased fluid velocity and pushed downstream, then this could happen. As the pocket(s) continues to accumulate air, a pressure drop higher than pump capacity can develop and stop all flow.

The second, and more likely occurrence, is that the increased velocity will cause all, or part of, the pocket to suddenly dislodge and be pushed downstream (Figure 5). The sudden and rapid change in fluid velocity when the pocket dislodges and is then stopped by another high point, can and often will, lead to a high pressure surge (water hammer). Serious damage to valves, fittings, gaskets, or even breakage of the line can occur. This is the most serious of the possible consequences of air being allowed to accumulate in system high points.

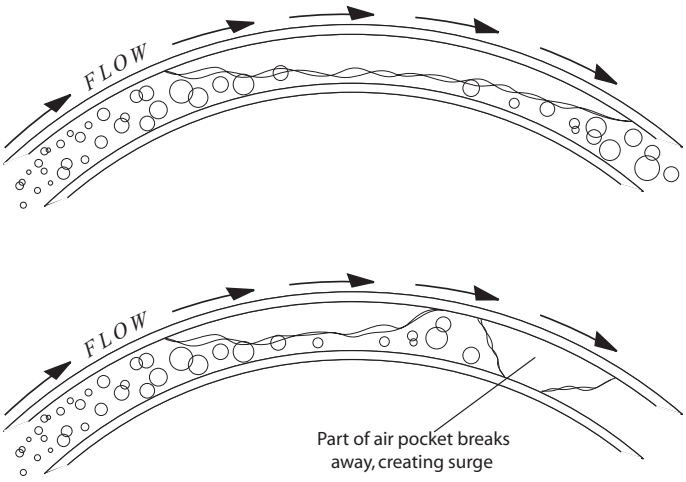


Figure 5
Air pockets can lead to surges in the line

HISTORICAL SOLUTIONS

As we can see, air in a pressurized pipeline is a serious concern. Obviously, its removal will result in a more efficient, cost effective operation and potentially avoid more serious problems. In the early 1900's, engineers and water works personnel started developing an understanding of the problems associated with air and the search for a solution began. Some depended on standpipes, believing that a large portion of the air would be expelled through them.

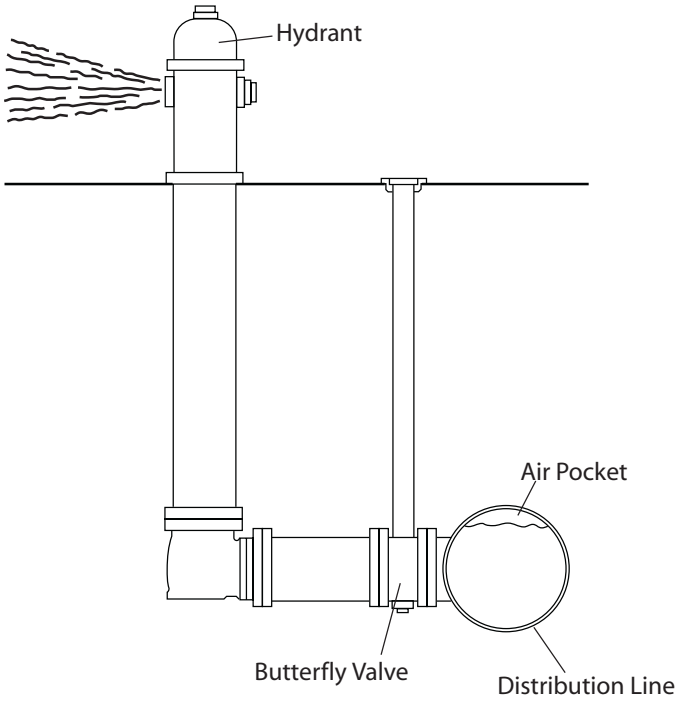


Figure 6
Opening a hydrant may not eliminate air pockets

Many began placing gate or ball valves at system high points to manually bleed off accumulated air. Unfortunately, it has proved impossible to predict when it is time to bleed the air. This proved impractical, especially on larger systems. Open fire hydrants (Figure 6) are frequently used under the assumption that all air in the pipeline will be released. Unfortunately, hydrants are generally connected to the side of the pipe, leaving air trapped at the top and at system high points. It should be noted that there are still municipalities using these methods.

"An added benefit of an Air/Vacuum Valve is its ability to provide pipeline vacuum protection. If a negative pressure develops, the valve will open, admitting air into the line, reducing the potential for surges related to column separation and possible pipeline collapse."

THE AIR VALVE SOLUTION

Today, most municipalities utilize Automatic Air Valves. They are available in many different designs and configurations for a wide range of applications. Their function is to automatically release and admit air without operator assistance. Today, countless Air Valves are performing this task around the globe on a daily basis.

Air Valves are available in three basic configurations (Figure 7): Air Release Valves, Air/Vacuum Valves and Combination Air Valves. Correct sizing and location of all three types are critical. Every high point greater than one pipe diameter where the pipeline converts from a positive grade to a negative grade requires an air valve. Even minimal high points with small air pockets can cause serious surge problems and reduce line efficiency. In addition, it is recommended that air valves be installed every half mile or 2500 feet on straight horizontal runs (AWWA M51). Air Valve Sizing Software is available, see page 27.

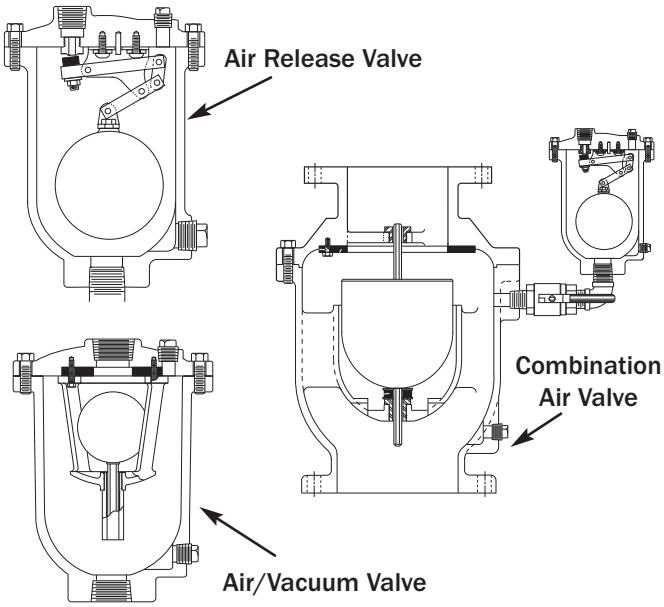


Figure 7
Basic Air Valve configurations

AIR RELEASE VALVES

An Air Release Valve (Figure 8), sometimes referred to as a "small orifice" valve, will continuously release accumulated air during system operation. As air from the pipeline enters the valve, it displaces the water, allowing the float to drop. The air is then released into the atmosphere through a small orifice. As the air is vented it is replaced by water, raising the float and closing the valve orifice. As air accumulates, the valve will continue to cycle in this manner to remove collected air.

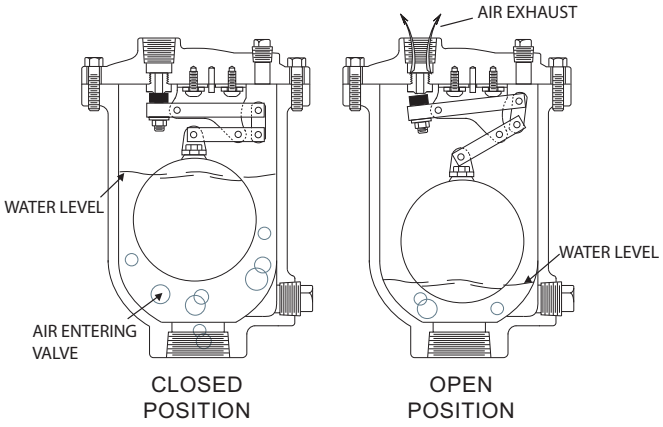


Figure 8
Air Release Valve in Operation

AIR/VACUUM VALVES

Air/Vacuum Valves (Figure 9), sometimes referred to as "large orifice" valves, are used to exhaust large quantities of air upon system start-up, as well as allowing air to re-enter the line upon system shut down or system failure. As water enters the valve, the float will rise, closing the discharge port. The valve will remain closed until system pressure drops to near zero psi. **It will not open to release any accumulation of air while the system is under pressure.**

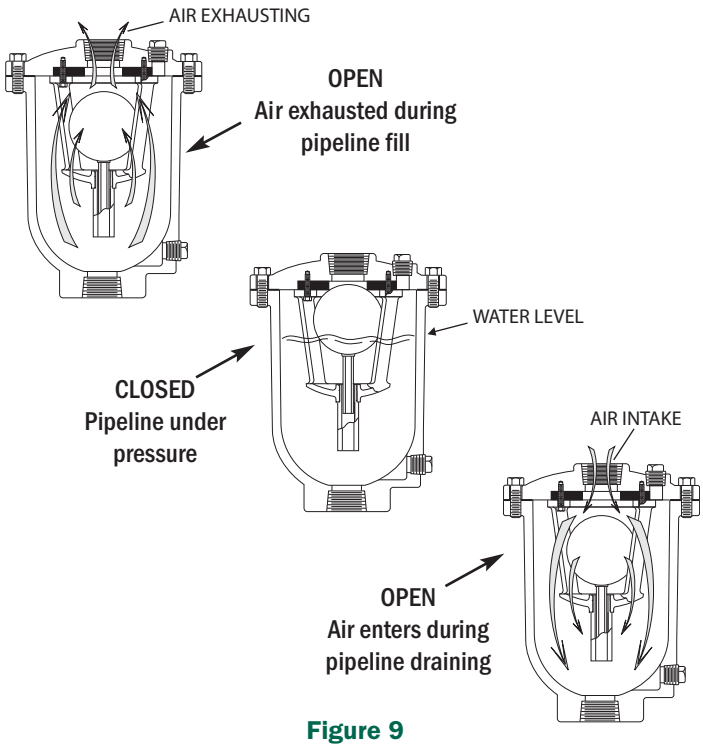


Figure 9
Air/Vacuum Valve Operation

An added benefit of an Air/Vacuum Valve is its ability to provide pipeline vacuum protection. If a negative pressure develops, the valve will open, admitting air into the line, reducing the potential for surges related to column separation and possible pipeline collapse. While Air/Vacuum Valves will exhaust large quantities of air upon start-up, it should be remembered that they will not continuously release air during system operation. For this function, an Air Release Valve is also required.

COMBINATION AIR VALVES

Combination Air Valves (Figure 10) are the most commonly used valves. They perform the functions of an Air/Vacuum Valve (exhaust large quantities of air on start-up, admit air on shut-down) and Air Release Valves (release air continuously during operation). Combination Air Valves are available in single body and dual body (an Air/Vacuum Valve and Air Release Valve piped together) configurations. The single body configuration is more compact and economical. The

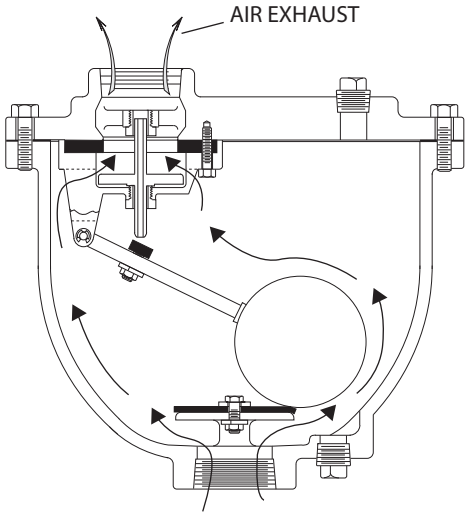


Figure 10
Single Body Combination Air Valve

dual body configuration provides two independent valves so that if maintenance is being performed on the Air Release Valve, the Air/Vacuum Valve is still protecting the pipeline. The dual body valve also provides a much wider range of sizing options.

SURGE-SUPPRESSION AIR VALVES

Pipelines with high points, where pressure transients or column separation can occur should have air valves equipped with slow closing devices (regulated-exhaust device) to restrict the outflow of air (AWWA C512-07). During these conditions, typically caused by unexpected pump shut down, line break, power outage etc., the air valve must allow air to flow rapidly into the pipeline. The large volume of air entering the pipeline will prevent the formation of a severe vacuum pocket and the damaging pressures that can occur when these pockets collapse. When the water columns rejoin and the pressure recovers, the air valve should exhaust the air in a regulated manner to suppress surges. While the pipeline is pressurized and in operation, the Air Valve must continue to automatically release entrained air to maintain the pipeline flow efficiency.

Surge-Suppression Air Valves are Combination Air Valves equipped with Regulated-Exhaust Devices (slow closing devices) as shown in Figure 11. The Regulated-Exhaust

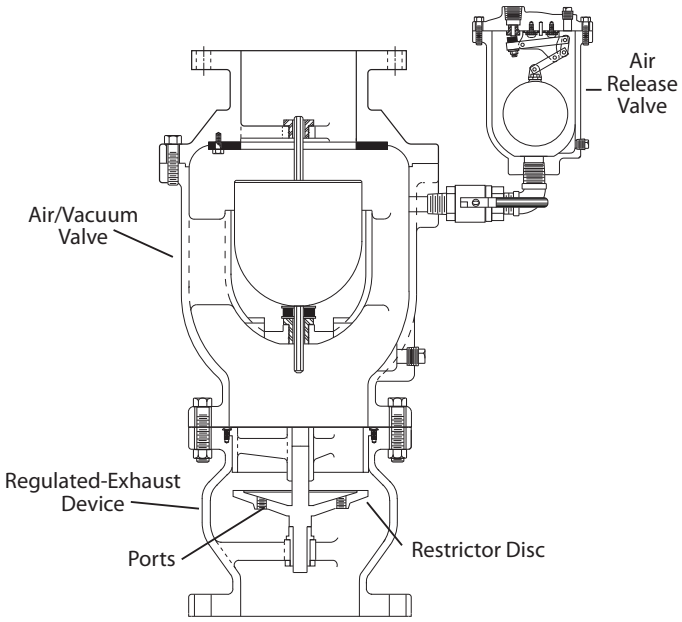


Figure 11
Surge-Suppression Air Valve

Device consists of a flanged or threaded body with a normally-open restrictor disc. The Surge-Suppression Air Valve provides full airflow into the pipeline during vacuum conditions to prevent a vapor pocket (vacuum) from forming. When the pressure recovers and the water column rejoins, air is expelled through the valve, which lifts the restrictor disc. This action regulates the discharge airflow creating an air pocket that cushions the surge effect of the returning water column. When the column reaches the restrictor disc, the water flows through the reduced ports and gently closes the air valve. Transient studies (Kroon 1984, Lingireddy 2004) have shown a dramatic reduction in pressure surges when the exhausting air is controlled under these conditions.

WELL SERVICE AIR VALVES

Well Service Air Valves (Figure 12) are a member of the Air/Vacuum Valve family and are used with vertical pumps. Vertical pumps (Figure 2) lift water from a reservoir or deep well at high velocities because they start against little head

and a pump column filled with air. Well Service Air Valves are specifically designed to vent the air from the pump column during pump start-up in a controlled manner before the check valve opens to reduce pressure surges that result from the accelerating water column.

Val-Matic provides Dual Port Throttling Devices (Figure 12) on the outlet of ½ to 3 in. Well Service Air Valves. The Dual Port Throttling Device regulates the exhaust rate through an adjustable exhaust port and provides full vacuum flow through a separate vacuum port during pump shutdown. This exclusive feature of the Dual Port reduces any potential for contaminated water being drawn into the system by vacuum during the pump shut down.

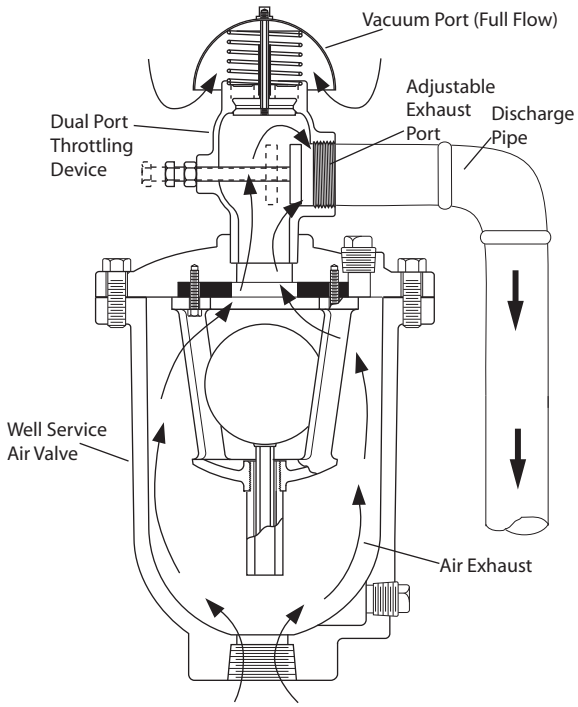


Figure 12
Well Service Air Valve with Dual Port Throttling Device

Val-Matic provides Regulated-Exhaust Devices on the inlet of 4 in. and larger (see Figure 11) Well Service Air Valves. The Regulated-Exhaust Device provides controlled air exhaust during start-up and full vacuum flow during shut down. The device controls the flow of air and water into the air valve and is effective in suppressing water hammer in the pump column and air valve during pump start-up.

VACUUM BREAKER VALVES

For critical applications where vacuum protection is a must or where column separation is predicted, a vacuum breaker (Figure 13) is used. The Vacuum Breaker is mounted at critical pipeline high points, penstocks, or tanks and allows for rapid inflow of atmospheric air to reduce vacuum conditions in piping systems.

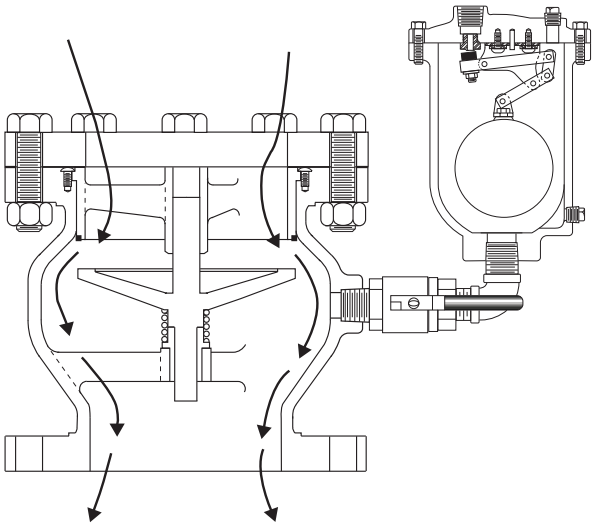


Figure 13
Vacuum Breaker with Air Release Valve (Open Position)

When positive pressure in the system is restored, the Vacuum Breaker provides a positive resilient seal to maintain system pressure. When equipped with an Air Release Valve, the Air Release Valve is used to slowly exhaust the air that was admitted to the pipeline. The slow release of air prevents the sudden rejoining of separated columns in a pipeline and the associated pressure surges or water hammer.

SUMMARY

When air is allowed to accumulate in pressurized pipelines, efficiency is sacrificed and serious damage can occur. A properly de-aerated pipeline will not solve all surge problems; however, the elimination of air can solve one of the most common causes. Air Valves are a cost effective, reliable method of improving efficiency and solving air related surge problems.

REFERENCES

Kroon, R. "Water Hammer: Causes and Effects," AWWA Journal. Nov., 1984. pp. 39-45.

Lingireddy, "Pressure Surges in Pipeline Systems Resulting From Air Releases," AWWA Journal. July, 2004. pp. 88-94.

Combination Air Valves

Operational Highlights:

- Provides the functions of both Air Release and Air/Vacuum Valves
- Exhausts large quantities of air at system start-up
- Releases air pockets during system operation
- Provides pipeline vacuum protection

Product Features:

- Single body incorporates both features within one valve
  - More compact and economical
- Dual body consists of two independent valves
  - Allows individual maintenance while still protecting the pipeline
  - Wider range of sizing options
- Inlets and outlets are equal to full nominal size
- Unconditionally guaranteed stainless steel floats
- Stainless steel 316 internal trim
- Non-clog design eliminates backwashing
- Exclusive high/low pressure resilient seating

Clean Water*

Wastewater

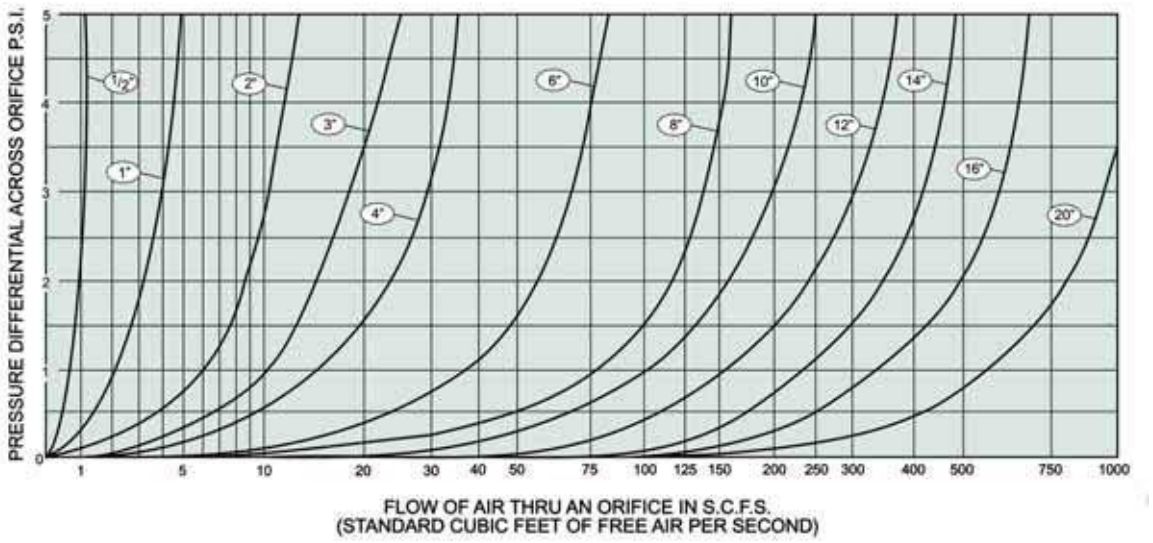
Optional Accessories:

- Outlet hood with screen (prevents debris from entering valves)
- Ball, plug and butterfly isolation valves (allows valve maintenance)
- Inflow Preventer on outlet (stops flood water and resulting contamination from entering pipeline)
- Backwash kit (for severe wastewater applications)

CLASSIFIED UL *WATER QUALITY

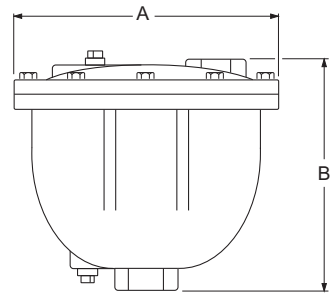
MATERIALS OF CONSTRUCTION		
COMPONENT	**STANDARD**	**OPTIONAL**
Body and Cover	Cast Iron ASTM A126 Class B Class 125 and 250	Ductile Iron ASTM A536 Grade 65-45-12 Stainless Steel ASTM A351 Grade CF8M
Trim	Type 316 Stainless Steel	-
Coating	Universal Alkyd Primer (external)	Non-Stick Fusion Bonded Epoxy (internal & external)

FLOW CAPACITY OF COMBINATION AIR VALVES

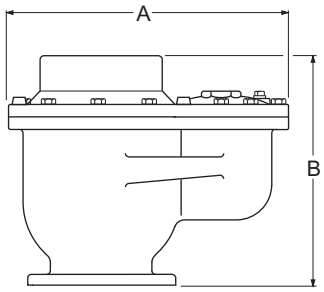


Combination Air Valves
Installation Dimensions

WATER COMBINATION AIR VALVES (SINGLE BODY)						
Inlet Size	Outlet Size	Model Number	CWP PSI	Orifice Size	Dimensions	
					A	B
1" NPT	1" NPT	201C.2	300	5/64"	11 3/8"	10 1/2"
2" NPT	2" NPT	202C.2	300	3/32"	14"	13"
3" NPT	3" NPT	203C.2	300	3/32"	16"	15"
3" 125lb Flg	3" NPT	203C.14	150	3/32"	16"	16 3/4"
3" 250lb Flg	3" NPT	203C.15	300	3/32"	16"	17 1/4"
4" NPT	4" NPT	204C.2	300	3/32"	18 1/2"	17"
4" 125lb Flg	4" NPT	204C.14	150	3/32"	18 1/2"	19 3/4"
4" 250lb Flg	4" NPT	204C.15	300	3/32"	18 1/2"	20 1/4"
6" 125lb Flg	6" NPT	206C	150	3/8"	21"	20 1/4"
6" 250lb Flg	6" NPT	256C	300	7/32"	21"	20 1/4"
8" 125lb Flg	8" NPT	208C	150	3/8"	25"	23 1/2"
8" 250lb Flg	8" NPT	258C	300	7/32"	25"	23 1/2"

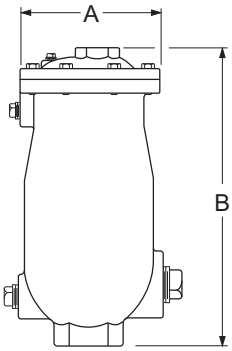


201C.2 - 204C.15
Single Body Combination Air Valves



206C - 258C
Single Body Combination Air Valves

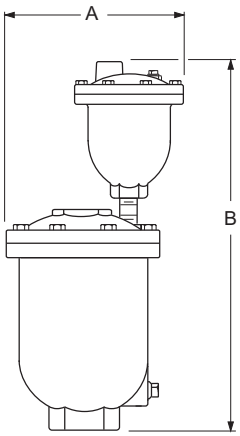
WASTEWATER COMBINATION AIR VALVES (SINGLE BODY)						
Inlet Size	Outlet Size	Model Number	CWP PSI	Orifice Size	Dimensions	
					A	B
2" NPT	1" NPT	801A	150	1/8"	7"	14 15/16"
2" NPT	2" NPT	802A	150	9/64"	9 1/2"	18 1/16"
3" NPT	3" NPT	803A	150	11/64"	11"	23 1/2"
4" NPT	4" NPT	804	150	11/64"	11"	23 1/2"



801A - 804
Wastewater Single Body Combination Air Valves

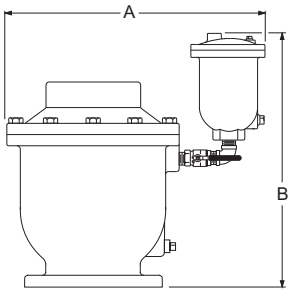
Surge-Suppression Air Valves and Isolation Valves in a pump discharge application.

Combination Air Valves Installation Dimensions



101S/22.9 - 103S/22.9 Dual Body Combination Air Valves

WATER COMBINATION AIR VALVES (DUAL BODY)						
Inlet Size	Outlet Size	Model Number	CWP PSI	Orifice Size	Dimensions	
					A	B
1" NPT	1" NPT	101S/22.9	300	1/16"	7 7/8"	15 5/8"
2" NPT	2" NPT	102S/22.9	300	1/16"	10 1/4"	17 7/8"
3" NPT	3" NPT	103S/22.9	300	1/16"	10 1/4"	18 1/4"



104S/38 - 166F/45.5 Dual Body Combination Air Valves

WATER COMBINATION AIR VALVES (DUAL BODY)						
Inlet Size	Outlet Size Air/Vacuum	Model Number	CWP PSI	Orifice Size Air Release	Dimensions	
					A	B
4" Flg	4" NPT	104S/38 154S/38.5	125lb - 150 250lb - 300	3/16" 5/32"	21"	22"
6" Flg	6" NPT	106S/38 156S/38.5	125lb - 150 250lb - 300	3/16" 5/32"	24"	23"
8" Flg	8" NPT	108S/38 158S/38.5	125lb - 150 250lb - 300	3/16" 5/32"	27"	26"
8" Flg	8" NPT	108S/45 158S/45.5	125lb - 150 250lb - 300	23/64" 7/32"	30"	29"
10" Flg	10" Flg	110F/38 160F/38.5	125lb - 150 250lb - 300	3/16" 5/32"	30"	28"
10" Flg	10" Flg	110F/45 160F/45.5	125lb - 150 250lb - 300	23/64" 7/32"	33"	31"
12" Flg	12" Flg	112F/38 162F/38.5	125lb - 150 250lb - 300	3/16" 5/32"	33"	32"
12" Flg	12" Flg	112F/45 162F/45.5	125lb - 150 250lb - 300	23/64" 7/32"	37"	34"
14" Flg	14" Flg	114F/38 164F/38.5	125lb - 150 250lb - 300	3/16" 5/32"	36"	34"
14" Flg	14" Flg	114F/45 164F/45.5	125lb - 150 250lb - 300	23/64" 7/32"	40"	36"
16" Flg	16" Flg	116F/38 166F/38.5	125lb - 150 250lb - 300	3/16" 5/32"	39"	34"
16" Flg	16" Flg	116F/45 166F/45.5	125lb - 150 250lb - 300	23/64" 7/32"	44"	37"

Installation Instructions for Equipment and Filter Media (7 pages)

Filter Tech Systems, Inc.

2844 Chipeta Avenue Grand Junction, CO 81501

AquaSand Filters
Equipment Installation Instructions
GreenSand^{+} Dual Media Filters

Filter & Project Information:

FTS Project #	4388
For Customer	Weber Basin; Green Road Well

Delivery:

The pre-assembled filter skid will arrive on a flat-bed truck. The contractor is responsible for off-loading the skid and setting it in place.

The filter skid is 24'-6" long x 9'-10" wide x 11'-4" high.

The bottom heads of each filter must be filled with concrete. This will take about 230 gallons of concrete (30 ft^3) per filter.

The contractor is responsible for installing the 8" Sch80 PVC underdrain header and the laterals prior to installing the media.

The contractor is responsible for installing the filter media per the following instructions.

Once the media is installed, the contractor is to install an 8" Sch80 PVC Inlet Distribution Header in each filter.

The contractor is responsible for disinfecting / conditioning the filter media per the following instructions.

Filter Tech Systems, Inc.
2844 Chipeta Avenue Grand Junction, CO 81501

AquaSand Filters
Media Installation Instructions
GreenSand^{+} Dual Media Filters

Filter & Project Information:

FTS Project # 4388

For Customer Weber Basin; Green Road Well

Filter Bed Area: 38.5 Ft^2

Backwash Rates: 192.5 GPM is 5 GPM/Ft^2

385.0 GPM is 10 GPM Ft^2

462.0 GPM is 12 GPM/Ft^2

577.5 GPM is 15 GPM/Ft^2

General

Do not let the bags of media be exposed to direct sunlight, as the bags will rot. Outside storage is generally acceptable as long as the media is covered n protected from the sun. Try not to let the media get frozen by storing it outside. If it does become frozen, it will not become damaged, but it MUST be thawed before it is installed.

Backwash water must be available to clean the media. Installation cannot be done without full backwash flow.

To complete the installation of the media the following water will be required:

577.5 GPM Max for 10 – 12 minutes up to 5 backwash cycles for each of the three filters.

103,950 Gallons Maximum Total

To avoid bed upset maximum backwash rate is 15 GPM/Ft^2 or 577.5 GPM

All layers except the gravel will need to be skimmed to remove the very fine material. Operators can choose to backwash at faster rates and longer times as opposed to doing multiple skimmings, but every layer (except gravel) must be skimmed at least once.

There are many ways to get media into the filter safely and effectively. It can be lowered in bags, dropped down a chute, dropped down a pipe, etc. One method that has worked effectively on large filters is to attach a length of hose to the bottom of a drum or basin. The media is then dumped in the basin and is spread by a person in the filter holding the hose. Otherwise the person in the filter must spread the media with a shovel or rake. With this technique, the hose must be at least 2-1/2" (fire hose) or larger.

To control dust when placing media in the filter, it is effective to place a garden hose in the chute or pipe that the media pours down. Filter masks will still be needed for some personnel, however.

Normally more media is shipped than is required for the depth of each layer. Add only the media required for the proper depth of each layer of grave, regardless of the quantity shipped. Load all of the sand and anthracite.

Media Depths and Layers

From the bottom to the top (in order of installation) per filter

6"	3/4" x 1/2" Gravel	(20) one-cubic foot bags, 100# each
4"	1/2" x 1/4" Gravel	(14) one-cubic foot bags, 100# each
4"	1/4" x 1/8" Gravel	(14) one-cubic foot bags, 100# each
4"	1/8" x 1/16" Gravel	(14) one-cubic foot bags, 100# each
4"	2.0 - 3.0 mm Gravel	(14) one-cubic foot bags, 100# each
18"	0.30 - 0.35 mm GreenSand+	(61) one-cubic foot bags, 85# each
12"	1.0 - 1.1 mm Anthracite	(41) one-cubic foot bags, 50# each

Filter Preparation

1. With the filter empty, mark the height of the gravel layers on the wall of the filter in a visible location.
2. Check that the filter floor is level.
3. Install the underdrain header and laterals. You can leave one or two laterals off so that you have a place to stand while loading the bottom layer of gravel. Care must be taken to avoid getting any gravel into the underdrain header when the laterals are off. Use tap or a rag to plug the open lateral ports on the header. Additionally, laterals must not be left unsupported!

Gravel Installation

The best & quickest way to level the media is by filling the filter with water. The water must enter the filter *slowly* at this point, as air bubbles in new media will cause the layers to mix. If the layers mix, all media must be removed, and the install started from scratch. 5 GPM/Sq Ft or 192.5 GPM should be slow enough.

1. After the filter has been prepped, the first layer to be added is the largest gravel, 3/4" x 1/2". Be very careful not to slip and fall on the underdrain nozzles. Hand pack the gravel under the laterals. When *slightly less* than the calculated amount of gravel has been added, raise the water level to the desired depth (measured against the marked wall), and grade the gravel gently to the level of the water, adding more media if necessary. Add only enough gravel to reach the marked levels. Additional media has been shipped.
2. Next, add the 1/2" x 1/4" gravel following the same procedure as above.

3. Next, add the 1/4" x 1/8" gravel following the same procedure as above. At this point you should stand on plywood or boards to avoid upsetting the graded gravel sections below.
4. Next, add the 1/8" x 1/16" gravel following the same procedure as above.
5. Next, add the 1.0 – 2.0 mm gravel following the same procedure as above.
6. After all gravel is in, do a 12 minute backwash at 5 GPM/SF or 192.5 GPM. Add water to the filter very slowly to avoid upsetting the bed, especially since there will be trapped air bubbles. This backwash will not completely clean the gravel, but it will remove a large percentage of the dust and silt that sits on the gravel.
7. Lower the water to the top of the gravel.

Sand and Anthracite Installation

Procedure

1. Now the layer of 0.30 – 0.35 mm GreenSand+ is ready to be added. This layer is 18" thick. Add all of the GreenSand+ that has been provided for the filter. Spread the GreenSand equally and level it with a 2x4.
2. Fill the filter slowly at 192.5 gpm maximum until the water is spilling out of the backwash effluent port.
3. NEVER BACKWASH AT A RATE HIGHER THAN 5 GPM/SQ FT UNLESS THE SAND IS IN AND THE WATER IS AT THE EFFLEUENT LEVEL.
4. Once water starts pouring over the backwash troughs, increase the backwash rate to 15 GPM/Sq Ft or 577.5 GPM. Hold that rate for 10 – 12 minutes. Drain the filter to about 18" below the top of the GreenSand.
5. There will be a layer of fines on the top of the sand. Remove the top 1/4" of the sand by undercutting with a flat trowel or shovel and discard. Do not rake the material, as this will cause the fines to be pushed into the filter bed.
6. Repeat steps 2 through 5 as required to remove all of the fines. This should remove the extra 1/2" – 3/4" that was added in step 1. At this point all fines should be removed. If they are not, filter runs will be shortened, and backwashing will be needed more frequently than it would be in a fully cleaned bed. It may be necessary to backwash as many as five times as determined by Filter Tech Systems' Technical Representative.
7. Now the filter is ready for the anthracite layer. Allow the water to enter the filter slowly so that it is at least 24 inches above the sand layer. Add the anthracite. Add all of the anthracite that is shipped for filter compartment.
8. Level the anthracite with a rake or 2x4.
9. Allow water into the filter at a rate of 5 GPM/Sq Ft. Fill the filter to 12 – 24" above the media. Allow the anthracite to sit and soak for at least 2 hours so the air can escape the pores in the particles.
10. After the anthracite has been soaked, fill the filter at 5 GPM/Sq Ft. Once water starts pouring oout of the backwash outlet, increase the backwash rate to 15 GPM/Sq Ft or 577.5 GPM. Hold that rate for 10 -12 minutes.
11. Stop the backwash, and drain the filter to 24 – 36" below the anthracite layer. There should be a layer of fines on the top of the anthracite. Remove the top 1/4" – 3/8" of the anthracite by undercutting with a flat trowel or shovel and discard. Do not rake the material, as this will cause the fines to be pushed into the filter bed.

12. Repeat steps 9 through 11 if necessary.

After all of the media is installed, the media must be conditioned and disinfected. Refer to separate instruction sheet.

Inversand Company
SINCE 1925

MINERS AND MANUFACTURERS OF MANGANESE GREENSAND

P.O. BOX 650 • CLAYTON, NEW JERSEY 08312
(856) 881-2345 FAX (856) 881-6859
E-MAIL mail@inversand.com

Conditioning and Disinfecting

Manganese Greensand and GreensandPlus

Before Greensand or Greensand Plus is placed in service, it **MUST** be conditioned by regenerating it. Chlorine, sodium permanganate, or potassium permanganate can be used as the regenerant. The media **MUST** be given a backwash and the fines removed from the bed surface before conditioning (See separate media loading instructions). The following procedure is recommended to properly condition the media.

1. Depressurize the vessel by opening the Rinse or Waste Valve and drain any water to below the lowest manway located on the top side of the tank, so that the tank can be safely accessed from the top.
2. Fill the tank with water until the water level is 4 - 5 inches below the Inlet Distributor, or open manway, whichever is lower.
3. Add the appropriate amount of the selected regenerant. (Refer to the chemical dosages that follow.)
4. Mix the solution in the tank using the air wash system. If air wash is not a part of the system provided, mixing can be accomplished with a suspended sump pump, fabricated air lance, or other device. Mix for approximately 5 minutes.
5. Open the Rinse or Drain Valve until the Greensand/GreensandPlus is soaking in the regenerant solution. If the solution level drops below the media bed surface add more water to the top of the bed to prevent the media from going dry.
6. If using chlorine, analyze the effluent for chlorine to ensure that the media is fully submerged in the chlorine solution. If using permanganate, the effluent will be purple in color, indicating the presence of permanganate.
7. If air is part of your filtering system, turn on the air blower and allow the media and solution to intermix for a period of 5-10 minutes.
8. Allow the filter to sit with the regeneration solution in contact with the media for 4 hours, or, if practical, overnight. If no chlorine residual or purple color when using permanganate, appears in the waste water after the regeneration solution has all been drained through the media bed, repeat Steps 2 through 7 using one-half the regenerant originally called for.

9. Replace the manhole cover and slowly refill the tank through the Backwash Inlet. The air should be exhausted through the Air Vent Valve. After the tank is re-pressurized, rinse the filter to waste at 1/3 the design flow rate until the regeneration solution is flushed. Then continue the rinse at the design flow rate until the water passing to waste is clear, iron and manganese free. The rinse should be stopped at this point and the filter placed in service.

NOTE: It is recommended that the conditioning be done before the anthracite is loaded, if any is required. However, the conditioning may be performed after the anthracite is installed. Just be sure that, if the bed is conditioned with anthracite, following conditioning, the bed is backwashed to restratify the dual media bed.

It is possible to develop a purple color in the solution when undiluted bleach comes in contact with the media. This will not hinder the regeneration process but might increase the rinse time required.

Chemical Dosages:

Every 100 cubic feet of Greensand or GreensandPlus requires:

20 gallons of 15% bleach, or

50 gallons of 6% bleach, or

11.5 gallons of Carusol 20*, or

6 gallons of Carusol 40*, or

25 pounds of potassium permanganate dissolved in 100 gallons of water.

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* Carusol-20 and Carusol-40 are liquid sodium permanganate products produced by Carus Chemical.

APPENDIX

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AGEC

Applied GeoTech

GEOTECHNICAL INVESTIGATION

PROPOSED WELL HOUSE

GREEN ROAD AND HIGHWAY 89

FRUIT HEIGHTS, UTAH

PREPARED FOR:

HANSEN ALLEN AND LUCE
859 WEST SOUTH JORDAN PARKWAY, #200
SOUTH JORDAN, UTAH 84095

ATTENTION: BEN MINER

PROJECT NO. 1200174

MAY 27, 2021

600 West Sandy Parkway • Sandy, Utah 84070 • (801) 566-6399 • www.agecinc.com

TABLE OF CONTENTS

EXECUTIVE SUMMARY. . . . . Page 1

SCOPE. . . . . Page 2

SITE CONDITIONS. . . . . Page 2

FIELD STUDY. . . . . Page 3

SUBSURFACE CONDITIONS. . . . . Page 3

SUBSURFACE WATER. . . . . Page 5

PROPOSED CONSTRUCTION. . . . . Page 5

RECOMMENDATIONS. . . . . Page 6

- A. Site Grading. . . . . Page 6
- B. Foundations. . . . . Page 9
- C. Concrete Slab-on-Grade. . . . . Page 11
- D. Lateral Earth Pressures. . . . . Page 11
- E. Seismicity, Faulting and Liquefaction. . . . . Page 12
- F. Water Soluble Sulfates. . . . . Page 14
- G. Corrosion. . . . . Page 14
- H. Pavement. . . . . Page 15
- I. Preconstruction Meeting. . . . . Page 16

LIMITATIONS. . . . . Page 17

REFERENCES. . . . . Page 18

FIGURES

EXPLORATORY BORING AND CPT LOCATIONS	FIGURE 1
EXPLORATORY BORING LOGS, LEGEND AND NOTES	FIGURE 2
CONSOLIDATION TEST RESULTS	FIGURES 3-4
SUMMARY OF LABORATORY TEST RESULTS	TABLE I

EXECUTIVE SUMMARY

1. Subsurface soils encountered in the borings consist of approximately 1½ and 3½ feet of fill in Borings B-1 and B-2, respectively. Lean clay was encountered below the fill and extends to the full depth investigated, approximately 20½ and 15½ feet in Borings B-1 and B-2, respectively. A silty sand layer was encountered from approximately 11 to 16 feet in Boring B-1.

   The results of CPT soundings are consistent with the conditions encountered in Boring B-1 to the depth of the boring. Clay is identified to a depth of approximately 26 feet. Frequent silty sand and silt layers are identified in the clay below a depth of about 26 feet to the full depth of the soundings, approximately 50½ feet.

2. Subsurface water was measured at a depth of approximately 14 feet below the ground surface in Borings B-1 and B-2 based on measurements taken on May 11, 2021.

3. The proposed buildings may be supported on spread footings bearing on the undisturbed natural soil or on compacted structural fill that extends down to the undisturbed natural soil. Spread footings bearing on the undisturbed natural soil or on compacted structural fill may be designed using an allowable net bearing pressure of 1,500 psf. Spread footings bearing on at least 2 feet of compacted structural fill may be designed using an allowable net bearing pressure of 2,500 psf.

4. The upper natural soil and some of the existing fill consists of clay and will be easily disturbed by construction equipment traffic when the upper soil is very moist to wet. Placement of approximately 1 to 2 feet of granular borrow consisting predominantly of gravel with less than 15 percent passing the No. 200 sieve may be needed to provide limited access for rubber-tired equipment and to facilitate pavement construction when the subgrade is very moist to wet. Consideration may be given to placing a support fabric over the subgrade prior to placing granular borrow.

5. Geotechnical information related to foundations, subgrade preparation, pavement and materials is included in the report.

SCOPE

This report presents the results of a geotechnical investigation for the proposed well house and fluoride building at Green Road and Highway 89 in Fruit Heights, Utah. The report presents the subsurface conditions encountered, laboratory test results and recommendations for foundations and pavement. The study was conducted in general accordance with our proposal dated March 10, 2020 except that a cone penetration test (CPT) was added to the scope of the study to evaluate the liquefaction potential at the site.

Field exploration was conducted to obtain information on the subsurface conditions. Samples obtained from the field investigation were tested in the laboratory to determine physical and engineering characteristics of the on-site soil. Information obtained from the field and laboratory was used to define conditions at the site for our engineering analysis and to develop recommendations for the proposed foundations and pavement.

This report has been prepared to summarize the data obtained during the study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to construction are included in the report.

SITE CONDITIONS

The site consists of an undeveloped field with no structures or pavement. A well has been constructed at the site.

The site has a gentle to moderate slope down to the west. There are several fill piles in the eastern portion of the site.

Vegetation consists of grass, weeds, brush and some trees.

There are residences to the southeast and east. Green Road borders the south side of the site and Highway 89 is to the west. There is vacant land to the north.

FIELD STUDY

Two borings were drilled at the approximate locations indicated on Figure 1 on April 29,2021. The borings were advanced using 8-inch-diameter hollow-stem auger powered by a truck-mounted drill rig. The borings were logged and soil samples obtained by a geologist from AGEC. Logs of the subsurface conditions encountered in the borings are presented on Figure 2.

CPT soundings were conducted at the approximate location indicated on Figure 1 on May 7, 2021. Information obtained from the CPT soundings is presented in the appendix.

SUBSURFACE CONDITIONS

Subsurface soils encountered in the borings consist of approximately 1½ and 3½ feet of fill in Borings B-1 and B-2, respectively. Lean clay was encountered below the fill and extends to the full depth investigated, approximately 20½ and 15½ feet in Borings B-1 and B-2, respectively. A silty sand layer was encountered from approximately 11 to 16 feet in Boring B-1.

The results of CPT soundings are consistent with the conditions encountered in Boring B-1 to the depth of the boring. Clay is identified to a depth of approximately 26 feet. Frequent silty sand and silt layers are identified in the clay below a depth of about 26 feet to the full depth of the soundings, approximately 50½ feet.

A description of the soils encountered in the borings follows:

Fill - The fill in Boring B-2 consists of sandy lean clay to silty sand. It is slightly moist and dark brown. Laboratory tests conducted on a sample of the fill indicate it has a moisture content of 5 percent and a dry density of 115 pounds per cubic foot (pcf).

The fill in Boring B-1 consists of silty gravel with sand. It is slightly moist and grayish brown.

Lean Clay - The clay contains occasional silty sand and silt layers. It is medium stiff to very stiff, slightly moist to wet and brown.

Laboratory tests conducted on samples of the clay indicate it has natural moisture contents of 12 to 23 percent and natural dry densities of 104 to 125 pcf.

Consolidation tests conducted on samples of the clay indicate that the soil will compress a small to moderate amount with the addition of light to moderate loads. Results of the consolidation tests are presented on Figures 3 and 4.

Silty Sand - The sand contains silt layers and occasional thin lean clay layers. It is medium dense, very moist to wet and brown.

Laboratory tests conducted on a sample of the sand indicate it has a natural moisture content of 23 percent.

Results of the laboratory tests are summarized on Table I and are included on the boring logs.

SUBSURFACE WATER

Subsurface water was measured at a depth of approximately 14 feet below the ground surface in Borings B-1 and B-2 based on measurements taken on May 11, 2021.

Slotted PVC pipe was installed in the borings to facilitate future measurement of the water level. Fluctuations in the water level can be expected over time. Generally, water levels are expected to be highest in the spring and summer and lowest in the fall and winter. An evaluation of the fluctuations in the water level is beyond the scope of this report.

PROPOSED CONSTRUCTION

We understand that the proposed pump house and fluoride buildings will consist of single-story, masonry structures with a slab-on-grade floors.

We have assumed building loads consisting of wall loads up to 4 kips per lineal foot.

We understand that pavement will be constructed at the site. We have assumed traffic for the pavement consisting predominantly of car traffic with occasional trucks such as maintenance vehicles.

If the proposed construction, building loads or traffic is significantly different from what is described above, we should be notified so that we can reevaluate the recommendations given.

RECOMMENDATIONS

Based on the subsoil conditions encountered, laboratory test results and the proposed construction, the following recommendations are given:

A. Site Grading

Site grading plans were not provided for our review. We anticipate that there will be relatively small amounts of cut and fill for site grading. We have assumed that the grade in the building areas will be within approximately 3 feet of the existing grade.

1. Subgrade Preparation

   Approximately 1½ to 3½ feet of fill was encountered in the borings. Unsuitable fill, topsoil, organics, debris and other deleterious material should be removed from below the proposed buildings, pavement and other improvements sensitive to differential settlement.

   The upper natural soil and some of the existing fill consist of clay and will be easily disturbed by construction equipment traffic when the upper soil is very moist to wet. Placement of approximately 1 to 2 feet of granular borrow consisting predominantly of gravel with less than 15 percent passing the No. 200 sieve may be needed to provide limited access for rubber-tired equipment and to facilitate pavement construction when the subgrade is very moist to wet. Consideration may be given to placing a support fabric over the subgrade prior to placing granular borrow.

2. Excavation

   Excavation at the site can be accomplished with typical excavation equipment.

A flat cutting edge should be used for excavation equipment when excavating for foundations, to reduce disturbance of the bearing soil.

Excavations that extend below the water table should be dewatered during fill and concrete placement. Fill placed below the original water level should consist of free-draining gravel with less than 5 percent passing the No. 200 sieve.

3. Compaction

Compaction of materials placed at the site should equal or exceed the minimum densities as indicated below when compared to the maximum dry density as determined by ASTM D 1557.

Fill To Support	Compaction
Foundations	≥ 95%
Concrete Flatwork	≥ 90%
Pavement	
Base Course	≥ 95%
Fill Placed Below Base Course	≥ 90%
Landscaping	≥ 85%
Retaining Wall Backfill	85 - 90%

To facilitate the compaction process, the fill should be compacted at a moisture content within 2 percent of the optimum moisture content.

Fill and pavement materials placed for the project should be frequently tested for compaction.

4. Materials

Listed below are materials recommended for imported structural fill.

Fill to Support	Recommendations
Footings	Non-expansive granular soil Passing No. 200 Sieve < 35% Liquid Limit < 30% Maximum size 4 inches
Floor Slab (Upper 4 inches)	Sand and/or Gravel Passing No. 200 Sieve < 5% Maximum size 2 inches
Slab Support	Non-expansive granular soil Passing No. 200 Sieve < 50% Liquid Limit < 30% Maximum size 6 inches

The natural soil and some of the existing fill consist of clay and are not recommended for use as fill below the proposed buildings. The on-site soils may be considered for use as wall or utility trench backfill or site grading fill outside of the proposed building areas if the debris, organics and other deleterious materials are removed or they may be used in landscape areas.

The existing fill that consists of sand and gravel may be considered for use as structural fill if it meets the recommendations given below for imported structural fill.

The moisture content of the soil placed as fill or backfill should be adjusted to within approximately 2 percent of the optimum moisture content to facilitate compaction. Drying of the soil may not be practical during cold or wet times of the year.

Fill placed below the original water level should consist of free-draining gravel with less than 5 percent passing the No. 200 sieve. A filter fabric should be provided between the free-draining gravel and natural soil.

5. Drainage

The ground surface surrounding the proposed buildings should be sloped away from the buildings in all directions. Roof downspouts and drains should discharge beyond the limits of backfill.

The collection and diversion of drainage away from the pavement surface is important to the satisfactory performance of the pavement section. Proper drainage should be provided.

B. Foundations

1. Bearing Material

With the proposed construction and the subsurface conditions encountered, the proposed buildings may be supported on spread footings bearing on the undisturbed natural soil or on compacted structural fill extending down to the undisturbed natural soil. Structural should extend out away from the edge of the footings a distance at least equal to the depth of fill beneath footings.

Topsoil, unsuitable fill, debris and other deleterious materials should be removed from below proposed foundations.

2. Bearing Pressure

Spread footings bearing on the undisturbed natural soil or on compacted structural fill may be designed using an allowable net bearing pressure of 1,500 psf. Spread footings bearing on at least 2 feet of compacted structural

fill may be designed using an allowable net bearing pressure of 2,500 psf. Footings should have a minimum width of 2 feet and a minimum depth of embedment of 1 foot.

3. Temporary Loading Conditions

The allowable bearing pressure may be increased by one-half for temporary loading conditions such as wind or seismic loads.

4. Settlement

Based on the subsurface soil conditions encountered and the assumed building loads, we estimate that total settlement will be less than 1 inch for foundations designed as indicated above. Differential settlement is estimated to be less than ¾ of an inch.

Care will be required to not disturb the natural soil at the base of foundation excavations to maintain settlement within tolerable limits.

5. Frost Depth

Exterior footings and footings beneath unheated areas should be placed at least 30 inches below grade for frost protection.

6. Foundation Base

The base of all footing excavations should be cleared of loose or deleterious material prior to structural fill or concrete placement.

7. Construction Observation

A representative of the geotechnical engineer should observe footing excavations prior to structural fill or concrete placement.

C. Concrete Slab-on-Grade

1. Slab Support

Concrete slabs may be supported on the undisturbed natural soil or on compacted structural fill extending down to the undisturbed natural soil.

Unsuitable fill, topsoil, organics and other deleterious materials should be removed from below proposed floor slab areas.

2. Underslab Sand and/or Gravel

A 4-inch layer of free draining sand and/or gravel (less than 5 percent passing the No. 200 sieve) should be placed below the concrete slabs for ease of construction and to promote even curing of the slab concrete.

D. Lateral Earth Pressures

1. Lateral Resistance for Footings

Lateral resistance for footings placed on the undisturbed, natural soil or on compacted structural fill is controlled by sliding resistance between the footing and the foundation soils. A friction value of 0.35 may be used in design for ultimate lateral resistance.

2. Subgrade Walls and Retaining Structures

The following equivalent fluid weights are given for design of subgrade walls and retaining structures. The active condition is where the wall moves away from the soil. The passive condition is where the wall moves into the soil and the at-rest condition is where the wall does not move. The values listed below assume a horizontal surface adjacent the wall.

Soil Type	Active	At-Rest	Passive
Clay & Silt	50 pcf	65 pcf	250 pcf
Sand & Gravel	40 pcf	55 pcf	300 pcf

3. Seismic Conditions

Under seismic conditions, the equivalent fluid weight should be increased by 39 pcf and 24 pcf for active and at-rest conditions, respectively, and decreased by 39 pcf for the passive condition. This assumes a peak horizontal ground acceleration of 0.65g for a 2 percent probability of exceedance in a 50-year period.

4. Safety Factors

The values recommended above assume mobilization of the soil to achieve the assumed soil strength. Conventional safety factors used for structural analysis for such items as overturning and sliding resistance should be used in design.

E. Seismicity, Faulting and Liquefaction

1. Seismicity

Listed below is a summary of the site parameters that may be used with the 2018 International Building Code.

Description	Value[1]
Site Class	D[2]
S_s - MCE_R ground motion (period = 0.2s)	1.29g
S_1 - MCE_R ground motion (period = 1.0s)	0.48g
F_a - Site amplification factor at 0.2s	1.0
F_v - Site amplification factor at 1.0s	1.82
PGA - MCE_G peak ground acceleration	0.59g
PGA_M - Site modified peak ground acceleration	0.65g

[1]Values obtained from information provided by the Applied Technology Council at https://hazards.atcouncil.org

[2]Site Class D was selected based on the subsurface conditions encountered at the site to the depth investigated and our understanding of geologic conditions.

2. Faulting

The closest mapped active fault to the site is the Wasatch fault zone, approximately 0.3 miles to the east (Utah Geological Survey, 2021).

3. Liquefaction

The site is located within an area mapped as having a "moderate" potential for liquefaction (Anderson and others, 1994).

The liquefaction hazard potential map can be conservative in identifying the potential liquefaction hazard. Research indicates that the soil type most susceptible to liquefaction during a large magnitude earthquake is loose, clean sand. The liquefaction potential for soil tends to decrease with an increase in fines content and density.

A site specific evaluation of the liquefaction potential was conducted. The natural clay and the soil above the groundwater level are not considered to be susceptible to liquefaction. Sand and silt encountered below the water

level may be susceptible to liquefaction. We estimate a potential for liquefaction-induced settlement on the order of ½ inch.

F. Water Soluble Sulfates

One sample of the natural soil was tested in the laboratory for water soluble sulfate content. The test results indicate there is less than 0.1 percent water soluble sulfate in the sample tested. Based on the results of the test and published literature, the natural soil possesses negligible sulfate attack potential on concrete. The concentration of water soluble sulfates present in the soil at the site indicates that sulfate resistant cement is not needed for concrete placed in contact with the natural soil. Other conditions may dictate the type of cement to be used in concrete for the project.

G. Corrosion

One sample of the clay was tested for the following parameters:

Parameter	Value
Resistivity	2,000 ohm-cm
pH	8.1
Redox	386 mV
Sulfides	0.228 ppm (Trace)

The above information should be considered in selecting the appropriate level of corrosion protection for metal placed in contact with the soil.

H. Pavement

Based on the subsoil conditions encountered, laboratory test results and the assumed traffic as indicated in the Proposed Construction section of the report, the following recommendations are given:

1. Subgrade Support

   The near surface soil consists of fill comprised of silty gravel with sand to sandy lean clay and the upper natural soil is lean clay. We have assumed a California Bearing Ratio (CBR) value of 3 percent which represents a clay subgrade.

2. Pavement Thickness

   Based on the subsoil conditions, assumed traffic, a design life of 20 years for flexible pavement and 30 years for rigid pavement and methods presented by AASHTO, a pavement section consisting of 3 inches of asphaltic concrete overlying 6 inches of base course is calculated. Alternatively, a rigid pavement section consisting of 5 inches of Portland cement concrete placed on a prepared subgrade may be considered.

   Approximately 1 to 2 feet of granular borrow may be needed for construction equipment access and to facilitate pavement construction when the subgrade is very moist to wet clay.

3. Pavement Materials and Construction

   a. Flexible Pavement (Asphaltic Concrete)

      The pavement materials should meet the specifications for the applicable jurisdiction. The use of other materials may result in the need for different pavement material thicknesses.

b. Rigid Pavement (Portland Cement Concrete)

The pavement thickness assumes that the pavement will have aggregate interlock joints and that a concrete shoulder or curb will be provided.

Pavement materials should meet the specifications for the applicable jurisdiction. The pavement thickness indicated above assumes that the concrete will have a 28-day compressive strength of 5,000 pounds per square inch. Concrete should be air entrained with approximately 6 percent air. Maximum allowable slump will depend on the method of placement but should not exceed 4 inches.

4. Jointing

Joints for concrete pavement should be laid out in a square or rectangular pattern. Joint spacings should not exceed 30 times the thickness of the slab. The joint spacings indicated should accommodate the contraction of the concrete and under these conditions steel reinforcing will not be required. The depth of joints should be approximately one-fourth of the slab thickness.

I. Preconstruction Meeting

A preconstruction meeting should be held with representatives of the owner, project architect, geotechnical engineer, general contractor, earthwork contractor and other design team members to view construction plans, specifications, methods and schedule.

LIMITATIONS

This report has been prepared in accordance with generally accepted soil and foundation engineering practices in the area for the use of the client for design purposes. The conclusions and recommendations included within the report are based on the information obtained from the borings drilled and CPT soundings at the approximate locations indicated on Figure 1 and the data obtained from laboratory testing. Variations in the subsurface conditions may not become evident until additional exploration or excavation is conducted. If the subsurface conditions or groundwater level is found to be significantly different from what is described above, we should be notified to reevaluate the recommendations given.

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

Jay R. McQuivey, P.E.

Reviewed by Douglas R. Hawkes, P.E., P.G.

JRM/bw

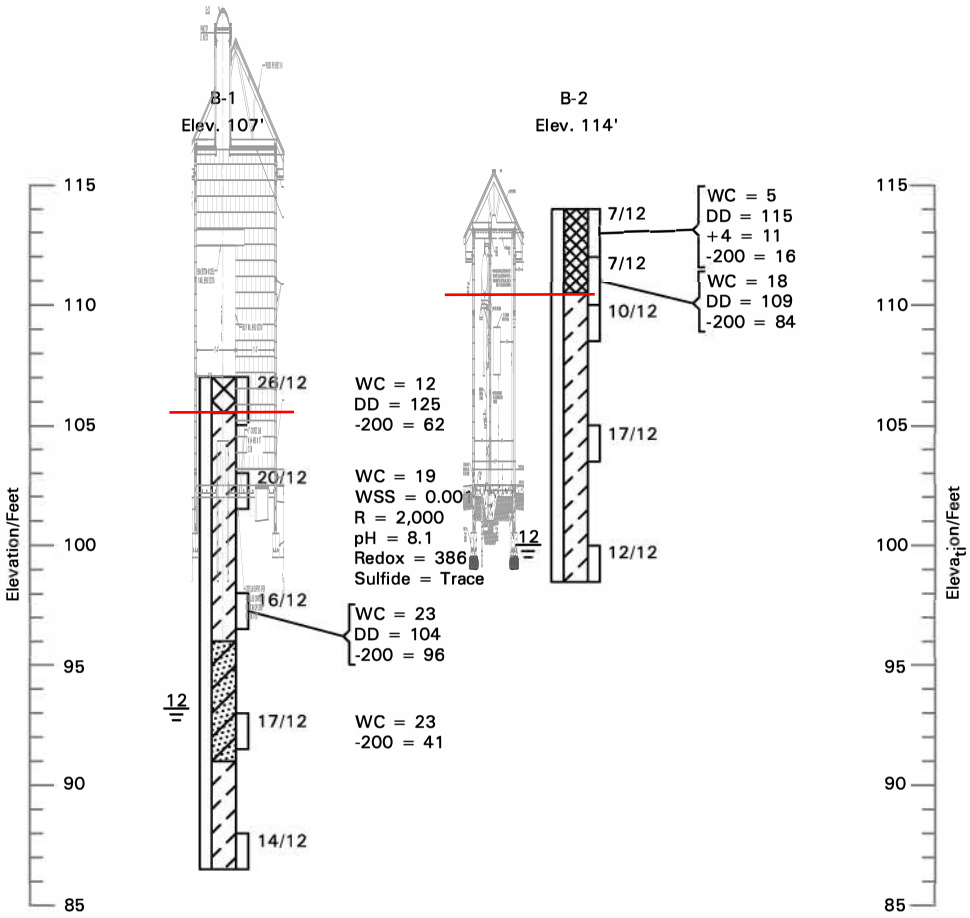
REFERENCES

American Society of Civil Engineers, 2017; Minimum design loads and associated criteria for buildings and other structures: ASCE/SEI 7-16, Reston, Virginia.

Anderson, L.R., Keaton, J.R., Aubrey, K. and Ellis, S., 1994; Liquefaction Potential Map for Davis County, Utah; Utah Geological Survey Contract Report 94-7.
International Code Council, 2017; 2018 International Building Code, Falls Church, Virginia.

Utah Geological Survey, 2021; Utah Quaternary Fault and Fold Database, http://geology.utah.gov/apps/qfaults/ Accessed May 25, 2021.

1200174	AGEC	Exploratory Boring and CPT Locations	Figure 1



Approximate Vertical Scale 1" = 8"

LEGEND:

Fill; sandy lean clay to silty sand, slightly moist, dark brown.

Fill; silty gravel with sand, slightly moist, grayish brown.

Lean Clay (CL); occasional silty sand and silt layers, medium stiff to very stiff, slightly moist to wet, brown.

Silty Sand (SM); silt layers, occasional thin lean clay layers, medium dense, very moist to wet, brown.

10/12 California Drive sample taken. The symbol 10/12 indicates that 10 blows from a 140 pound automatic hammer falling 30 inches were required to drive the sampler 12 inches.

Indicates slotted 1½ inch PVC pipe installed in the boring to the depth shown.

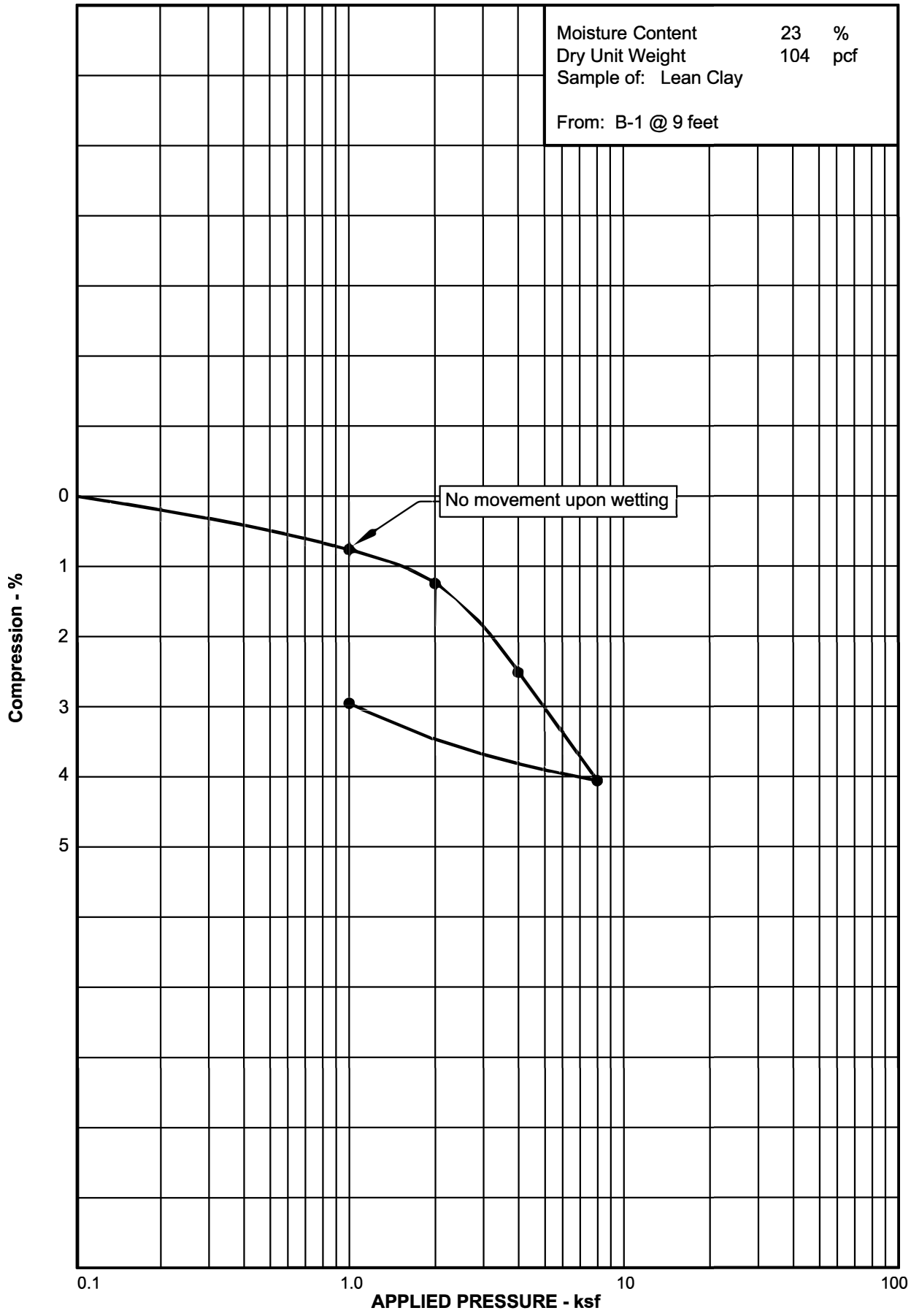
12 Indicates the depth to free water and the number of days after drilling the measurement was taken.

NOTES:

1. The borings were drilled on April 29, 2021 with 8-inch diameter hollow-stem auger.
2. The locations of the borings were measured approximately by pacing from features shown on the site plan provided.
3. The elevations of the borings were measured by automatic level and refer to the benchmark shown on Figure 1.
4. The boring locations and elevations should be considered accurate only to the degree implied by the method used.
5. The lines between materials shown on the boring logs represent the approximate boundaries between material types and the transitions may be gradual.
6. The water level readings shown on the logs were made at the time and under the conditions indicated. Fluctuations in the water will occur with time.
7. WC = Water Content (%);
   DD = Dry Density (pcf);
   +4 = Percent Retained on the No. 4 Sieve;
   -200 = Percent Passing the No. 200 Sieve;
   WSS = Water Soluble Sulfates (%);
   R = Resistivity (ohm-cm);
   pH = pH;
   Redox = Redox Potential (mV);
   Sulfide = Sulfide Content (negative, trace, positive).

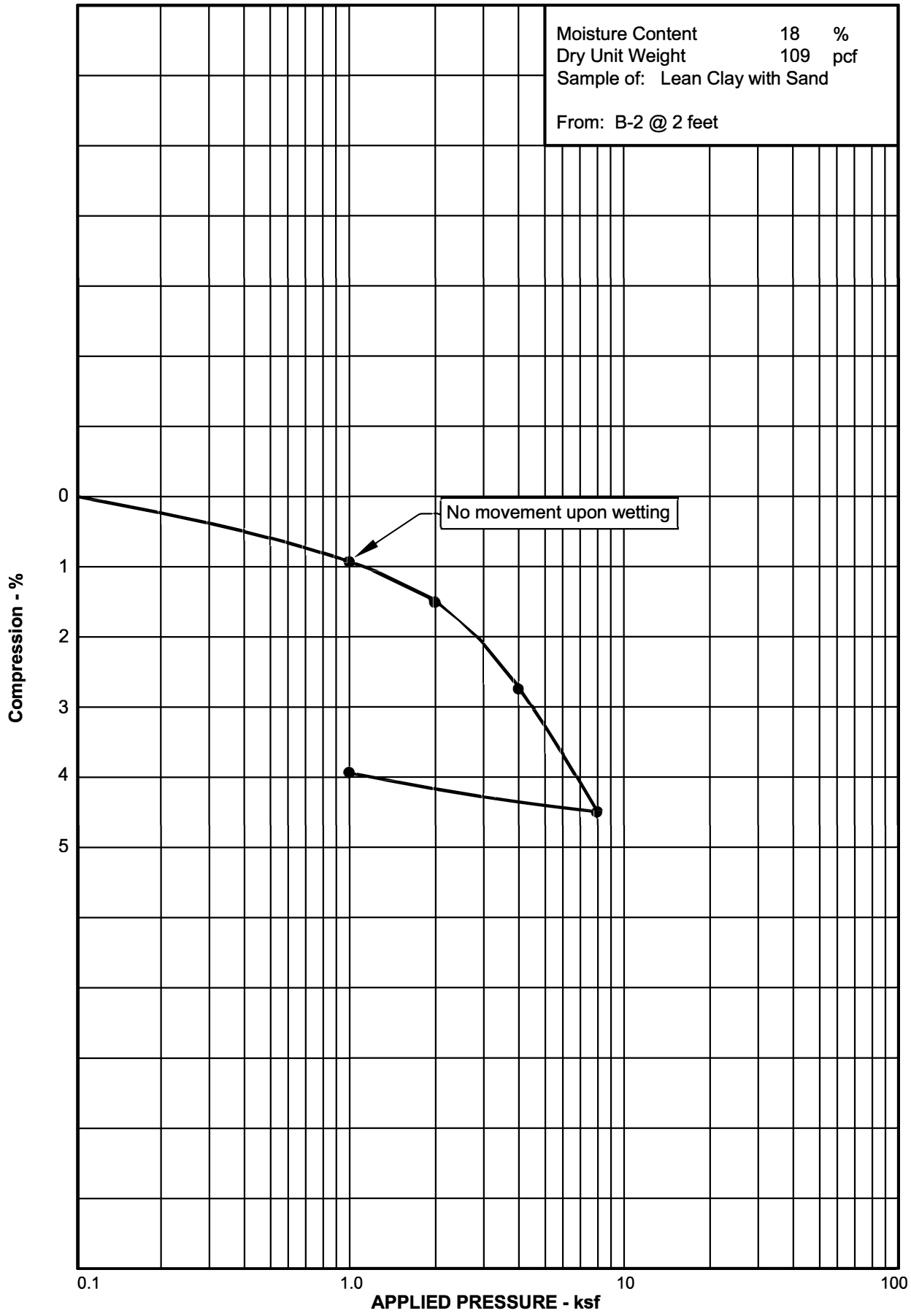
1200174	AGEC	Exploratory Boring Logs, Legend and Notes	Figure 2

Applied Geotechnical Engineering Consultants, Inc.



Project No. 1200174 **CONSOLIDATION TEST RESULTS** **Figure 3**

Applied Geotechnical Engineering Consultants, Inc.



Project No. 1200174 **CONSOLIDATION TEST RESULTS** **Figure 4**

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

PROJECT NUMBER: 1200174

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (PCF)	GRADATION			RESISTIVITY (OHM-CM)	pH	REDOX (MV)	SULFIDE	WATER SOLUBLE SULFATE (%)	SAMPLE CLASSIFICATION
BORING	DEPTH (FEET)			GRAVEL (%)	SAND (%)	SILT/ CLAY (%)						
B-1	0	12	125			62						Sandy Lean Clay
	4	19					2,000	8.1	386	Trace	0.001	Lean Clay
	9	23	104			96						Lean Clay
	14	23				41						Silty Sand
B-2	0	5	115	11	73	16						Fill; Silty Sand
	2	18	109			84						Lean Clay with Sand

APPENDIX

CPT RESULTS

AGEC
Applied GeoTech

600 W. Sandy Parkway
Sandy, UT 84070

CPT: CPT-1
Total depth: 50.52 ft, Date: 5/7/2021
Surface Elevation: 107.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Nova
Cone Operator: Nate Salazar

Project: **1200174**
Location: **Fruit Heights Well House**